Biology by Miller and Levine

A New Textbook Resource for High School Biology

An informal guide for teachers using the Dragonfly Book

For textbook In-Service Workshops

Updated: July 29, 2002

Contents

Additional copies of this booklet are available at:

millerandlevine.com

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An Introduction

This textbook began with a phone call to Joe Levine, then an assistant professor at Boston College, from a senior editor at a publishing house. The editor had read a story on the fish of the Red Sea that Joe, an accomplished diver and marine biologist, had just published in *Smithsonian* magazine. "You really make biology seem interesting," the editor told him, and maybe he'd like to write a textbook that would "make" biology interesting to students?

"Biology *is* interesting!" was Joe's quick reply. "In fact, *everything* about it is interesting." Well, the editor asked, so how about that book?

To make a long story short, Joe recruited me to help write the book, and before long we were both immersed in the work of explaining biology to 9th and 10th-graders. It took a while, but in 1990 our very first textbook, sometimes known as the "elephant book," was published by Prentice Hall. The book was an immediate hit with schools around the country. From the very beginning, teachers and students noticed there was something different about the book, even if they couldn't quite put their fingers on it. We like think we know what that something was — the personal voice of its authors.

Joe and I were both experienced research scientists and teachers long before we ever thought of collaborating on a text. That meant that experimental science, to us, was much more than an abstraction to be lectured and written about. Knowing the scientific process from the inside gave us a sense of the passion and excitement that drives science, and over the years we have applied that sense to both our teaching and our writing. Students who read our books realized at once that they were written by people, by individuals with a first-hand connection to the material and a genuine love for the science of life. We think that our latest textbook, the one with the Dragonfly on its cover, is by far the best of the lot. Over the past two years, we have worked to combine the excitement of 21st century biology with the clarity and readability needed to open that world to your students. We hope and believe that we have succeeded, but you will be the judges of that.

What we can promise you is that we have given it our best efforts — and that we regard authorship as something enduring. We're in this for the long haul. Both of us are at your service to answer questions, provide support, and accept suggestions and criticism. We've written this brief guide to help you understand what we had in mind and to use the book effectively, and we hope that it will be useful to you. We also hope that you will regard it as the beginning of a long-term relationship. Our young people are growing up in a century in which the life sciences will play a central role, and nothing would give us greater pleasure than to assist you in preparing them to master the most important science of the new century, Biology.

Author Biographies

Kenneth R. Miller grew up in Rahway, New Jersey, attended the local public schools, and graduated from Rahway High School in 1966. He became interested in science in junior high, often experimenting with a chemistry set in his basement, and winning second prize in a school science fair with a project on Euglena. Miller attended Brown University on a scholarship and graduated with honors. He was awarded a National Defense Education Act fellowship for graduate study, and earned his Ph. D. in Biology at the University of Colorado. After teaching at Harvard University for six years, he is now Professor of Biology at Brown University in Providence, Rhode Island, where he teaches courses in general biology and cell biology.

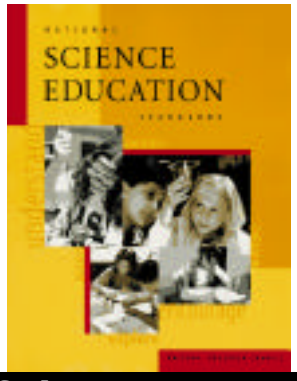
Miller is a cell biologist whose research specialty is the structure of biological membranes. He has published more than 70 research papers in journals such as CELL, Nature, and Scientific American. In 1999 he wrote Finding Darwin's God, a book examining the religious implications of evolution.

Miller lives with his wife, Jody, on a small farm in Rehoboth, Massachusetts. He is the father of two daughters, one of whom is a wildlife biologist. He swims competitively in the masters' swimming program, and umpires high school and collegiate softball.

