美国著名医学院校教材系列

SECOND EDITION

The Living World

GEORGE B. JOHNSON

生命科学概论

（英文影印版）

中国协和医科大学出版社
科文（香港）出版有限公司
麦格劳-希尔教育出版集团

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PREFACE

When I set out to write *The Living World*, it was with the intention of creating a text that would be very easy to learn from—a book that focused on concepts rather than information. More than most subjects that students encounter, biology is a set of ideas, and if students can master these basic ideas, the rest comes easy. To make the ideas of biology more accessible to students, I trimmed away a lot of detail traditionally taught in freshman biology courses, presenting the concepts of biology—as much as my writing skills would allow—as a narrative. I used analogies frequently, as analogies provides students a way to visualize new concepts, to make them concrete and so approachable. A student using *The Living World*, I hoped, might be exposed to less information than provided by other texts but would walk away knowing more biology.

The first edition of *The Living World* was quite successful in the sense it was adopted for use by many classrooms. In talking to teachers around the country I have been pleased to see that the first edition was also successful in meeting the goals I had set for it. Students seem to find *The Living World* fun and approachable and to learn a lot from using it.

Features of This Revision

But no text is perfect, least of all a first edition. In carrying out this revision, I've tried to listen carefully to the many comments of teachers and students using the first edition, and to address their concerns. I have focused my efforts on six areas:

Improved Art Program

In the process of revising the text, I've made a real effort to also improve the art program. A consistent art program makes it a powerful visual teaching tool, so I have taken care that particular atoms are always presented in the same color, membrane proteins always portrayed the same way, and so forth. Of the 500 pieces of art in the second edition, nearly all are new or completely revised.

Content Enhancement

To meet the needs of the many teachers who require a text covering more than the first edition did, yet do not want a book at a higher level of difficulty, I have added some 120 pages of new material. To each chapter of the book I have added one or more new "concept modules" that open up new avenues of inquiry. This doesn't make the book any harder—just more fun and more useful to a broader range of teachers.

Learning Modules

Each chapter is now organized into one-or two-page "concept modules" (a few are longer) each devoted to teaching a particular idea or concept. Each module starts on a new page and ends with a summary of what the student should have learned. Individual chapters are broken into three or four sections, each composed of several concept modules. The outline at the start of the chapter thus serves as a convenient and easily comprehended outline of the ideas and concepts that form the skeleton of the chapter.

Process Boxes

The principal task of any student confronting an introductory biology course is to learn the ideas behind certain key processes—not simply to memorize a list of terms but rather to be able to visualize and understand what's going on. For some four dozen important processes that students encounter in introductory biology (osmosis, meiosis, the Krebs cycle, etc.) I have prepared special "This is how it works" process boxes that walk the student through the process a step at a time.

Essential Study Partner

Interactive inquiry is the most powerful way to learn. This revised edition of *The Living World* comes with a two-CD-ROM interactive Essential Study Partner, packaged free with every book. Packed with about 100 animations and 200 learning activities, the interactive study partner provides a student with self-quizzes and interactive diagrams that allow each student to test knowledge of a topic before moving on to a new module.

Online Learning Center

This text has an Internet web site on which I post monthly updates of key advances. For the new edition this site is folded into a greatly enhanced home page, the *Online Learning Center* (OLC). The OLC features, for text users, not only the updates and other resources of the old web site but also many new goodies, including *enhancement chapters* written by me that allow a class to explore particular areas in more depth (there is a full enhancement chapter on *Dinosaurs,* and another on *Conservation Biology*); my own *lecture notes* for my Washington University course using this text and devoted to important current issues (AIDS, cancer, biodiversity, etc.) and the biology needed to understand them, with a full library of *exam questions* from several years of that course.

New This Edition: Content Enhancement

In this revision almost every chapter has seen significant change. The chapters below serve as examples, although they are by no means the only chapters that have undergone major change.

CHAPTER 2 Evolution and Ecology

At the suggestion of users who like to begin with the larger concepts of ecology and evolution, the second edition has a new introductory chapter that presents the basics of evolution and ecology. It has a complete treatment of Darwin (six pages) and an up-close examination of four cases of "evolution in action" (Galapagos finches, Hawaiian *Drosophila*, Lake Victoria cichlid fishes, and New Zealand alpine buttercups). The introduction to ecology introduces the concept of ecosystems and analyzes patterns of population growth.

CHAPTER 5 Energy and Life

A treatment of the basics of energy now opens the chapter. Treatment of the light-dependent reactions of photosynthesis has been expanded to four pages, with a detailed look at the molecular anatomy of photosystems and a step-by-step account of how a chloroplast's two photosystems act together to convert light to chemical energy. Process boxes make the overall architecture of glycolysis and the Krebs cycle much clearer and more approachable to students.

CHAPTER 6 How Cells Divide

At the suggestion of many users, this new chapter gathers together mitosis and meiosis so that they can be taught together and positions them immediately before Mendelian genetics, where meiosis provides a key explanation. A detailed treatment of "control of the cell cycle" has been added, followed by a four-page examination of how cancer results from damage to these controls and recent exciting progress in curing cancer. Mitosis and meiosis are compared, and the evolutionary consequences of sex discussed, in a new overview that ends the chapter.

