
PREFACE

More than twelve years ago, we wrote the first edition of *Biology: The Unity and Diversity of Life*. Our approach was novel at the time; we introduced the principles of evolution and energy flow early on and then *used* them as a way of interpreting the observations and experiments described throughout the book. We believed then, as we do now, that students can make more sense of life in general and their own lives in particular when they truly understand the integrative power of those two great principles.

Why will it be difficult to produce a vaccine against HIV, the causative agent of AIDS? How can we explain the similarities and differences between a human and a chimp? What repercussions can we expect from the rapid and wholesale destruction of tropical rain forests? What will happen if the average temperature near the earth's surface continues to rise through amplification of the greenhouse effect? With the principles of evolution and energy flow to guide them, students can think their way through any number of issues or observations about the natural world; and they can better evaluate what they hear about and read every day of their lives.

Several thousand instructors apparently liked our approach; over the years, close to a million of their students have used our book in its new and previously owned forms. The acceptance has been gratifying, but it also has reinforced our deep sense of responsibility to those who have placed their trust in our efforts. That is why, as soon as one edition is published, we begin work on the next, using the following standards as our guide:

1. Use the principles of evolution and energy flow as a conceptual framework for each chapter.
2. Distill the main concepts and outline the research trends in all major fields.
3. Give enough examples of problem solving and experiments to provide familiarity with a scientific approach to interpreting the world.
4. Include enough comparative biology to convey a sense of the unity and diversity among organisms.
5. Include enough human biology to enhance understanding of our evolution, behavior, and ecology as well as our body structure and functioning.
6. Be selective in developing the vocabulary necessary to comprehend what is being talked about today in each field.

7. Present the material accurately but not at a high level.
8. Write clearly, in a style that is not boring or patronizing.
9. Create easy-to-follow line illustrations and select photographs that are informative as well as beautiful.
10. Keep the writing free of bias, thereby giving students the chance to form their own opinions about the material being presented.

REVISION HIGHLIGHTS

This is a major revision effort, with eighty percent of the book being updated and rewritten for greater clarity. We researched the current literature and corresponded with specialists in different fields to identify new information or ideas that called for new approaches or shifts in emphasis. Simultaneously, thirty adopters throughout the country were preparing "diary" reviews of the fourth edition. They evaluated the effectiveness of each chapter and let us know whenever a portion of their students had trouble with some inherently difficult topic. This drove us to write draft after draft manuscript, until instructors who said their students had *liked* the material before were actually enthusiastic about how much more effective it has become.

The revision is too extensive to describe completely, but the following examples provide insight into the types of changes that were made:

1. Chapter 5, which starts students thinking about the relationships between cell structure and function, is more tightly written; see, for example, the sections on chromosomes and the cytomembrane system. The section on the cytoskeleton was revised to reflect emerging ideas about how the cytoskeleton organizes the cell division planes during embryonic development. Similarly, Chapter 6 is updated to reflect advances in our understanding of membrane structure and function; Figure 6.2 is an example of how the recent data are incorporated into illustrations as well as into the text.
2. The unit on metabolism has been simplified without distorting the science. Chapter 7, for example, has sharper descriptions of metabolic pathways, enzyme structure and function, the ADP-ATP cycle, coenzymes,

and electron transport systems. Because the basics are covered in this separate chapter, the subsequent chapters on photosynthesis and aerobic respiration are kept uncluttered. The entire unit benefits from many new, informative illustrations.

3. The chapters on mitosis and meiosis (10 and 11) are reorganized and rewritten. Inherently confusing terms (chromosome and chromatid, haploidy, diploidy, pairs of homologues) are explained at the outset in words and simple pictures (pages 140 and 141). By the time students start Chapter 11, a few simple “refresher” paragraphs on terminology (page 151) set the stage for the discussion. A word-picture overview of meiosis follows (page 152). With this preparation, students can focus on *details* of the division mechanisms, these being the critical foundation for the remaining chapters in the unit.

4. Take a moment to look at the many new illustrations throughout the genetics unit, particularly the three-dimensional paintings. More than thirty instructors and specialists—and here we must acknowledge the valuable ideas of Joseph Bonfiglio—worked with us to make the new art accurate and pedagogically effective. This may be one of the reasons why the book works so well in the classroom: while each chapter is being worked on, the illustrations receive as much attention as the text. Over the years, students have let us know how much they appreciate the results.

