Special Book Article

The evolving role of the textbook in introductory biology

I
t is 1940: The first edition of This Living World is published by McGraw-Hill Book Company, Inc. Its 500-plus pages include 16 chapters that focus mainly on humans, with scattered black-and-white line art and a few photos. In the preface, authors C. C. Clark and R. H. Hall write, “The aim of this book is to present, in a form which combines accuracy with pleasant reading, the gist of modern knowledge about the living world....”

It is 1967: The first edition of Elements of Biological Science is published by W. W. Norton and Company, Inc. Its nearly 600 pages include 22 chapters organized into five parts that progress from the level of the cell through tissues, organs, organ systems, and ecosystems. Art and photos are still sparse, still black and white. In the preface, author William Keeton writes, “A textbook for today’s better-prepared students must do justice to the newer areas of biological science without neglecting the older areas that provide the foundation upon which the new rests.”

It is 1998: The first edition of Asking About Life debuts from Saunders College Publishing, written by Allan Tobin and Jennie Dusheck. Its nearly 1000 pages cover 44 chapters, in seven parts, again moving from the microscopic up the biological ladder of organization. The authors write in the preface, “Our philosophy is that biology is a story, and as such, it must be presented as continuously as possible.” Many pages have full-color drawings or photographs, and the book is just one part of the package. Textbooks in the nineties aren’t complete, and can’t compete, without manuals, lab guides, overheads, lecture outlines, test banks, CD-ROMs, laser disks, and Web pages.

by Ricki Lewis

Look beyond the paraphernalia and the spectacular art that accompanies today’s introductory life science textbooks, and the overall goal is close to that of books written decades ago. A biology textbook seeks to inform and engage, preparing the student to study biology further or to become a scientifically literate citizen. The many beginning books differ by how well they meet these challenges and how closely they fit a particular instructor’s syllabus, as well as in special features that help to capture students’ attention, such as high-interest chapter introductions, interviews with scientists, or learning aids, such as subheads posed as questions. “It is the job of the editor and author to make certain that basic content is covered, but it is also their job to come up with new features or emphases that will appeal to a broad group of potential users,” says Michael Lange, publisher for the life sciences at WCB/ McGraw-Hill College Publishing in Dubuque, Iowa.

Sorting through a pile of tomes left by publishers’ sales reps can be a daunting task. All of the books are beautiful and come with enticing goodies. Many stress inquiry, evolution, or readability, all desirable characteristics. Choosing among them, or at least narrowing the field, may be just a matter of reading a few pages, says Lange. “As a general rule, the best-selling books tend to succeed on some simple features: they tend to be better written, better organized, more accurate, and more pedagogical than their competitors.”

Authors and professors alike try to impart their passion for biology to students—often reluctant students. Following is a look at some of the questions that instructors are asking about textbooks, and at how the publishing industry is responding to their concerns.

Supplementing texts

The days in which a student gets all of the course information from the lecture and assigned textbook may be numbered. With life science research playing an increasingly important role in society, sources of information extend well beyond the printed textbook page. Although the textbook remains an excellent and handy resource, many professors supplement, or even replace, textbooks with other sources of information, such as magazine articles, scientific papers, and relevant Web sites.

A novel approach that takes advantage of the seeming sameness of most introductory textbooks is to allow students to choose which book to use to back up lecture material. “A truly innovative approach would be to have students buy a ‘professional’ text of their choice. The challenge for the teacher would then be to capitalize on this diversity and create activities in which the various viewpoints could be incorporated to the advantage of the students,” says Dave Williams, chair of the science department at Valencia Community College in Orlando, Florida. In addition to a text, Williams uses his own “book,” a compendium of lecture notes, diagrams, graphics, and assignments. “If you really want to enjoy teaching, you should have your own book. I don’t see how one can not write such a book while teaching continuously for many years,” he adds.

Peter Ommundsen, a biology professor at Selkirk College in Castlegar, British Columbia, also supplements whichever text he uses because he has yet to find a book with a fully problem-based approach. “Many current biology texts are written in support of the old paradigm of biology teaching—mindless memorization. I much prefer to engage stu-
Tichenor, a professor of biology at the University of Arkansas in Fayetteville, says "I've found one of the most successful approaches, especially for pre-meds, is a case-studies way to teach physiology and genetics. Students like case studies and problem-based learning. It puts content on top of real problems. We should find a way to do that for introductory biology."