CHAPTER 9 Gene Technology

Totally redone, this chapter carefully outlines the stages of a gene transfer experiment and explains PCR and DNA fingerprinting. Up-to-date information on genome sequencing and the Human Genome Project are provided. A new section has been added on cloning, with the most recent advances noted and potential ethical problems discussed.

CHAPTER 10 Evolution and Natural Selection

Reorganized, this chapter now starts with a consideration of the importance of genetic variation and how it affects the pace of evolution. Industrial melanism, the most famous case of evolution in action, is reexamined in light of new information.

CHAPTER 12 The First Single-Celled Creatures

A detailed comparison of bacteria to eukaryotes has been added, as well as a two-page treatment of how animal viruses enter cells, featuring new information on the HIV life cycle. The controversy over prions and Prusiner's Nobel Prize is examined in a new section that also considers viroids.

CHAPTER 20 How Humans Evolved

This chapter has been entirely redone, using considerable recent information to bring it up to date in a rapidly developing field. Much of the early human family tree has been redrawn by recent fossil finds. The out-of-Africa versus multiregional hypotheses are contrasted, an area of considerable current controversy.

CHAPTER 21 The Animal Body and How It Moves

This chapter now begins with a four-page consideration of the animal body plan, focusing on four issues: radial versus bilateral symmetry, solid body versus body cavity, segmented versus non-segmented bodies, and protostome versus deuterostome embryos. Throughout, nonhuman vertebrates and other animals are emphasized as appropriate, rather than restricting the treatment to humans as in the past edition.

CHAPTER 22 Circulation and Respiration

This chapter has been expanded by half, with extensive new coverage of nonhuman animals. It now opens with a two-page discussion of the variety of animal circulation systems, followed by a two-page discussion of the evolution of vertebrate circulatory systems. Later in the chapter, respiration is similarly introduced by four more pages on the diversity and evolution of animal respiratory systems.

CHAPTER 25 The Nervous System

This chapter now opens with a two-page discussion of the evolution of animal nervous systems and then moves to neurons and synapses. The treatment of the molecular basis of drug addiction has been greatly expanded. There is a new two-page section on the evolution of the vertebrate brain and one page devoted to the evolution of the eye.

CHAPTER 29 Living in Ecosystems

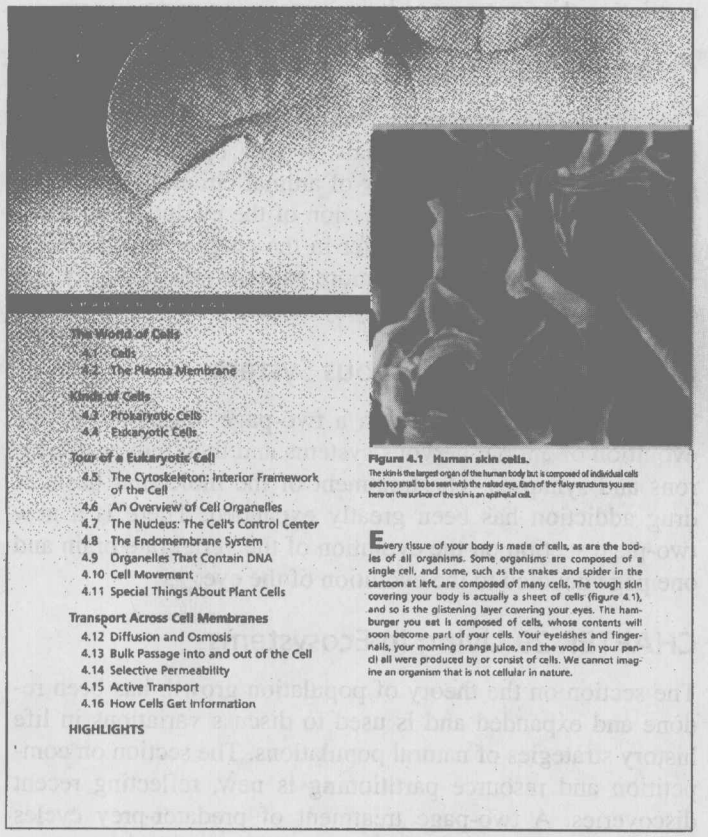
The section on the theory of population growth has been redone and expanded and is used to discuss variations in life history strategies of natural populations. The section on competition and resource partitioning is new, reflecting recent discoveries. A two-page treatment of predator-prey cycles has been added, the section on biodiversity rewritten to reflect new ideas being discussed by researchers, and a new section on island biogeography added.

New This Edition: Learning Modules

You will find the chapters in this edition of *The Living World* organized in discrete one-and-two page units, a practice now common among introductory texts. In this edition I have tried to improve on this approach by crafting each of these units around a single concept, so that the units become concept learning modules. Each chapter deals with three or four general issues that together explain the key ideas that the chapter addresses, with each issue explored in a series of numbered learning modules. Each learning module is typically one-or-two page spreads (a few use three or four pages) ending with a statement of the key concept the student should have mastered from that module.

Here's How It Works

Each chapter's opening page contains an outline that presents an overview of the concepts covered in the chapter. A portion of the chapter outline for chapter 4 is reproduced here. The four sections, each devoted to a major issue, provide the student with a clear outline of how the various topics covered in the chapter relate to one another, revealing in a direct way the conceptual skeleton of the chapter so students don't miss the "big picture."