Joseph S. Levine was born in Mount Vernon, New York, where he attended public schools (Traphagen Elementary, AB Davis Jr. High, and Mount Vernon High School). After completing a B.S. in Biology at Tufts University, Joe obtained a Masters Degree from the Boston University Marine Program. He earned his Ph.D. at Harvard University, studying the physiology and evolution of color vision. At Harvard, Joe was honored as a Graduate Fellow, and won the prestigious Bowdoin Prize for an essay of literary merit in the natural sciences. His research has been published in scientific journals ranging from Science to Scientific American, and in several academic books. He taught introductory biology, marine ecology, and neurobiology for 6 years at Boston College.

After being awarded a Macy Fellowship in Science Broadcast Journalism at WGBH-TV, Joe dedicated himself to improving public understanding of science. His popular scientific writing has appeared in five trade books and in magazines such as Smithsonian, GEO, and Natural History. He produced science features for National Public Radio, Morning Edition, and All Things Considered, and helped launch the Discovery Channel's Discover Magazine. He has designed exhibit programs for state aquarium projects in Texas, New Jersey, and Florida.

Since 1987, Joe has served as scientific advisor to the Science Unit at WGBH, producers of the award-winning PBS television series NOVA. There, he has worked on NOVA programs and on special projects including the OMNI-MAX film Cocos: Island of Sharks, and the series Living Wild, Odyssey of Life, and The Secret of Life, for which he served as Science Editor. He is currently serving as Science Editor for The Evolution Project, an eight-hour PBS series on evolutionary biology, first broadcast in Fall of 2001.



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Philosophy of the Text

As you work from the Dragonfly book, you will see that it closely follows the National Science Education Standards. The reason, as you might expect, is that from the very beginning, we planned this book to fit those standards. As a result, the book, just like the national standards, is a comprehensive attempt to cover all aspects of biology at a depth and breadth appropriate for beginning high school students.

One of the most common questions that we receive from teachers is whether we expect them to cover "everything" in our book in a single year. The simple answer is "no," and we hope you'll understand our reasoning. A textbook is a teaching *resource*, not a curriculum. Yes, we carefully constructed the book so that it has what we regard as a logical sequence of presentation — you can indeed progress from Chapter 1 to Chapter 40 and be assured that material will be introduced in a step-by-step fashion that will make life easier for you and for your students. However, we also knew that different teachers would emphasize different aspects of biology, and also that the specifics of science curricula differ from state to state. Therefore, we planned and wrote a book that has, quite frankly, a little extra in just about every topic you might cover.

We hope you think of this as an opportunity, and not a burden. Our goal was to provide you with *more* resources than you would need for a year of study, allowing you to pick and choose among them in a way that — in your professional judgment — makes sense. After all, that's why *you're* in the classroom and laboratory — because *you* know your own students better than anyone else.

You will also find places throughout the text where we've done our best to make clear to students what is not understood about living organisms. A textbook is supposed to be full of answers, of course, but we think that a science textbook should also be full of questions, just like science itself!

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Chapter Organization

Unit I - The Nature of Life
1) Biology & the Living World
2) The Chemistry of Life

Unit II - Ecology
3) The Biosphere
4) Ecosystems & Communities
5) Populations
6) Humans in the Biosphere

Unit III - Cells
7) Cell Structure & Function
8) Photosynthesis
9) Respiration
10) Cell Growth & Division

Unit IV - Genetics
11) Introduction to Genetics
12) DNA & RNA
13) Genetic Engineering
14) The Human Genome

Unit V - Evolution
15) Darwin's Theory of Evolution
16) Evolution of Populations
17) The History of Life
18) Biodiversity & Classification

Unit VI - Microorganisms
19) Viruses & Bacteria
20) Protists
21) Fungi

Unit VII - Plants
22) Algae
23) Plant Diversity
24) Plant Structure & Function
25) Plant Growth & Reproduction

Unit VIII - Invertebrates
26) Sponges & Cnidarians
27) Worms & Mollusks
28) Arthropods & Echinoderms
29) Comparing Invertebrates

Unit IX - Chordates
30) Nonvertebrate chordates, Fishes & Amphibians
31) Reptiles & Birds
32) Mammals
33) Comparing Chordates
34) Animal Behavior

Unit X - The Human Body
35) Nervous System
36) Skin, Muscle, & Bone
37) Circulation & Respiration
38) Digestion & Excretion
39) Endocrine & Reproduction
40) Immunity & Disease