Their dissatisfaction with standard publishers' fare has led the entire expansion of biology texts over the years. "Is less more?" Considering that the number of students in active learning—analysis, decision-making, and creative and critical thinking activities through the use of authentic case problems—has led the entire怪 passenger fare has led the entire problem-based learning. It puts content on top of real problems. We should find a way to do that for introductory biology."

A common criticism of introductory texts from all concerned is length—a typical book exceeds 750 pages. The expansion of biology texts over time reflects not only spectacular increases in knowledge, but also the need to make room for art and learning aids. "I've looked at a lot of standard college biology textbooks, and they are depressingly the same, and so loaded with material as to overwhelm students," says Mahlon Hoagland, the discoverer of transfer RNA and a molecular biologist who retired in 1985 after a career spent at Harvard University, Dartmouth College, and the Worcester Biomedical Institute in Massachusetts.

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Hoagland hadn't intended to write a short biology text, but that's exactly what he did with The Way Life Works: Everything You Need to Know About the Way All Life Grows, Develops, Reproduces, and Gets Along. The book, with six chapters—covering an introduction to biology, energy, information, feedback, development, and evolution—was published by Times Books, Random House, in 1995. The spectacular cartoonlike illustrations by coauthor Bert Dodson set this book apart.

Instructors were hesitant to try a book so much shorter than the rest of the pack. But once they were assured that all the major topics suggested in Developing Biological Literacy, a monograph published by the Colorado Springs-based Biological Sciences Curriculum Study (BSCS) in 1993, were, in fact, covered, some took the plunge, Baker relates.

BSCS, a nonprofit organization spun off of a committee of the American Institute of Biological Sciences 40 years ago, develops educational materials that are published commercially. The organization will soon introduce its own attempt to counter the encyclopedic nature of most introductory texts—Biological Perspectives, which will be available from Kendall/Hunt Publishing Company this spring. It is targeted to nonscience majors.

Joseph McInerney, executive director of BSCS, explains the creative presentation of Biological Perspectives. "There are three units. The introduction is a medical exam as a way to get into anatomy and physiology, homeostasis, and energy. The second unit, called 'Legacies,' focuses on human genetics and evolution, and the third unit, 'Preserving the Commons,' discusses ecological principles." The National Science Foundation and an anonymous donor funded the project. It is about 600 pages and has significantly fewer boldfaced terms than other texts, a common criticism of jargon-rich textbooks.
The idea for Biological Perspectives grew out of BSCS’s 1993 monograph. The text was written by six scientists who are part of the organization, says Lynda Mckikas, project director. The book is hole-punched for a three-ring binder and has large margins to encourage note taking. This “consumable” design lowers the price. An extensive faculty guide, laboratory manual, and CD-ROM suggest many ways that specific experiments, demonstrations, and activities can be part of lecture presentations. “The goal is to get college faculty to be more hands-on and interactive, even in a lecture setting,” says McInerney.

Choices, choices

Although any introductory biology text is likely to cover such staples as mitosis and meiosis, cell structure and function, organ systems, and ecology, presentation of topics varies in several ways. Instructors seem to be divided in their preferences to these approaches.

Micro to macro, or vice versa? For decades, most courses, and most textbooks, have followed a reductionist approach of “micro to macro.” That is, a student needs to know what an atom is before a molecule makes sense; chemistry to understand cell biology; cell structure to comprehend how tissues and organs form; and anatomy and physiology to understand ecology. The problem with this approach, instructors say, is that many students have difficulty envisioning or understanding what they cannot see. Atoms and molecules are foreign entities; animals and biomes are not. “It takes a good teacher to do micro-to-macro right, to make it interesting enough to be palatable,” says Williams.