The World of Cells
- 4.1 Cells
- 4.2 The Plasma Membrane

Kinds of Cells
- 4.3 Prokaryotic Cells
- 4.4 Eukaryotic Cells

Tour of a Eukaryotic Cell
- 4.5 The Cytoskeleton: Interior Framework of the Cell
- 4.6 An Overview of Cell Organelles
- 4.7 The Nucleus: The Cell's Control Center
- 4.8 The Endomembrane System
- 4.9 Organelles That Contain DNA
- 4.10 Cell Movement
- 4.11 Special Things About Plant Cells

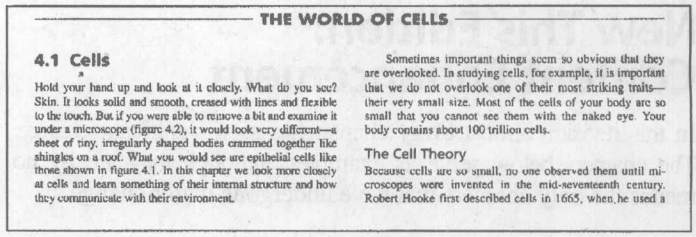
Transport Across Cell Membranes
- 4.12 Diffusion and Osmosis
- 4.13 Bulk Passage into and out of the Cell
- 4.14 Selective Permeability
- 4.15 Active Transport
- 4.16 How Cells Get Information

HIGHLIGHTS

Figure 4.1 Human skin cells.
The skin is the largest organ of the human body but is composed of individual cells each too small to be seen with the naked eye. Each of the flaky structures you see here on the surface of the skin is an epithelial cell.

Every tissue of your body is made of cells, as are the bodies of all organisms. Some organisms are composed of a single cell, and some, such as the snakes and spider in the cartoon at left, are composed of many cells. The tough skin covering your body is actually a sheet of cells (figure 4.1), and so is the glistening layer covering your eyes. The hamburger you eat is composed of cells, whose contents will soon become part of your cells. Your eyelashes and fingernails, your morning orange juice, and the wood in your pencil all were produced by or consist of cells. We cannot imagine an organism that is not cellular in nature.

Each section is organized as a series of numbered conceptual units. These learning modules are typically covered on one page or on two facing pages. The first learning module under the section "The World of Cells" is reproduced here.



THE WORLD OF CELLS

4.1 Cells

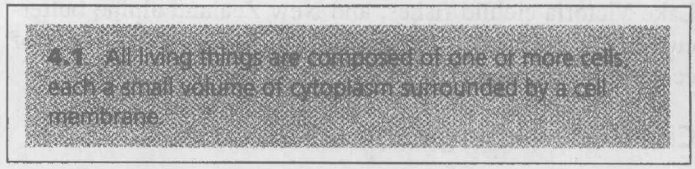
Hold your hand up and look at it closely. What do you see? Skin. It looks solid and smooth, creased with lines and flexible to the touch. But if you were able to remove a bit and examine it under a microscope (figure 4.2), it would look very different—a sheet of tiny, irregularly shaped bodies crammed together like shingles on a roof. What you would see are epithelial cells like those shown in figure 4.1. In this chapter we look more closely at cells and learn something of their internal structure and how they communicate with their environment.

Sometimes important things seem so obvious that they are overlooked. In studying cells, for example, it is important that we do not overlook one of their most striking traits—their very small size. Most of the cells of your body are so small that you cannot see them with the naked eye. Your body contains about 100 trillion cells.

The Cell Theory

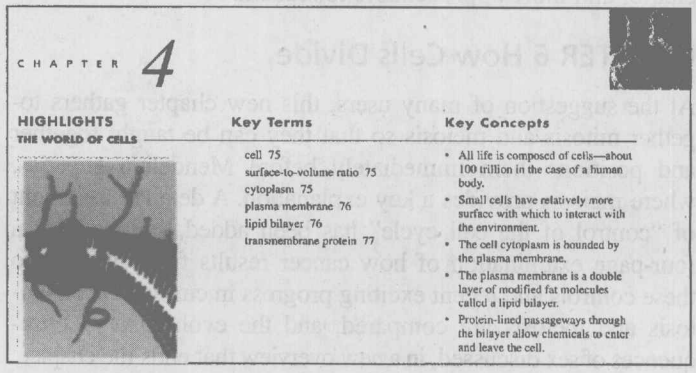
Because cells are so small, no one observed them until microscopes were invented in the mid-seventeenth century. Robert Hooke first described cells in 1665, when he used a

This learning module, "4.1 Cells," ends with the concept statement shown below. All learning modules end with a similar concept statement, whether they cover one page or two or more pages. This both makes it clear to a student where discussion of a topic ends and what lesson the student is intended to take away.



4.1 All living things are composed of one or more cells, each a small volume of cytoplasm surrounded by a cell membrane.

The organization of the material into these conceptual units is carried through to the end of the chapter. The chapter summaries, called Highlights, at the end of the chapter are organized according to the chapter outline found at the beginning, presenting for each section summary statements of the key ideas found in its concept learning modules.



