

PREFACE

In recent years, several groups have tested the scientific literacy of American adults, and the results have been startling.

- Nearly a quarter of Americans think the sun revolves around the earth.
- Forty percent can't place the Pacific Ocean on an unlabeled map.
- One third couldn't say what a molecule is.
- Five out of six don't know the basics of genetic engineering.
- More than half failed a Kinsey Institute quiz on sex and reproduction.
- Even our best high school biology students (those in advanced placement courses) scored lowest, on average, among their peers from thirteen other industrialized nations in a recent exam.

While there are several, often conflicting, explanations for our national illiteracy in biology and other sciences, surveys reveal unambiguously negative attitudes among the very people who have the most to learn. The public, to put it simply, doesn't like science very much. Most students think the subjects are difficult, only for top scholars, and all-around just plain boring.

Required to memorize biological details such as the life cycles of the slime molds, the molecular structure of a ribosome, or the anatomy of a worm, students will quite logically wonder: What's this got to do with me and my life? Texts and courses have frequently overlooked the need for a clear framework showing how details like these can fit into the broader themes of biology and everyday life, not to mention underemphasizing health, fitness, food, sex, the environment, and other topics of intrinsic interest to students.

Somehow, despite our nation's superiority in science and technology, students have missed out on the excitement of scientific discovery and the pleasure of exploring and understanding the physical world. Their natural curiosity about nature has all too often been stifled by the time they reach college, and thus they are unaware of the vital role that biology and other sciences play in our survival, now and in the future. People today are faced with dozens of important choices about what to eat or avoid; what to buy or not buy; what to support politically or vote down; how to protect themselves against AIDS, heart disease, obesity, and other conditions; and what they can do personally to prevent the global environment from being further denuded, planted, paved, and polluted. Quite clearly, we face a dilemma of serious proportions: an entire generation of unprepared students who nevertheless need to understand biological science as never before.

It was against this challenging backdrop that we planned and produced *Biology! Bringing Science to Life*. We wanted to create a learning tool that was not simply a shortened version of our well-received book *The Nature of Life*. Instead, we designed a book that could provide any beginning college student, regardless of previous biology courses or attitudes toward science, with the information he or she needs to make informed personal and societal choices as a citizen of the late twentieth century. To do this, the book would have to selectively present those supporting facts and concepts needed for clear understanding, place them in a broad context, and deliver them in a way that would interest, entertain, and provoke the reader. While the student was acquiring the basic knowledge to make informed life choices, he or she could also pick up a heightened appreciation along the way for the natural world, and for the ways biologists think, work, and discover. Beginning students and their professors have repeatedly called for such a book, and we hope *Biology!* does the job.

Each chapter begins with a story—a dilemma, really.

- How can people, all of whom are 65 percent water, live and thrive in the desert?
- How does solar energy (indirectly, of course) power a hiker up a mountain trail?
- Why do some diseases resist treatment with antibiotics?
- Why can't some people drink diet sodas?
- How can a climber reach the top of Mt. Everest without an oxygen tank?
- How does cocaine damage the nerves and brain of an unborn baby?
- Is our environment heating up, and how will that affect us?

Each chapter then provides the necessary background facts and concepts to answer the question, as well as raising and addressing related ones, many of direct relevance to the students.

- Should you catch some rays?
- Should you undergo genetic screening?
- What can you do to help prevent global warming and ozone depletion?

We pose many of these questions in the boxes called Health Choices, Societal Choices, and Environmental Choices. These essays always provide evidence about various sides of the issues, and encourage students to formulate their own opinions and plans of action. The essays end with lists of additional sources of information, and the lists represent our response to an interesting point raised by surveys of science literacy. The vast majority of respondents

consider it far more important for a citizen to be able to locate, read, and apply scientific information than to memorize science facts and concepts and spout them at will. The much sought-after educational commodity called "critical thinking" depends on this information gathering and processing. The boxed essays called Personal Impact are also designed to stimulate critical thinking by applying basic material from the surrounding chapter to topics of student interest.

The book further encourages critical thinking through another series of boxes called Discovery. These boxes are models of the scientific process that show how biologists study the world—how they make observations, pose specific questions, and test possible answers. The boxes are designed to be more than a recitation of the scientific method. They are intended to show how scientists think and what processes they use—processes which we all employ every day—in solving problems.

The contemporary graphic and art styles we have chosen for *Biology!* are intended to invite and appeal to readers, as well as to illustrate the material in a simple, clear way. An innovative feature called At a Glance provides an illustrated summary at the end of each chapter. Other study tools in each chapter include underlined take-home messages, a Connections section to review and interrelate concepts, a New Terms list, Study Questions, and a For Further Reading list. Our approach is deliberately visual and oriented toward high student interest and easy review. We hope it accomplishes our goals and will help in some small way to close the worrisome gap between society's science illiteracy and its desperate need to understand and apply science facts and ideas to daily life and global directions.

SUPPLEMENTARY MATERIALS

A comprehensive and completely integrated package of supplementary materials accompanies *Biology! Bringing Science to Life*.