Get to the Point More Quickly

Expand Ecology - and Move it up Front

Separate Chapters on Photosynthesis & Respiration

Coherent, Detailed coverage of Molecular Biology

Unit I - The World of Life
1) The Nature of Science
2) The Scientific Method
3) Introduction to Chemistry
4) The Chemical Basis of Life

Unit II - Cell Structure & Function
5) Cell Structure
6) Photosynthesis & Respiration
7) Nucleic Acids & Protein Synthesis
8) Cell Growth & Division

Unit III - Continuity of Life
9) Introduction to Genetics
10) Genes & Chromosomes
11) Human Heredity
12) Genetic Engineering

Unit IV - Diversity of Life
13) Evolution - Evidence of Change
14) Evolution - How Change Occurs
15) Classification

Unit V - Life on Earth
16) The Origin of Life
17) Viruses & Monerans
18) Protists
19) Fungi

Unit VI - Plants
20) Multicellular Algae
21) Mosses & Ferns
22) Plants with Seeds
23) Roots, Stems, and Leaves
24) Plant Growth & Development
25) Reproduction in Seed Plants

Unit VII - Invertebrates
26) Sponges, Cnidarians & Worms
27) Molluscs & Annelids
28) Arthropods
29) Echinoderms & Invert. Chordates
30) Compariung Invertebrates

Unit VIII - Vertebrates
31) Fishes & Amphibians
32) Reptiles & Birds
33) Mammals
34) Humans
35) Animal Behavior
36) Comparing Invertebrates

Unit IX - Human Biology
37) Nervous System
38) Bone, Muscle, & Skin
39) Nutrition & Digestion
40) Respiratory System
41) Circulatory & Excretory System
42) Endocrine System
43) Reproduction & Development
44) Human Diseases
45) Immune System
46) Drugs, Alcohol, & Tobacco

Unit X - Ecology
47) The Biosphere
48) Populations & Communities
49) People & the Biosphere

The Dragonfly book has 40 chapters organized into 10 units, as shown at left. How does this differ from a "typical" textbook? At the top right of this page you'll see the 49-chapter table of contents of the elephant book, which was typical of the "micro to macro" approach traditionally used to teach biology — chemistry and biochemistry first, then cells and organisms, and, finally, ecology last.

We have found that students benefit from an approach in which ecology comes early in the text, and that's the most radical change in our book. You'll find that the ecology section comes before units on cells and genetics, giving students a chance to apply their real-world experiences with living organisms as early as possible in the course.

We've also placed two of the most difficult topics, photosynthesis and respiration, in separate chapters. We've used the extra coverage to take the time to explain them more carefully than ever before. We think you'll see the difference this approach makes in terms of better student understanding of these key topics. We've also written a completely new unit on genetic and molecular biology that will help to bring the immediacy and excitement of the human genome project into your classroom.

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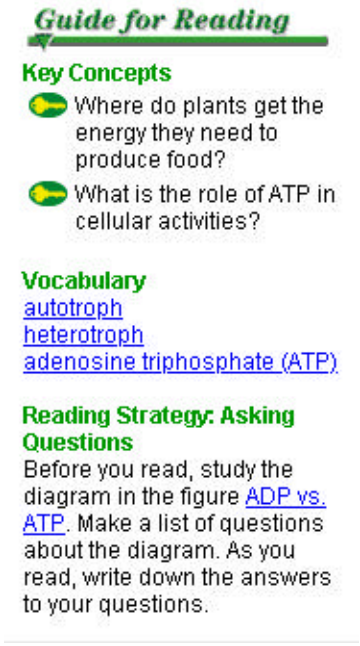
Important New Features of the Text