CHAPTER 4

HIGHLIGHTS

THE WORLD OF CELLS

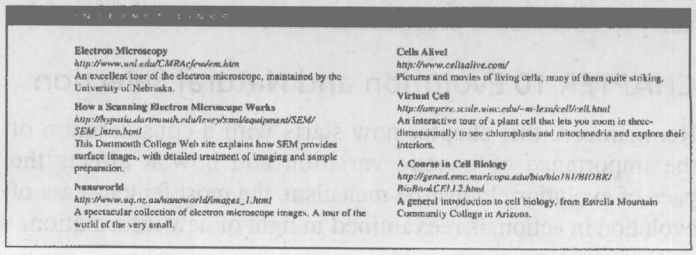
Key Terms

cell 75
surface-to-volume ratio 75
cytoplasm 75
plasma membrane 76
lipid bilayer 76
transmembrane protein 77

Key Concepts

- All life is composed of cells—about 100 trillion in the case of a human body.
- Small cells have relatively more surface with which to interact with the environment.
- The cell cytoplasm is bounded by the plasma membrane.
- The plasma membrane is a double layer of modified fat molecules called a lipid bilayer.
- Protein-lined passageways through the bilayer allow chemicals to enter and leave the cell.

A section at the end of the chapter entitled "Internet Links" is far more than a list of potential references accessible with a computer. Each link has been selected by me to allow students to explore the concepts encountered in the chapter in depth, in an unstructured and open-ended way. There is no better way to learn.



INTERNET LINKS

Electron Microscopy
http://www.unl.edu/CMRAcfem/em.htm
An excellent tour of the electron microscope, maintained by the University of Nebraska.

How a Scanning Electron Microscope Works
http://hypatia.dartmouth.edu/lavey/xml/equipment/SEM/SEM_intro.html
This Dartmouth College Web site explains how SEM provides surface images, with detailed treatment of imaging and sample preparation.

Nanoworld
http://www.uq.oz.au/nanoworld/images_1.html
A spectacular collection of electron microscope images. A tour of the world of the very small.

Cells Alive!
http://www.cellsalive.com/
Pictures and movies of living cells, many of them quite striking.

Virtual Cell
http://lumpere.scale.uiuc.edu/~m-lexa/cell/cell.html
An interactive tour of a plant cell that lets you zoom in three-dimensionally to see chloroplasts and mitochondria and explore their interiors.

A Course in Cell Biology
http://gened.emc.maricopa.edu/bio/bio181/BIORK/BioBookCEL12.html
A general introduction to cell biology, from Estrella Mountain Community College in Arizona.

