Preface

As we enter the 21st century, we reflect on the important contributions of the biological sciences to modern society. As biologists have studied life, we have gained greater understanding of human life processes and have become more aware of our interdependence with the vast diversity of organisms with which we share our planet. With new advances in biological research, our lives have become healthier, safer, more comfortable, and also more challenging.

One of our principal goals in developing *Biology*, fifth edition, has been to share with beginning biology students our sense of excitement about the biological sciences. We want students to understand and appreciate the diverse organisms on Earth, their remarkable adaptations to the environment, and their evolutionary and ecological relationships. Special emphasis is placed on the basic unity of life and the fundamental similarities of the challenges that have been faced and solved by all living organisms. We are very aware of our responsibility to impress upon our readers our interdependence with the many life forms with which we share planet Earth.

Important Features of the Fifth Edition

The evolution of *Biology* through its editions reflects the advances in the biological sciences and in biological education. Every effort has been made to update its content and pedagogy so that the book accurately presents modern biology.

As in the fourth edition, a significant effort was made in the preparation of this edition to speak directly to students and determine how they use the text and what might be done to enhance its efficacy in teaching biology. To that end, focus groups of students from many colleges and universities were conducted to gauge how students felt we could improve the utility of the text, artwork, and pedagogy. Students met with our editors and told them how they study, which pedagogical elements are most helpful, and which pieces of art are effective (or ineffective) in helping them learn the subject matter.

Themes

Throughout the book, we emphasize three basic themes of biology: transmission of information, evolution of life, and 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. In this new edition, we also emphasize the process of science and the role of the many scientists who have contributed to our current understanding of biology.

The author team

Rapid advances in the biological sciences require a multiauthor team who specialize in particular areas of biology. The author team of the fifth edition includes Dr. Eldra Solomon, zoologist and physiologist; botanist Dr. Linda Berg; and cell biologist/geneticist Dr. Diana Martin. We also acknowledge the legacy of Dr. Claude A. Villee, Professor Emeritus, Harvard University, who contributed to previous editions. All of the authors are experienced college biology teachers.

Tools for learning

Learning the principles of biology is a challenging endeavor. A variety of learning aids are included within the textbook to help the student achieve mastery of the concepts presented.

1. Each **chapter introduction** provides an overview to the chapter contents and ties it to material in previous chapters.
2. **Learning Objectives** that follow the chapter introduction indicate in behavioral terms what the student must be able to do in order to demonstrate mastery of the material in the chapter.
3. **Concept-statement heads** introduce each section, previewing and summarizing the key idea(s) that will be discussed in that section. The subheadings provide a concise outline of the chapter's contents.
4. **Making the Connection** boxes and **Focus On** boxes facilitate integration of concepts, spark interest, and reinforce the scientific process. For example, *Making the Connection: Terrestrial-Aquatic Linkages and the Detritus Connection* in Chapter 54 describes recent field evidence that supports a long-held assumption that a forest provides a stream flowing through it with an important energy input in the form of detritus. *Focus On Mammalian Cloning* in Chapter 16 emphasizes the scientific process as

it relates the groundbreaking research of Ian Wilmut and coworkers in cloning a sheep from a cultured mammary gland cell.

5. **On the Cutting Edge** boxes present exciting research areas that are currently being explored. In Chapter 19, for example, *On the Cutting Edge: Explaining the Rapid Loss of Cichlid Diversity in Lake Victoria* discusses how hybridization caused by human-induced changes in habitat is destroying cichlid species in Lake Victoria.
6. Numerous **tables,** many of them illustrated, summarize and organize material presented in the text. *Table 52–1: Ecological Interactions among Species* in Chapter 52 is an example of a table that is new to the fifth edition.
7. Carefully rendered **illustrations,** many of them new in this edition, support concepts covered in the text. Many of the illustrations are sequential, with close-ups "exploded" to reveal greater detail. Composite pieces of line art and photographs help students to interpret electron micrographs. **Scale bars** accompany micrographs to provide information regarding magnification. As requested by student focus groups, **figure legends** in the fifth edition identify each micrograph as a LM, TEM, or SEM. Figures 17–15 (phylogenetic tree of selected primates) and 22–4 (monophyletic, paraphyletic, and polyphyletic taxa) are examples of line art that are new to the fifth edition.
8. **Sequence Summaries** highlight with a beige background reviews of sequential material discussed in the text. For example, Chapter 33 contains two new sequence summaries, phloem loading at the source and phloem unloading at the sink.
9. **Boldface terms** facilitate identification of key terms and their definitions, and provide emphasis. Chapter 55, for example, introduces and defines the term *biotic pollution* and then discusses its impact on threatened and endangered species.
10. A **Summary With Key Terms** in outline form at the end of each chapter provides a review of the material presented. New to this edition is the integration of boldfaced selected key terms with the summary, enabling students to study vocabulary words in context with related concepts.
11. A **Post-Test** provides students with the opportunity to evaluate their mastery of the material in the chapter. In the fifth edition, these questions are multiple choice, as requested by students and professors. For example, examine the Post-Test at the end of Chapter 3; some questions are based on the recall of important terms, whereas other questions challenge students to integrate their knowledge. Answers are provided in Appendix A.
12. **Review Questions** test knowledge of important concepts and applications. They are designed to help students test their mastery of the chapter learning objectives. New to the fifth edition are quantitative problems on population genetics (see Chapter 18 Review Questions). Answers to all Review Questions in chapters 10 and 18 are provided in Appendix A.
13. **You Make the Connection** questions (1) challenge the student to relate information in the chapter to principles in other chapters or (2) require the student to apply concepts to new situations. These questions can be used for class discussions or essay assignments. Examples of You Make the Connection questions that are new to the fifth edition include numbers 1, 2, and 4 in Chapter 7.
14. A list of **Recommended Readings** at the end of each chapter provides references for further learning. All lists have been updated from the last edition; examine the Recommended Readings for Chapter 52, all of which are new to this edition. Each Recommended Readings list ends with the address of our website, where students can find links to additional resources on the World Wide Web.
15. **Career Visions** present a variety of professional possibilities in the biological sciences for students to explore. An interview with a professional who majored in biology is presented at the end of each of the book's eight parts. Interviewees discuss how they decided on and prepared for their career and what they do professionally. Two examples of careers new to the fifth edition are renal dietitian and aquarist.
16. **To the Student,** which appears immediately before the Contents, is newly conceived in this edition to offer students specific, tried-and-true advice on how to prepare, study, and succeed in introductory biology courses.
17. A separate **Glossary,** expanded for the fifth edition, facilitates rapid definition of terms. As in the fourth edition, vertical color bars along the margin facilitate rapid access to the Glossary.
18. **Appendices** provide post-test answers, the complete periodic table of the elements (new to this edition), an overview of biological classification, career information, understanding biological terms, and abbreviations used in the text. Scientific measurement is located inside the back cover for easy access.