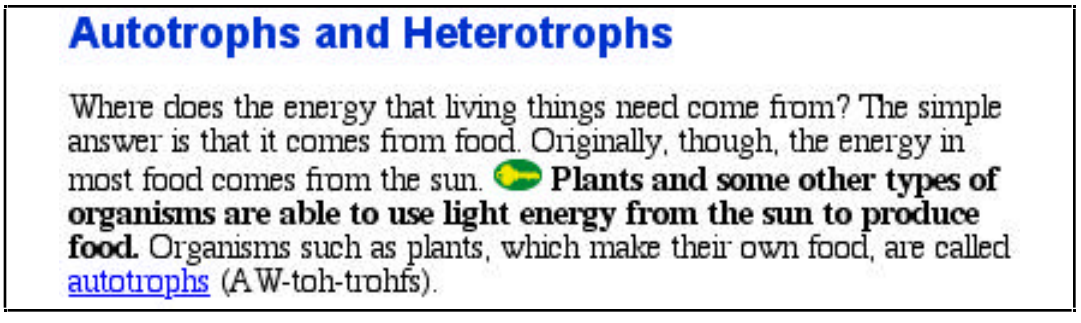
In developing the Dragonfly book, we collaborated with experts in teaching and learning who built a series of powerful teaching aids into each and every chapter. Turn to the opening pages of any chapter, and you'll see an ***Inquiry Activity*** on the very first page:

The purpose of the ***Inquiry Activity*** is to "set the table," to motivate students to explore a new topic by *doing* rather than by reading. Try using them for each new chapter, and we think you'll see your students gain a new appreciation of biology as a science of observation and experiment.

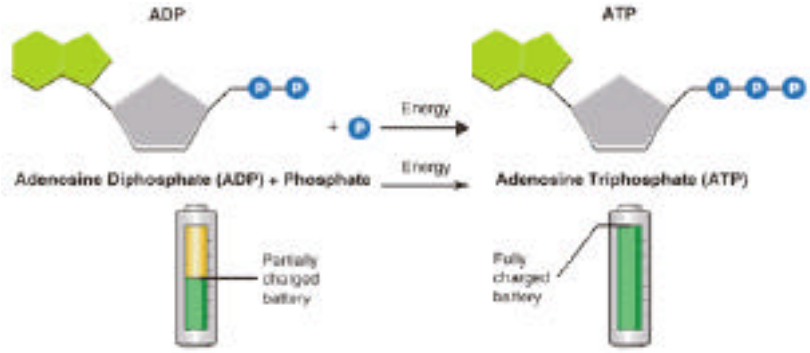


Reading is still important, of course, but reading works best when students understand what they are reading and why they are reading it. Therefore, at the beginning of every section you'll see a Guide for Reading in the margin. The guide will tell students the **Key Concepts** they're about to read, list the vocabulary they should master in the section, and pose a **Reading Strategy** to serve as a goal in developing their understanding of the material.

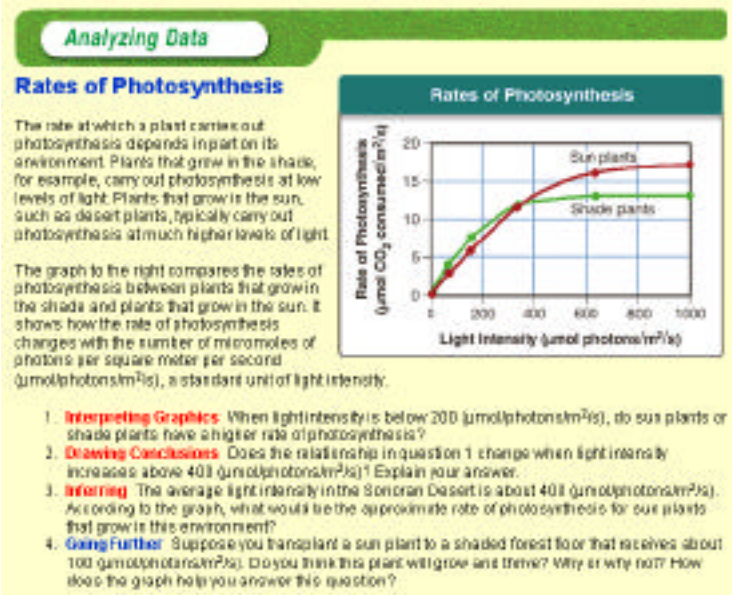
Each of the Key Concepts is marked with a Key Icon that reappears in the body of the text when the concept is explained or described. This helps students to identify and master the most important elements of the material.