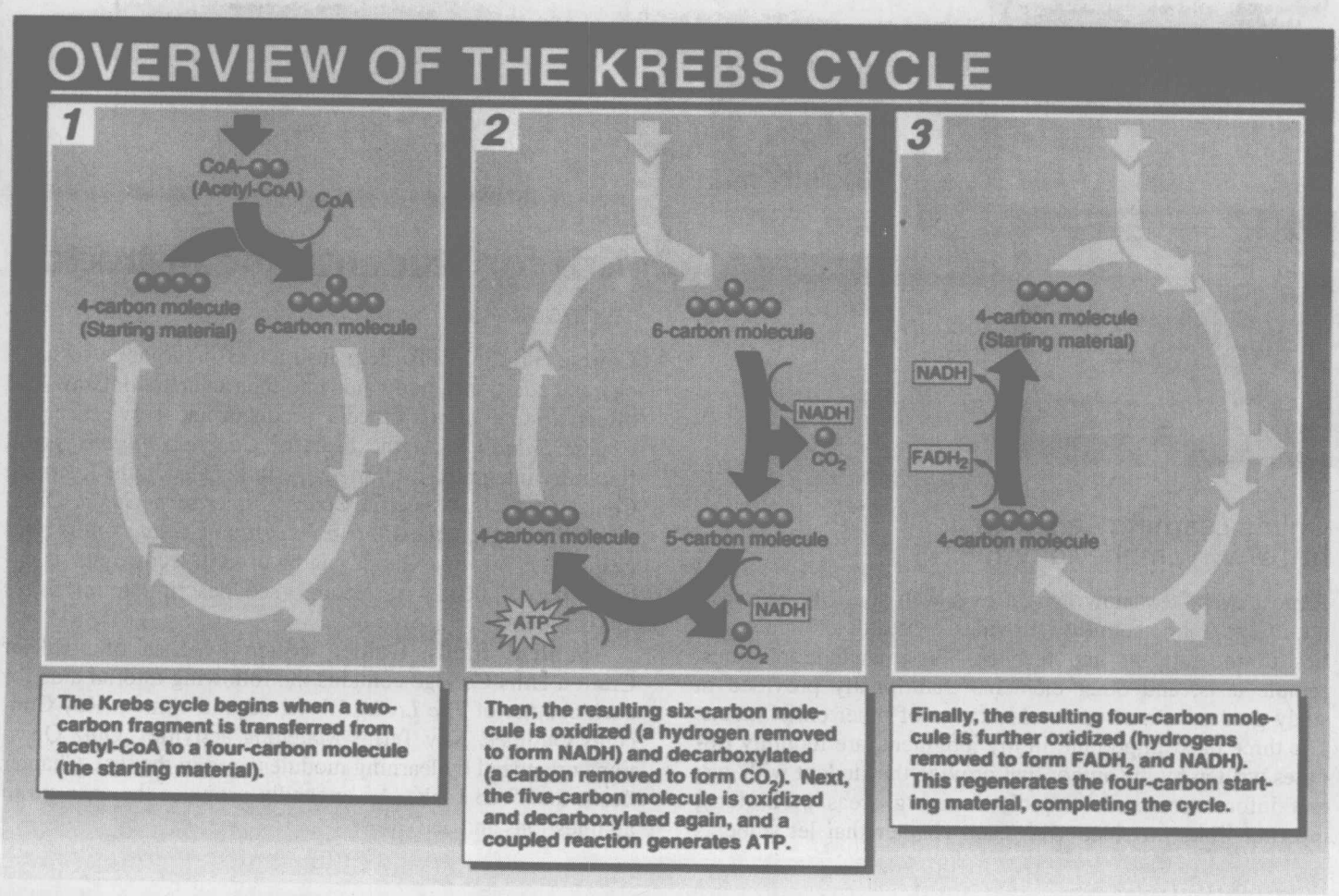
New This Edition: Process Boxes

Every year when I teach biology to a new crop of students, I am impressed with the fact that the same topics prove difficult to them, year after year. Osmosis, meiosis, photosynthesis, the Krebs cycle—every year, these topics are blocks over which my students stumble in trying to approach biology. In preparing this edition of *The Living World*, I made a list of those places in my freshman course that seem to consistently give problems to students, some four dozen items in all. Not suprisingly, these four dozen stumbling blocks proved to have a lot in common. In practically every case, they represented *conceptual processes*. Such conceptual process often present points of particular difficulty to beginning students simply because so much is going on—the overall process gets lost in the welter of details.

In an attempt to make the beginning student's approach to biology a bit easier, I have in this edition attempted to take each of those key processes of biology apart in simple, user-friendly *process boxes*. The idea in a process box is to strip away the detail and focus on the essence of what is going on. If a student can once grasp, in a concrete way, how the overall process works, the rest of the learning comes easy. The process ceases to be a stumbling block and instead forms part of a strong foundation of concepts supporting the rest of the introductory course.

To illustrate how one of these process boxes works, consider the Krebs cycle. The series of nine sequential reactions that cells use to extract energetic electrons from food molecules during oxidative respiration presents a major problem to most of my beginning students. The reactions themselves are complicated, and there are a lot of them to learn, each with a particular enzyme doing a specialized biochemical task. Faced with the blizzard of detail, students often throw up their hands and simply don't learn any of it. The process box, by ignoring the detail and focusing on an overview of what's really going on, provides the student a point of entry, a conceptual foothold that enables learning to take place.

The Krebs cycle process box you see below walks the student through this complex process in stages. In the first stage, a two-carbon molecule is added to the starting material, beginning the cycle. In the second stage, oxidations and decarboxylations occur, harvesting energetic electrons and spitting out the two carbon atoms that had been added to the starting material. In the third stage, the starting material is reformed. And that's it. This simple three-stage telling of the Krebs cycle story empowers a student to learn more, because the basic concept of what's going on—of how the process works—is there in plain sight for the student to grasp.

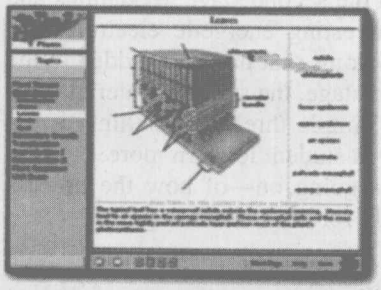


Technology

In this edition technology is put to work to help the student learn. Two particularly powerful new tools are the *Essential Study Partner* CD-ROM and the "Online Learning Center" located on my text-specific web site http://www.mhhe.com/tlw.

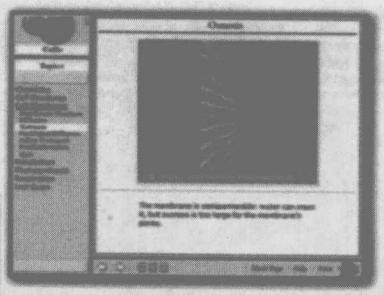
Essential Study Partner (ESP) CD-ROM

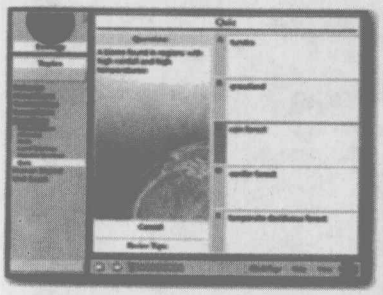
You will find a new CD-ROM tutorial available with this second edition of *The Living World.* The *Essential Study Partner* (ESP) is available **free** with this edition of *The Living World* and contains high quality 3-D animations, interactive study activities, illustrated overviews of key topics in the text, and supplementary quizzing and exams that students will find extremely valuable. This is a study tool that your students must have, so they receive it free.