5. Chapter 12 (Mendelian genetics) has been called “the” model chapter for giving students a sense of how to think critically; even so, we tightened the writing and improved the illustrations. Chapters 12 and 13 are updated and rewritten for greater clarity. The human genetics chapter (14) is now clearly organized by major patterns of inheritance (autosomal recessive, autosomal dominant, and X-linked); it also has a new section on RFLPs. Gordon Edlin deserves special thanks for his insights concerning this and other genetics chapters.

6. Chapter 17 has been reorganized; prokaryotic control mechanisms are described simply and accurately, and there are better examples of gene control in eukaryotes. The chapter on recombinant DNA and genetic engineering (18) has been completely rewritten. It starts with a nonthreatening, historical perspective before getting into the new technologies, and it concludes with a balanced look at the social implications of genetic engineering.

7. At the suggestion of Lisa Wagner, we reorganized and simplified Chapter 19 (plant structure). A brief overview of the plant body precedes the discussion of tissue types, primary growth, and secondary growth. Related art is grouped together (see the comparison of monocot and dicot stems on page 254, for example).

8. Similarly, Chapter 23 (animal tissues and organ systems) now begins with an overview of the levels of tissue organization and a “road map” (Figure 23.4) of the human organ systems to be covered in subsequent chapters. The entire animal anatomy-physiology unit has more micrographs and accompanying diagrams of tissues.

9. Nearly all students approach the topics of neural and endocrine function with justifiable trepidation. We worked hard to simplify as well as update our coverage of these topics (in Chapters 24 and 26) and to develop new illustrations that make the concepts more accessible (Figures 24.6 and 26.12, for example). Chapters 28 (skeletal-muscular systems) and 29 (circulatory systems) have valuable new art, and both have updated, simpler text descriptions. The Commentary on cardiovascular disorders (page 408) is expanded and includes new illustrations.

10. Chapter 30, on immunology, has been reorganized and rewritten to keep pace with this rapidly changing field and to make the material more accessible to students; the illustrations also reflect new information. The section on antibody diversity is much improved; the Commentary on AIDS is updated and expanded. Chapter 33 (temperature control, fluid regulation) is rewritten. The descriptions of renal function are clarified and there is a new section on acid-base balance.

11. Chapter 34 (animal reproduction, embryonic development) is reorganized into two parts: first a description of the main developmental stages, then a discussion of mechanisms underlying development. This organization, recommended by William Bradshaw, affords a clear intellectual path through complex material; it also affords more flexibility in assigning only the basics. Chapter 35 (human reproduction, development) is updated and expanded, with refined illustrations (Figure 35.8 is an example). Figure 35.21, a new figure, diagrams the critical periods of human embryonic development. Also new is a Commentary on cancer in the reproductive tract (page 526).

12. All chapters in the evolution and diversity unit are greatly improved. Chapter 39 has better coverage of viruses and bacteria, including new life-cycle illustrations, photographs, and paintings. Chapter 40 (fungi and plants) is rewritten to give more balanced coverage of the different groups. It has more examples of interest to students, such as the Commentary on fungi (page 620) and commercial uses of red and brown algae. The tables are simplified. Working with several specialists in botany, we developed beautiful, accurate paintings of life cycles (pages 618, 628, 631, and 639, for example). The new life cycle on monocots (the lily) is included to

round out the picture for flowering plants (Chapter 21 has a life cycle for dicots).

13. Eugene Kozloff worked with us to improve the invertebrate section in Chapter 41 (animal diversity). The vertebrate section is expanded and has a much clearer organization. The new photographs and line illustrations here are truly spectacular. After consulting with prominent physical anthropologists, we rewrote the chapter on human origins and evolution (42). It has a new introduction to mammalian and then primate characteristics, an updated picture of hominid evolution, and many new, excellent illustrations.

14. The ecology unit is revised considerably. The text and illustrations of human population growth (Chapter 43) have been updated. Ecosystems concepts are now in sharp focus, and there is a new Commentary on the greenhouse effect (Chapter 45). The global forces that shape the distribution of ecosystems are now a major theme in Chapter 46 (biosphere). The classification of biomes is improved, and there is now a balanced coverage of aquatic ecosystems, including more on marine ecosystems. Concepts are given practical application in the new Commentary at the chapter's end, which describes how the El Niño Southern Oscillation profoundly disrupts the world's climates and human affairs. Chapter 47 (human impact on the biosphere) is rewritten. It is now global rather than regional in focus, with attention given to acid deposition, the ozone hole, tropical forest destruction, desertification, and depletion of energy reserves, all in the context of human population growth.