Checkpoints appear several times in each section, asking questions that are designed to test student understanding of the material they've just read. The purpose of the checkpoint question, as students will quickly understand, is to make sure they've really understood the essential information in the paragraphs they've just completed. Students will quickly learn to use the checkpoints to ensure they've understood the material, making the textbook a more effective learning tool.



We believe that all good teachers use **analogies** to get difficult concepts across, and we've done our best to pack the book with stories and analogies that will aid student understanding. Because we developed the art at the same time we wrote the text, we were often able to carry these analogies over into the artwork. The analogy between ATP and a storage battery on page 203 is a perfect example of the way in which we've made analogies visual and verbal, making them more memorable and more effective for students.



Numbers matter in science, and that's why you'll find a feature called **Analyzing Data** at various places throughout the text, like this one on page 213.

These features give your students practice in handling real world experimental data and results, interpretation of graphs, and challenge them to draw conclusions from the information. These features will help your students to think like scientists — and will also prepare them for problems of this sort found on state and national exams.

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Teacher's Edition

The Annotated Teacher's Edition (ATE) of the Dragonfly book is a wraparound-style supplement to the student text. The teaching experts at Prentice Hall have placed a number of features in the margins of the ATE to assist your work in classroom and laboratory. The authors have used the ATE as well, always trying to give you a little extra to share with your class. To see what we had in mind, turn to page 72 of the textbook, which describes ecological pyramids and the so-called "Rule of 10" with respect to trophic levels. The rule of 10 is a well-established principle of ecology, but your students may wonder just how precise that rule actually is. Not precise at all is the answer. Joe Levine's **Biology Update** at the margin of the ATE on that page explains that the rule doesn't apply equally well to all ecosystems. In fact, the differences between levels in such systems varies widely, ranging from 0.05% to 20%.

Teacher to Teacher: We've even pasted-in teaching hints and ideas from your colleagues. Turn back to page 71, and you'll see a great teaching suggestion from LouEllen Brademan of Virginia on a student activity involving food webs.

Chapter Planner: The true value of the ATE is to be found in the 2-page Chapter Planner section that precedes each chapter. In the Chapter Planner you'll find a coordinated guide to each and every feature that Prentice Hall has put together to support and assist your teaching efforts for this particular chapter. Take a look, for example, at the Chapter Planner on page 200a for Section 8-1. In addition to listing the activities and labs for that section, it describes the Study Workbook materials for the section, lists the relevant slides in the Presentation Assistant and iText, and also lets you know that there is a clip on ATP formation in the Videotape Library for the program.

Move through the chapter, and you'll see (page 202) that the relevant slides from the Presentation Assistant are listed on the very page where showing them would make sense, as well as a series of suggestions on how to use the graphics and visuals that have been prepared for this section.

The ATE also contains answers to questions posed in the Student Edition, suggests writing activities, teaching and prep tips for the labs, and teacher keys to other features such as Analyzing Data.

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Print Ancillaries

Although Joe Levine and I wrote every word of the Dragonfly textbook (subject to our editors' blue pencils, of course), we did not write any of the ancillaries. We did, however, have an opportunity to review them, and we know that they provide strong support for what we tried to do in the textbook itself. They include:

Lab Manual, Level A (advanced)
Lab Manual, Level B (basic)
TEs of both Laboratory Manuals
Guided Reading and Study Workbook
Core Teaching Resources (including section reviews, vocabulary, lab and study work sheets, and answer keys, all organized by unit to save time)
Biotechnology Manual
Issues and Decision-Making
Biology Assessment System (including test prep resources, standardized test prep workbook, skills and content review, and diagnostic tests)

In addition, many of these printed ancillaries are also found on the **Resource Pro**, a CD-ROM disk that contains PDF copies of the ancillaries in forms that can be easily organized into lesson groups and then printed out as you need them for your class schedule.