Interactive

Animation

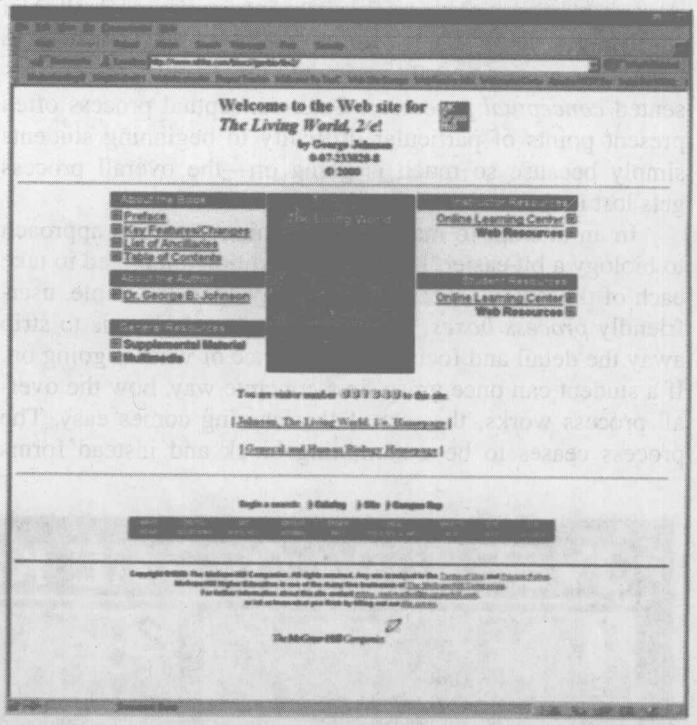




Quizzing

Online Learning Center at http://www.mhhe.com/tlw

Almost every text now has its own web site. My web site, http://www.mhhe.com/tlw, provides a wealth of opportunities to the student and teacher. These include readings, sample tests, and other elements traditionally provided in study guides, as well as a wide range of other enrichments. The three most important, in my judgment, are monthly **updates** written by the author that provide the student with current information about rapidly-changing areas of biology, **internet links** provided with each chapter that let students see the range of internet opportunities available, and **enhancement chapters** written by the author that allow students and instructors to explore rapidly changing areas of biology in more depth. The two enhancement chapters included with this edition are *Conservation Biology* and *Dinosaurs.* I did not wish to lengthen the text more than necessary, and so have placed these chapters on my web site, http://www.mhhe.com/tlw, where anyone using my text will have access to them.



Aids for Students and Instructors

Textbook Aids

Course Solutions. To help instructors incorporate technology and additional study aids into their course, McGraw-Hill offers a suite of multimedia products and services called *Course Solutions.* At the heart of *Course Solutions* you'll find fully integrated multimedia, a full-scale Online Learning Center and a text-specific *Course Integration Guide.* Organized by chapter, the *Course Integration Guide* offers suggestions on how ancillaries can be used in lecture and as enhancements outside of lecture (see description on pages xix–xx in this preface).

Student Study Guide, written by Lisa Shimeld of Crafton Hills College contains the following tutorial aids for each chapter of *The Living World,* second edition: Key Concepts Outlines, Key Terms Matching activities, Quiz Questions organized by learning modules used in the text, Chapter Tests, and Web Links. An appendix provides the answers to all questions and activities.

Transparency Set of 200 acetates contains 200 images from the text.

Instructor's Manual and Test Item File, written by Jennifer Carr Burtwistle of Northeast Community College provides the following instructional aids for each chapter of *The Living World,* second edition: Extended Lecture Outline, Learning Objectives, Key Terms, Lecture Suggestions and Enrichment Tips, Changes to the New Edition, Critical Thinking Questions, Films/Media Suggestions. The Test Item File offers approximately 35 questions per chapter (multiple-choice, fill-in-the-blank, and essay) with answers.

Computerized Testing Software, is available in Mac and Windows platforms. These questions are the same as those included in the Test Item File of the Instructor's Manual.

Other Technology

McGraw-Hill offers students and professors various technology products to support the second edition of *The Living World.*

Essential Study Partner (ESP) CD-ROM

This CD-ROM tutorial supports and enhances the material presented in the fifth edition of *Biology.* The ESP is offered free with the text and will enhance student learning with the use of high quality 3-D animations, activities that require the student to be active in the learning process, module and unit quizzes that take the student back into the material on the CD to review immediately, and illustrated overviews of key topics.

Visual Resource Library CD-ROM

The McGraw-Hill *Visual Resource Library* CD-ROM for *The Living World* contains nearly all of the illustrations found in the second edition. The CD-ROM contains an easy-to-use program that enables users to quickly view images, and easily import the images into PowerPoint to create multimedia presentations.

Exploring the Internet on the Johnson Web Site http://www.mhhe.com/tlw

This text-specific site has been developed exclusively for users of the second edition of *The Living World.* When visiting the site, students can access additional study aids including quizzes, explore links to other relevant biology sites, catch up on current information, and pursue other activities, including content updates and enhancement chapters.

Life Science Animations 3-D Videotape

The *Life Science Animations* 3-D videotape contains 42 high-quality 3-D animations. These animations bring visual movement to biological processes that are difficult to understand. These 42 animations also appear as part of the *Essential Study Partner* CD-ROM.

Life Science Animations Visual Resource Library CD-ROM

This CD-ROM contains approximately 150 animations in an easy-to-use program that enables users to quickly view the animations and import the animations into PowerPoint to create multimedia presentations.

The Dynamic Human CD-ROM Version 2.0

This guide to anatomy and physiology interactively illustrates the complex relationships between anatomical structures and their functions in the human body. Realistic 3-D visuals are the premier feature of this exciting learning tool.

Explorations in Human Biology CD-ROM; Explorations in Cell Biology and Genetics CD-ROM

These interactive CDs, created by me, feature 33 different interactive modules that cover key topics in biology.

Virtual Physiology Laboratory CD-ROM

This CD-ROM features ten simulations of the most common and important animal-based experiments ordinarily performed in introductory lab courses. The program contains video, audio, and text to clarify complex physiological functions.