THE ORGANIZATION OF *BIOLOGY*, FIFTH EDITION

Educators present the major topics of an introductory biology course in a variety of orders. A lack of consensus regarding sequence of topics is understandable because reasonable arguments can be advanced for each of the many possible combinations and permutations. All aspects of biology are intimately related, and each could be grasped much more readily if all other topics had been mastered previously. Because this feat cannot be accomplished, each instructor must select the topic sequence that seems most reasonable. For this reason, we have carefully designed each of the eight parts so that they do not depend heavily on preceding chapters and parts. The eight parts and their chapters can be presented in any number of sequences with pedagogical success.

The content updates and changes to the fifth edition are far too numerous to list. In this brief survey of the eight parts of *Biology,* we include representative examples of what is new.

Part 1: The Organization of Life

Chapter 1, A View of Life: Basic Concepts of Biology, introduces several major concepts of biology, including the fundamental similarities of all living things; the organization of life on individual and ecological levels; the transfer of information; the evolution of life; the diversity of life and how biologists classify organisms; energy transfer among organisms; and how science works. Chapters 2 and 3 focus on the molecular level of organization and lay the foundations in chemistry needed for an understanding of biological processes. Chapters 4 and 5 focus on the cellular level of organization, with emphasis on recent advances in cell biology. New and expanded discussions of cell signaling appear in the information transfer section of Chapter 1 and in Chapter 5.

Part 2: Energy Transfer Through Living Systems

Part 2, which focuses on the metabolism and energy transactions involved in life processes, has been extensively revised for this edition. Chapter 6 introduces energy in cells and organisms. 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. Examples of new line art in Chapter 6 include Figure 6–2, which distinguishes between closed and open systems, and Figure 6–16, which illustrates feedback inhibition.

Part 3: The Continuity of Life: Genetics

Because knowledge is advancing so rapidly in the field of genetics, Part 3 has been extensively updated. This unit begins with a discussion of mitosis and meiosis in Chapter 9. Chapter 10 describes Mendelian genetics and related patterns of inheritance. Chapter 11 discusses the structure and replication of DNA, and Chapter 12 presents RNA and protein synthesis. Gene regulation is discussed in Chapter 13. In Chapter 14, we focus on genetic engineering; and in Chapter 15, we focus on human genetics. In Chapter 16, we introduce the role of genes in development, including the latest findings in this exciting and rapidly changing area of biology. The fifth edition places greater emphasis on the significance of genetics in our lives; Chapter 15, for example, contains a new section on the issue of genetic discrimination.

Part 4: The Continuity of Life: Evolution

The unit on evolution has been revised for this edition. Chapter 17 introduces Darwinian evolution and presents scientific evidence for 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. New to the fifth edition are a section on the testing of evolutionary hypotheses experimentally in Chapter 17 and a discussion of recently discovered fossil finds in early hominid evolution in Chapter 21.

Part 5: The Diversity of Life

An evolutionary framework is used in our survey of the kingdoms of organisms. In Chapter 22, we discuss why and how organisms are classified. Chapter 23 is devoted to the viruses and bacteria. Chapter 24 describes the protists, and Chapter 25 describes the fungi. Chapters 26 and 27 present the members of the plant kingdom. Chapters 28 through 30 focus on the diversity of animals. The discussion of each group of organisms focuses on their evolutionary relationships and on their structural and functional adaptations. In this edition, discussion of both the kingdom/domain debate and cladistics has been expanded in Chapter 22.

Part 6: Structure and Life Processes in Plants

This part integrates plant structure and function, beginning in Chapter 31 with a discussion of 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. New topics include *On the Cutting Edge: Mycorrhizae and Carbon Exchange between Plant Species in a Forest Ecosystem* in Chapter 34, *Making the Connection: Flowers and Evolution* in Chapter 35, and new material on the basic mode of action of all plant hormones in Chapter 36.

Part 7: Structure and Life Processes in Animals

This part emphasizes the structural, functional, and behavioral adaptations that help animals meet environmental challenges.