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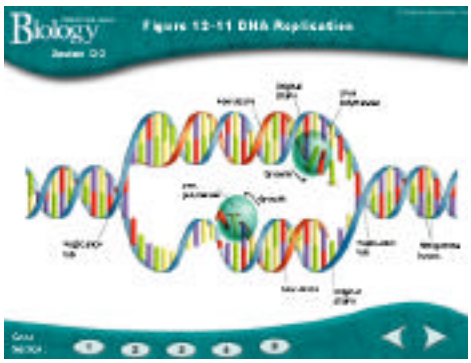
Electronic Ancillaries

Quite frankly, our publisher has outdone itself with the electronic resources that are available to support the Dragonfly Book. There are 7 principal resources, shown here, that are part of the program:



You may already be familiar with several of these, but we'd advise you to make an effort to try all of them before the school year begins. If you do, you'll be in a better position to determine which ones you'd like to work into your teaching routine.

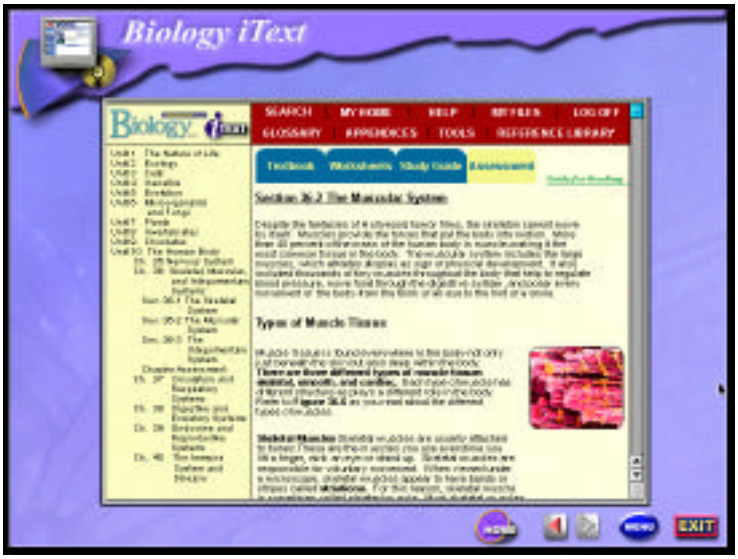
One of the most useful, shown at the left, is the **Presentation Assistant Plus.** This is a CD with a set of more than 800 PowerPoint slides keyed to each chapter in the textbook. You can copy and edit them as you wish, use them with a computer projector, or simply print them out for use in the classroom. The images are identical to key diagrams in the textbook, making them ideal for discussing important concepts in front of your class.

Among the most interesting resources are the **BioDetective** videotapes, which were prepared with the help of the Discovery Channel. You owe it to yourself to take these home and watch them. If you do, I suspect that you'll have plenty of ideas on how to use these throughout the year. There are 10 different programs on the tapes, each one presenting students with a mystery that can only be solved by the careful application of biological knowledge.

There's also a complete teaching guide to the videotapes, complete with suggestions on how to prepare your students for the programs, and how to energize your students in solving the mysteries.

Prentice Hall has also prepared a Video Library of **Animated Biological Concepts** that will help your students understand processes that are best illustrated with the aid of animation. The tapes are available in both English and Spanish.

The most innovative electronic component of the Dragonfly program is the ***iText***. This is a complete, interactive version of the textbook on CD.



The **iText** contains the complete student text, as well as a series of videos, animations, and learning tools for your students.

The **iText** does more than just duplicate the textbook. It contains a whole range of features that make it a unique learning resource that you may wish to use to supplement, rather than to replace, the traditional book. The **iText** is also available directly over the internet — meaning that your students may never again complain about having to lug those bulky textbooks to and from class!