Life Science Living Lexicon CD-ROM

by William N. Marchuk, Red Deer College

A Life Science Living Lexicon CD-ROM contains a comprehensive collection of life science terms, including definitions of their roots, prefixes, and suffixes as well as audio pronunciations and illustrations. The Lexicon is student interactive, providing quizzing and notetaking capabilities. It contains 4,500 terms, which can be broken down for study into the following categories: anatomy and physiology, botany, cell and molecular biology, genetics, ecology and evolution, and zoology.

Life Science Animations Videotape Series (6 tapes)

Complex processes such as active transport and osmosis come to life in this series. Students can now review more than 65 animations (in the six-tape set) of the most difficult to learn concepts.

Biology Start Up Software (Mac Only)

This 5-set computer tutorial has complete coverage of basic biological principles such as cellular respiration and cell division.

Math Prep for Biology Software

With this computer tutorial, students are given practice with their math skills through biology-specific math applications. This tutorial allows students to master their math skills for further life science study.

Additional Supplements

How Scientists Think

by George Johnson

I wrote this paperbound text describing twenty-one experiments that have shaped our understanding of genetics and molecular biology. It fosters critical thinking and reinforces the scientific method.

Basic Chemistry for Biology, second edition

by Carolyn Chapman of Suffolk County Community College

A self-paced book that leads students through basic concepts of inorganic and organic chemistry.

How to Study Science, second edition

by Fred Drewes, Suffolk County Community College

This excellent workbook offers students helpful suggestions for meeting the considerable challenges of a college science course. It offers tips on how to take notes, how to get the most out of laboratories, and how to overcome science anxiety. The book's unique design helps students develop critical thinking skills while facilitating careful notetaking.

Critical Thinking Case Study Workbook

by Robert Allen

This ancillary includes 34 critical thinking case studies that are designed to immerse students in the "process of science" and challenge them to solve problems in the same way biologists do. The case studies are divided into three levels of difficulty (introductory, intermediate, and advanced) to afford instructors greater choice and flexibility. An answer key accompanies this workbook.

Acknowledgments

No one is born able to write a textbook of introductory biology. The knowledge and judgment needed to sift through mountains of information, trying always to understand not only the details of what is going on in a particular process but also how it relates to the broader picture of what biology should be to a beginning student, are gifts an author is given by a long parade of teachers and students.

I have been gifted indeed by my teachers and students. I went to Dartmouth College in 1960 fully intending to be a writer—but of fiction. The change in my career path was a course in biology I took as a freshman to fulfill a distribution requirement. The course was taught by a new biology faculty member, David Dennison, and it changed my life. His lectures were a model of clarity, intellectually exciting to a young open mind. For the first time, in Dennison's lectures, I saw science as process rather than information, as a give-and-take of inquiry and investigation. I would not have embarked on a career in biology had Dave Dennison not done such a superlative job as a teacher. His example always serves to remind me of the importance of what we do as teachers—that every single student matters, that every lecture we give is important.