15. The classification scheme followed throughout the book (and summarized in an appendix) has been brought in line with current thinking. There is no consensus here, but responses to a detailed questionnaire told us which groupings are most acceptable to the most instructors and specialists. Page numbers after the entries refer to text pages on which the different organisms are described and illustrated.

THE ILLUSTRATION PROGRAM

We worked directly with outstanding artists, medical illustrators, and photographers in developing an additional 400 illustrations. Moreover, existing art has been recast in a three-dimensional style. We personally blocked out the placement of text and illustrations on each page and sized and color-coded the art (we did this to make it easier for students to see how the text and illustrations, as well as the parts within an illustration, fit together).

New to this edition are three-dimensional paintings that help make hard-to-visualize topics more tangible. Also new are the full-color life cycles of plants, as well as paintings that detail the structure and function of viruses, bacteria, fungi, plants, and animals.

We expanded the number of illustrations in which visual and written summaries are combined to make concepts easier to grasp. Wherever feasible, we broke down the information into a series of steps, which are far less threatening to students than one large, complicated diagram.

STUDY AIDS

Students taking introductory biology will not already know enough about biology to spot all key concepts in page after text page. *Major summary statements* are highlighted with blue lines and printed in boldface for emphasis. Taken together, the statements are an easy-to-identify, *in-context summary* of key concepts. Many are in list form (see, for example, pages 88, 141, and 163). Concepts are also reinforced by *end-of-chapter summaries* as well as *summary illustrations* (see pages 160 and 218 for examples of the latter). This edition also has more *summary tables*.

Review questions are keyed to italic and boldfaced sentences as a way of reinforcing the main concepts. Italicized numerals at the end of each question refer to pages on which students can find the answers.

Chapters 12–14 have *genetics problems*, with *detailed solutions* in Appendix II. The *glossary* brings together the text's main definitions. It includes pronunciation guides and origins of words, when such information will make seemingly formidable words less so. The *index* is extensive, simply because students may find a door to the text more quickly through finer divisions of topics.

APPLICATIONS

Within the chapters, we address numerous topics of social concern from a biological perspective, including the effects of smoking (covered in the respiration chapter and in the discussion of human embryonic development), anorexia nervosa, bulimia, fetal alcohol syndrome (FAS), abortion, and genetic engineering. Many more topics important to students have been added.

Many chapters also have *Case Studies* that show how general concepts apply to specific situations. For example, after the discussion of immunity, a case study shows students how their own body would mount an immune response to a bacterial attack (page 429).

The *Commentaries* are “outside readings” built into the book. They explore such thought-provoking topics as drug abuse, cancer, death, cardiovascular and lung disorders, AIDS, sexually transmitted diseases, the greenhouse effect, tropical forest destruction, and drought prediction based on studies of interactions between the oceans and the atmosphere.

The *Perspectives* are end-of-chapter sections that encourage students to take a moment to think about the connections between chapters and units. Many also bridge chapter topics and the student’s world, inviting reflections on the past and possible futures. Two examples appear on pages 133 and 805.

SUPPLEMENTS

An extensive package of 14 supplements accompanies this text. There are now 140 illustrations on full-color transparencies. These figures also are available on 35mm slides. An additional 200 figures are available on transparency masters. All transparencies and slides are labeled with large, bold type.

There is a new *Test Items* booklet, with 2,500 questions. The questions are also available on IBM, Apple IIe, and Macintosh disks. Accompanying the disks is a database manager and word processor that helps instructors prepare tests. The disks also include a chapter objectives data bank that allows instructors to select and modify learning objectives.

New for this edition is a comprehensive *Instructor’s Resource Manual* by Larry Lewis, Susan Feldkamp, Larry Sellers, and Jane Taylor. Each chapter includes revision highlights, a chapter outline, a list of boldface or italic terms, chapter objectives, a detailed lecture outline correlated with the transparencies, suggestions for presenting the material, suggestions for classroom and laboratory demonstrations, suggested discussion questions, research paper topics and library activities, and annotated lists of filmstrips and videos. There also are three valuable appendices: a list of library sources for student research, a bibliography of filmstrip and video sources, and a ten-page guide that aids student in writing research papers and reports.

Jane Taylor revised the *Study Guide* to correspond with the new edition. In this supplement, learning aids are organized by chapter section, allowing students to focus on smaller amounts of material and to skip over unassigned sections. Because students learn in different ways, there is a variety of pedagogical aids to help them. Each chapter section has a detailed summary, list of key terms, learning objectives, and different kinds of self-quizz questions. The new edition has a multiple-choice test at the end of each chapter. Also available is an *Answer Book* by David Cotter that provides detailed

responses for end-of-chapter Review Questions found in the book.