http://www.phschool.com/atschool/biology/

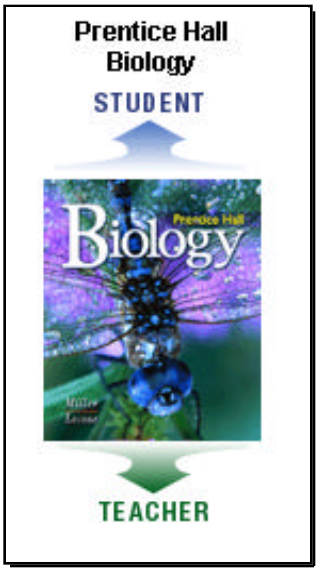
The Web

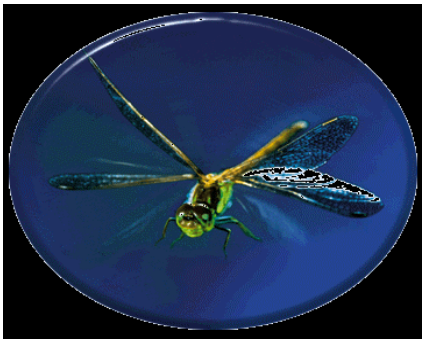
Finally, Prentice Hall maintains its own web site for the Dragonfly text at its **phschool.com** address.

The web site contains resource material for each chapter of the text, a "BioBits" question of the day, and even a link to ask questions (indirectly) of the authors.

One of the interesting aspects of the site it that it has separate entryways for students and teachers, with slightly different resources for each:

This seems like a good idea to me, but you should be aware that there is no registration process required to use either side of the site. So, you don't have to be a "real" teacher to enter to teacher side — meaning that one shouldn't assume that students will not read the material made available on the teacher gateway.





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millerandlevine.com

Our Personal Web Site

As useful as our publisher's web site for our book may be, we decided about a year ago that we would set up our own site. Why should you visit our web site when our publisher has a perfectly good one? For the very simple reason that ours is better (no kidding!):

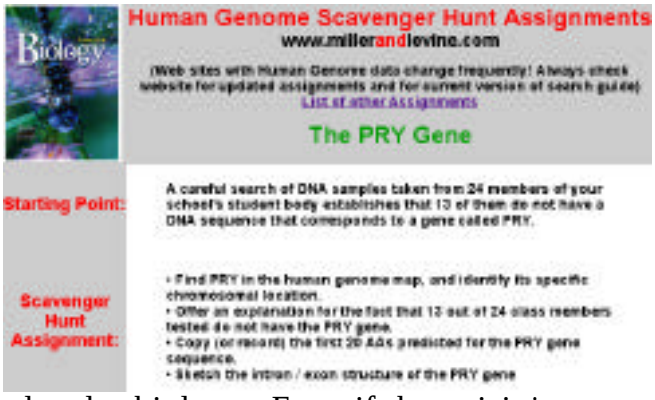
What we've done is to take all of the chapter support material from PH's site, and place it on ours in a more logical and accessible layout. In fact, all you have to do is to click on the cover of the book, and you'll be taken to a complete table of contents from which you can select the chapter of your choice.

Once you open the chapter page, you'll find the same features available at the PH site. These are Hot Links on the Internet, Teaching Resources, "Take it to the Web," and a 10-question interactive quiz. However, because we program the site ourselves, we can update and change the material for each chapter literally overnight. You'll find that the site contains scores of valuable links not available from our publisher, teaching ideas, revised figures, and scientific updates to the text.

In addition, we've added a whole series of features that you and your students will be able to use and enjoy in the laboratory and classroom. We place links to breaking news stories right on the front page (note the link to the reports of a new hominid from Chad, in central Africa, which appeared in July 2002), we have a link for questions and answers submitted directly by students and teachers, and we've prepared special pages of web resources for key issues like genetically-modified foods, stem cells, and human cloning research.

We've paid special attention to the Human Genome Project, providing a Genome Gateway that will allow you and your students to explore the human genome directly.

In addition to a page of Genome educational resources, we've provided a page of links to allow you and your students to access Human Genome databanks directly. This means that your students are able to explore each and every human chromosome, scanning for genes, reading the DNA base sequences, and tapping into the latest information on genome structure, genetic disorders, and other aspects of human genetics. Too complicated, you suggest? Not at all. We've written a 5-page guide to searching the human genome, and we've even prepared a "scavenger hunt" exercise to help your students gain familiarity with the genome. We hope you'll feel free to download copies of the guide, share them with your colleagues and students, and poke around in the genome to your heart's content.