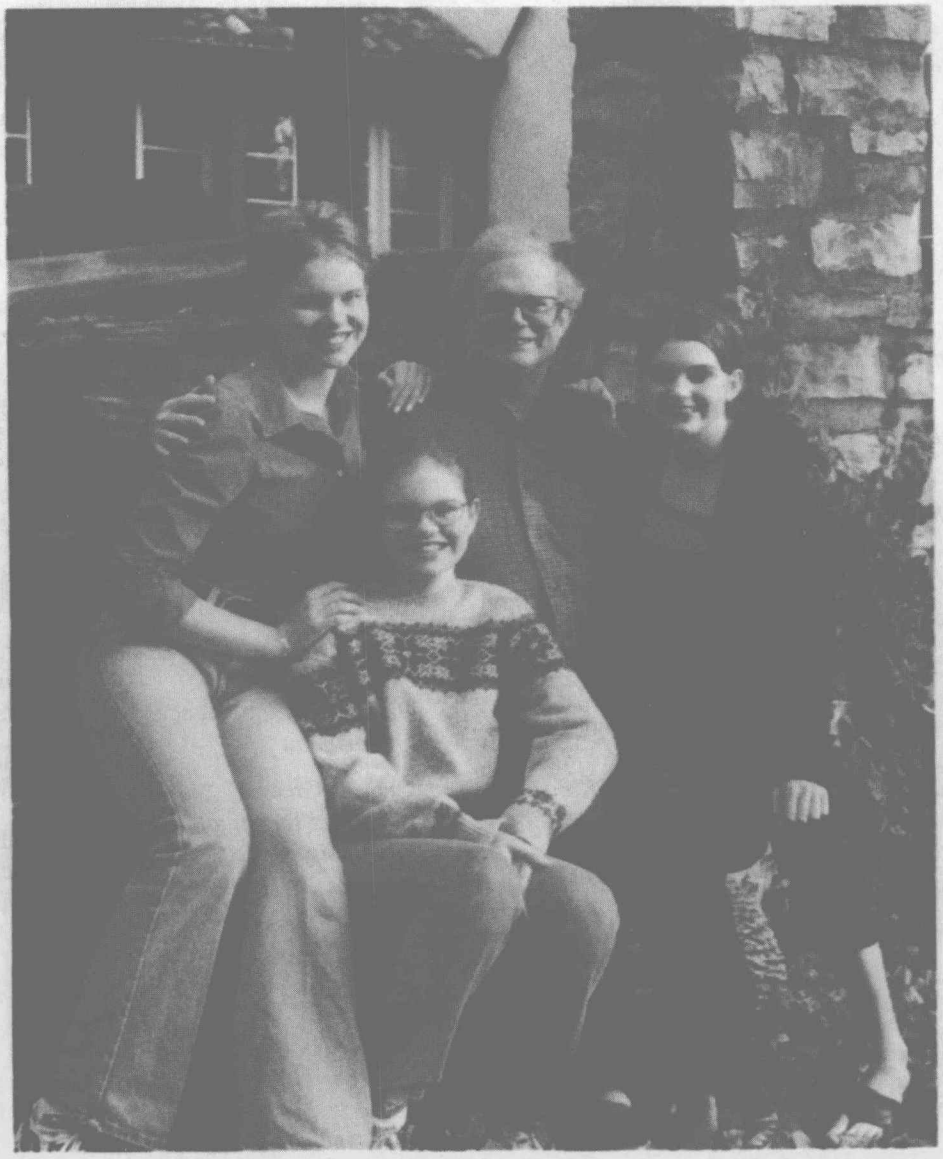
An appreciation of what makes a successful experiment lies at the heart of the education of every biologist. In my first year of graduate school at Stanford, I was in the laboratory of a prominent molecular geneticist named Charles Yanofsky. Every week or so the graduate students, post docs, and faculty of this and a few other labs with related interests got together for lunch and "journal club," and one person described and evaluated a current experiment recently reported in a scientific journal. Faculty and students all took their turns and were expected to spend weeks preparing. There was no mercy shown to the presenter during the discussion that followed if he or she had not clearly and accurately analyzed the experiment, its results, and its relation to other findings. The free-for-all discussion might involve Paul Berg (now a Nobel laureate) or any of dozens of other sharp minds, and students were expected to hold their own, to justify their opinions, and to argue for what they thought was right. No experience in my life has done more to shape my appreciation of the nature of scientific inquiry than the shattering experience of preparing for these journal club presentations. To this day I can recount the experiments I presented over 30 years ago. I have taught undergraduates biology for 27 years, and I have increasingly come to believe that Charlie Yanofsky had it right—that the best way to understand science in general is to study science in particular. Whatever scientific judgment I have been able to bring to bear in writing this text, I owe in large measure to Charlie.

The second edition of *The Living World* has had the benefit of the same strong editorial team that so ably aided me in preparing the first edition. Megan Jackman, my on-site developmental editor and strong right arm, and Elizabeth Sievers, senior developmental editor, fair referee and firm friend; Pat Reidy, sponsoring editor and brash supporter, and Mike Lange, publisher and tough critic; Peggy Selle, dextrous production editor, and Lisa Gottshalk, tireless marketing manager. The new edition benefits as much from their contributions as mine.

As in the first edition, the side-splitting "The Far Side" cartoons of Gary Larson* grace each chapter opener, and again I want to explicitly thank Gary Larson and Toni Carmichael for letting *The Living World* continue to use so many of their cartoons.

Again the powerful and intriguing art of Charles Bragg contributes to *The Living World* an arresting cover. Covers have always seemed important to me, the first sniff of what awaits within, and Charles Bragg's pictures speak volumes about the fun and mystery of biology.

*"THE FAR SIDE" is a registered trademark of FarWorks, Inc.



This is the fifteenth time I have thanked my family in the preface to one of my books, the seventeenth year of a long detour into text writing. I looked for the first time at my first child the same night I held the first edition of my first book in my hands. Since then, as I have written, my family has grown around me. The three girls you see above, Nikki (15), Caitlin (13), and Susie (11), are a far richer reward than any book, even this new edition of *The Living World*. My wife, giver of this rich bounty and in my absence bearer of much of the stress and bother of raising three girls, has provided support without which I could not have written any book, much less fifteen.

Finally, I want to thank my reviewers. Every text owes a great debt to the many faculty across the country who review it. The reviewers of the second edition of *The Living World,* my most sensitive antennae for unintended errors, and my most useful sounding boards for new approaches, have been one of the most valuable tools at my disposal. Representing a very diverse array of institutions and interests, they have provided me with invaluable feedback. Many new features and improvements are a direct result of their suggestions. Every one of them has my sincere thanks.

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Edwin Powell
Iowa State University

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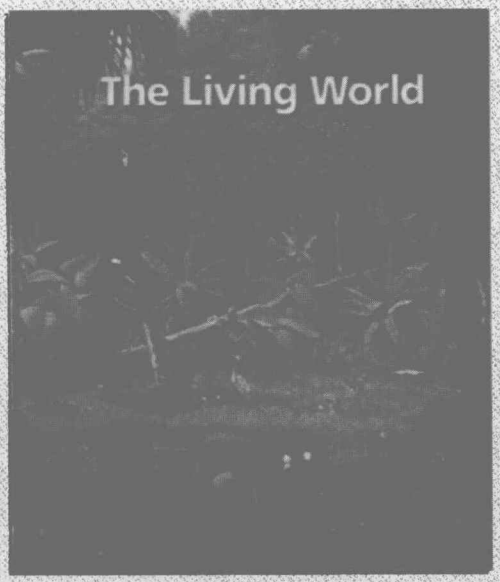

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