The ecology-down approach makes a certain practical sense, but many of those who have tried it report that they often had to backtrack and diverge to explain the underpinnings of large-scale phenomena. “I thought it might be advantageous to start nonmajors off on concepts and objects which might be a little more familiar. I found, however, that without some background in cell structure and basic chemistry, my students were confused by anything other than surface coverage,” says Robert Jones, an associate professor of biology at Cotry College in Nevada, Missouri. He uses the textbook Biology: Discovering Life, by Kenneth Miller and Joseph Levine, published by D. C. Heath/Houghton Mifflin Company (1994) and one of the few macro-to-micro texts. But he still has to skip among the chapters.

Jack Baker, a professor of biology at Evergreen Valley College in San Jose, California, shuts between macro and micro several times during a semester so that all of his students can learn. “Some students appear to understand the fine points but never seem to grasp the big picture, while others deal well with macro-scale concepts but get lost in the small details,” he says. A discussion of acid rain, for example, would include ecological principles as well as basic chemistry.

Peppler versus connected. Several books have gone modular, packaging topics into neat, short doses. It is the MTV, sound-bite version of a textbook, and many students find the material easy to understand. “I love the approach, but it has to be done right. A unit should optimally be two to four pages. A head introduces a concept, and at the bottom right corner of the last page of each unit is a summary. Students can see the structure of the material, how ideas are organized, and it doesn’t change the content,” says George Johnson, a professor of biology and genetics at Washington University in St. Louis, Missouri, and author of The Living World (WCB/McGraw-Hill College Publishing, 1996) and two high school textbooks for Holt, Rinehart and Winston. From a publisher’s viewpoint, modular organization greatly facilitates production.

But the modular approach, some instructors say, runs counter to the idea of linking information. “Biology is full of themes, with concepts running through different areas, tying things together. You can’t do this as well with a modular approach,” says Santa Cruz–based science writer Dusheck. And an inexperienced student may not be able to judge the relative importance of different dollops of information. “With the modular approach, there is no hierarchy of information to tell the main points from other points,” Dusheck adds. Her and Tobin’s book instead relies on storytelling and connecting topics. BSCS’s Biological Perspectives combines the modular and storytelling approaches by having two types of narratives. “We try to place most of the content in sections called ‘Basics About,’ in a very direct, visual way, and let the rest of the text explore, describe and discuss the big ideas, the unifying principles of biology, in a relevant context. The book makes it clear that facts are different from ideas,” says McInerney.

Majors versus nonmajors. Biology majors and nonmajors are vastly different creatures—the former often en route to medical school, the latter often not terribly interested in the subject. Can these two species use the same text? Opinions vary, although many instructors concur that the texts written for nonmajors or “mixed” classes are often much more readable than the jargon- and fact-packed tomes aimed at biology majors.

Williams feels that a good instructor and text can successfully teach the fundamentals of biology to either type of student and that a course should not be “watered down” to accommodate nonscience majors. But Jack Baker thinks that the differences between the two types of students should be addressed in separate textbooks. “Nonmajors need much more support with terminology and jargon, pronunciation, and explanation of basic scientific concepts. Their math skills are typically weaker too. This is not an argument to steer clear of numbers, graphs,
and tables, but rather it means they need more explanation and incorporation directly in the written text," he says.

The student perspective

Today's students learn in many ways, and most introductory biology textbooks are put together so thoughtfully that there is literally something for everyone. Tables, graphics, and CD-ROMs target the visual learner; interesting asides and anecdotes attract the unenthusiastic; and modular presentations and summary devices help those who wish to learn quickly. Books may go from micro to macro or the converse, and they may offer an eloquent narrative or bare-bone facts. Ancillary enticements grow each semester. But perhaps students are the best at summing up what appeals to them in a textbook, reports Helen Pigage, a professor of biology at the US Air Force Academy in Colorado—and those requirements echo back to the textbooks of years ago. “My students want a book that is readable, not too long, clearly written, and interesting.” Publishers, authors, and instructors, take note!

Ricki Lewis, a writer based in upstate New York, is the author of two college textbooks, Life and Human Genetics, and coauthor of two others, Hole's Human Anatomy and Physiology and Hole's Essentials of Human Anatomy and Physiology (all published by WCB/McGraw-Hill College Publishing). She has a doctorate in genetics and has published more than 2000 magazine articles.