As your students will quickly discover, even though these databanks were designed for researchers, there's nothing about them that prevents a high school student from looking around, exploring the arrangement of genes on chromosomes, and using these tools to learn as much as they like about human genetics and molecular biology. Even if they visit just a few times, your students will gain a most valuable lesson — that science is a wide-open activity in which everyone is welcome.

The **millerandlevine** web site also has a direct e-mail link to the authors, which we hope you will use regularly. If there's anything you'd like to see on the site, all you have to do is ask. Remember, we're the programmers, and we can literally put something up *tomorrow* if you'd find it useful. One of the resources we would like to add to the site this year is a library of lab exercises written by high school teachers. If you have a lab that really works, tell us about it and we'll place it on the web site — with full credit to you — for your colleagues to try and admire.

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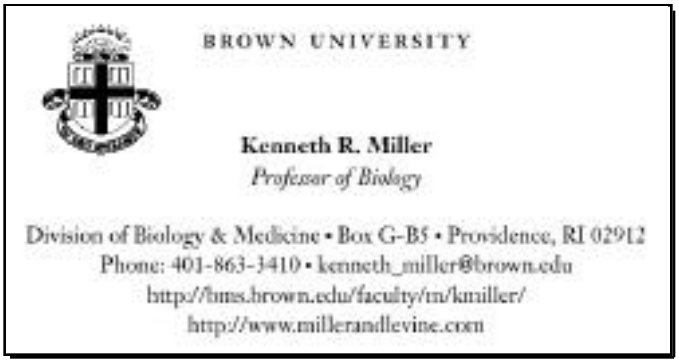
Finally, a Personal Promise

This book is only a part of the commitment that Joe Levine and I have made to supporting science education. We are honored by your choice of our textbook for your students, and we will do anything to support and enhance your efforts in classroom and laboratory. As many of you know, Joe and I attend more than a score of state, regional, and national science education meetings ever year, and meet with teachers on a regular basis. If you're able to attend any of these meetings be sure to visit us and say hi. We're always eager to hear how things are going in your classroom and school.

As we mentioned earlier in this booklet, our web site has an e-mail link that you can use at any time to get in touch. Here's a copy of my card, which includes the URL for my faculty web page (below) as well as my mailing address and phone number.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http://www.millerandlevine.com

I hope you'll feel free to use it whenever you like. Both of us are busy, of course, just like you, but we're never too busy to talk to a fellow biologist, especially one using our textbook.


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Research — My research involves problems of structure and function in biological membranes. Principal research tools are a variety of techniques associated with electron microscopy.

Brief CV — A summary of academic training, recent research papers, books, and honors.

Personal — A few personal photos, hobbies, and pictures of good-looking pets.

Biology 20 — In the Spring I teach Bio 20, an introductory biology course intended for science concentrators and non-concentrators. This link will take you to the Bio 20 web pages from 2001.

Biology 105 — In the Fall, along with Prof. Susan Gerbi, I teach Biology 105, an upper-level Cell Biology course for graduate and undergraduate students.

Evolution — One of my principal interests is the public understanding of evolution. I have written a number of articles defending the scientific integrity of evolution, answering challenges such as "intelligent design," and have debated a number of anti-evolutionists. This link will take you to some of these articles, debates, and even a couple of on-line videos.

Textbooks — Joseph S. Levine and I have written a series of high school and college textbooks. They are generally know by the animals on their cover, and we have put together website for each of them. Our newest is the "Dragonfly Book," published in 2002 by Prentice Hall. However, we also have websites for the "Elephant Book," and the "Lion Book."

Finding Darwin's God — Finding Darwin's God, "A scientist's search for common ground between God and evolution," is a book in which I analyze the religious implications of evolution. If you are interested in such questions, I think you will find it interesting, especially in light of the continuing "evolution - creation" controversies around the country.

Please keep in touch, and let us know how the book is working for your students — and, most especially, of any ideas you have on how to make it better.

With Best Wishes,

Ken Miller

millerandlevine.com