Although the new edition contains many more applications, *Current Readings in Biology*, an anthology compiled by John Crane, provides additional applications of biological concepts. Another rich anthology, *Science and the Human Spirit: Context for Writing and Learning* by Fred O. White, helps students learn how to read and write about the sciences. Topics include ethical issues, significant discoveries and breakthroughs, and women in science.

Finally, Jim Perry and David Morton revised their *Laboratory Manual* to correspond with the new edition and to take advantage of feedback from ten instructors who class-tested it. This well-received manual has thirty-three experiments and exercises, each divided into distinct parts that can be assigned individually, depending on the time available in the laboratory. All experiments and exercises have the same format, with objectives, a discussion (introduction, background, and relevance), a list of materials for each part of the experiment, procedure, pre-lab questions, and post-lab questions. Each procedure is in list form, with each step numbered. The procedures are detailed enough so each exercise is self-explanatory. An *Instructor’s Manual* by Joy Perry accompanies the laboratory manual. It covers quantities, procedures for preparing reagents, time requirements for each portion of the exercise, notes to help make the lab a success, and vendors of materials, with item numbers.

A COMMUNITY EFFORT

It would be rather fatuous of any author to pretend that a general biology book can be written in a vacuum; biology simply has diverged too rapidly in too many directions for any one person to keep up with all of it. Over the years, more than 1,000 instructors and research specialists have given us the benefit of their insights, and they must be given credit for their contribution. We owe special thanks to John Alcock, Robert Colwell, Cleon Ross, and Samuel Sweet—not only for contributing chapters in their specialized areas but also for their good grace in allowing us to rewrite the material in the style and at the level of the entire book. We owe special thanks also to James Bonner, Eugene Kozloff, George Lefevre, and William Parson for their warm advice, support, and contributions over the years.

We owe thanks to William Fennel, Stephen Hedman, John Jackson, Kenneth Jones, Joyce Maxwell, Heather McKean, Douglas Reynolds, John Rickett, and Pat Starr. They all transcend the “reviewer” designation; they have made detailed criticisms of the entire manuscript, edition after edition. This time around, Thomas Gray, Michael Tansey, and Larry Sellers join them. The advice of Gary

Atchison, George Cox, William Schlesinger, and David Tilman was invaluable in revising the ecology unit.

Some of the biologists mentioned earlier in the preface were diary reviewers, along with Samuel Bieber, Jean Bowles, William Bradshaw, William Brunckhorst, Lynn Clark, R. Dean Decker, Dorothy Dunning, Thomas Eickbush, Charles Flora, Robert Kull, Kim Mattson, Mary McKittrick, William Morrison, Diane Nelson, Tom Palko, and Lisa Wagner. By helping us class-test the material, all were instrumental in shaping the revision. They and the other reviewers listed on the next two pages will know, in reading through this new edition, where they have left their imprint.

A word for Wadsworth. Once again, we lured Mary Forkner Douglas into becoming our production manager; once again, Stephen Rapley was our art director. Anyone looking through the text and sophisticated graphics of this book will know at once how great these two individuals are. They have been absolutely unwavering in their personal and professional support. And once again, Dick Greenberg, Kathie Head, and Steve Rutter gave their unqualified support to the revision effort.

After the last time, we didn't think Marion Hansen would put up with our demands this time; but she did, and students can thank her for finding the beautiful new photographs in this edition. Sue Belmessieri kept the revision effort going smoothly with her organizational skills and good humor. Deborah Cogan came through in the eleventh hour. Lewis Calver, Raychel Ciemma, Darwen Hennings, Vally Hennings, and Victor Royer deserve special recognition; these outstanding artists are deservedly well known, and they have done their best for us over the years. This edition, Joan Carol and Keith Kasnot made valuable artistic contributions. Susan Breitbard, Alan Noyes, and Jeannie Schreiber played a major role in developing complex pieces of art and in making soothing noises for exhausted authors. The staff at Jonathan Peck Typographers did their usual superb job.

Jack Carey has guided the development of this book through all of its editions. Today, biology textbooks must do so much for so many diverse students; and it takes a serious, knowledgeable editor to help authors produce a good one. Over the past twenty-five years, Jack has met with instructors and researchers throughout North America and has developed what is possibly the most comprehensive list of respected reviewers in biology education. He is the catalyst for the intellectual actions and reactions that are the foundation of this book.

FIFTH EDITION

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