- **Instructor's Manual and Resource Guide**
Dennis Todd, University of Oregon
- **LecturePak** (transparency masters of lecture outlines)
Dennis Todd, University of Oregon
- **Study Guide**
Deborah M. Brosnan, Oregon State University
- **Test Bank**
Dennis Todd, University of Oregon
- **Laboratory Manual**
Eileen Jokinen, University of Connecticut, Storrs
Theodore Taigen, University of Connecticut, Storrs
Thomas Terry, University of Connecticut, Storrs
David Wagner, University of Connecticut, Storrs
- **Laboratory Preparator's Guide**
Eileen Jokinen, University of Connecticut, Storrs
Theodore Taigen, University of Connecticut, Storrs

- Thomas Terry, University of Connecticut, Storrs
- David Wagner, University of Connecticut, Storrs
- **Computerized Instructor's Manual** (available in IBM, Macintosh, Apple)
- **Computerized Test Bank** (available in IBM, Macintosh, Apple)
- **BioPartner** (Computerized Study Guide; available in IBM, Macintosh)
- **Videos**
- **Biology Slides and Acetate Package**
- **Videodisk**
- **HyperMedia Software** (Macintosh):
Lecture Planner (to accompany the Videodisk)
Daniel Udovic, University of Oregon
Biological Diversity (interactive software)
Daniel Udovic, University of Oregon

For further information regarding the supplements available, please contact your local McGraw-Hill representative.

ACKNOWLEDGMENTS

We have sought the advice of hundreds of instructors around the country to help us create a textbook that would meet the unique needs of the introductory biology market. Our sincere thanks are extended to the following individuals who responded to our market questionnaires:

Dr. Laura Adamkewicz, George Mason University; Olu-kemi Adewusi, Ferris State University; Kraig Adler, Cornell University; Dr. John U. Aliff, Glendale Community College; Joanna T. Ambron, Queensborough Community College; Steven Austad, Harvard University; Robert J. Baalman, California State University, Hayward; Stuart S. Bamforth, Tulane University; Sarah F. Barlow, Middle Tennessee State University; R. J. Barnett, California State University, Chico; Joseph A. Beatty, Southern Illinois University, Carbondale; Nancy Benchimol, Nassau Community College; Dr. Rolf W. Benseler, California State University, Hayward; Gerald Bergtrom, University of Wisconsin, Milwaukee; Dr. Dorothy B. Berner, Temple University; Dr. A. K. Boateng, Florida Community College, Jacksonville; William S. Bradshaw, Brigham Young University; Jonathan Brosin, Sacramento City College; Howard E. Buhse, Jr., University of Illinois, Chicago; John Burger, University of New Hampshire; F. M. Butterworth, Oakland University; Guy Cameron, University of Houston; Ian M. Campbell, University of Pittsburgh; John L. Caruso, University of Cincinnati; Brenda Casper, University of Pennsylvania; Doug Cheeseman, De Anza College; Dr. Gregory Cheplick, University of Wisconsin; Dr. Joseph P. Chinnici, Virginia Commonwealth University; Carl F. Chuey, Youngstown State University; Dr. Simon Chung, Northeastern Illinois University; Norman S. Cohn, Ohio University; Paul Colinviaux, Ohio State University; Scott L. Collins, University of Oklahoma; Dr. August J. Colo, Middlesex County College; G. Dennis Cooke, Kent State; Jack D. Cote, College of Lake

County; **Gerald T. Cowley**, University of South Carolina; **Louis Crescitelli**, Bergen Community College; **Orlando Cuellar**, University of Utah; **Thomas Daniel**, University of Washington; **J. Michael DeBow**, San Joaquin Delta College; **Loren Denny**, Southwest Missouri State University; **Ron DePry**, Fresno City College; **Dr. Kathryn Dickson**, California State University, Fullerton; **Patrick J. Doyle**, Middle Tennessee State University; **Dr. David W. Eldridge**, Baylor University; **Lynne Elkin**, California State University, Hayward; **Paul R. Elliott**, Florida State University; **Eldon Enger**, Delta College; **Gauhari Farooka**, University of Nebraska, Omaha; **Marvin Fawley**, North Dakota State University; **Ronald R. Fenstermacher**, Community College of Philadelphia; **Edwin Franks**, Western Illinois University; **C. E. Freeman**, University of Texas, El Paso; **Lawrence D. Friedman**, University of Missouri, St. Louis; **Dr. Ric A. Garcia**, Clemson University; **Wendell Gauger**, University of Nebraska, Lincoln; **Dr. S. M. Gittleson**, Fairleigh Dickinson University; **E. Goudsmit**, Oakland University; **John S. Graham**, Bowling Green State University; **Shirley Graham**, Kent State University; **Thomas Gregg**, Miami University; **Alan Groeger**, Southwest Texas State University; **Thaddeus A. Grudzien**, Oakland University; **James A. Guikema**, Kansas State University; **Robert W. Hamilton**, Loyola University of Chicago; **Richard C. Harrel**, Lamar University; **T. P. Harrison**, Central State University; **Maurice E. Hartman**, Palm Beach Community College; **Dr. Karl H. Hasenstein**, University of Southwestern Louisiana; **Martin A. Hegyi**, Fordham University; **Dr. John J. Heise**, Georgia Institute of Technology; **H. T. Hendrickson**, University of North Carolina, Greensboro; **T. R. Hoage**, Sam Houston State University; **Kurt G. Hofer**, Florida State University; **Dr. Rhodes B. Holliman**, Virginia Polytechnic Institute and State University; **Harry L. Holloway**, University of North Dakota; **E. Bruce Holmes**, Western Illinois University; **Jerry H. Hubschman**, Wright State University; **Hadar Isseroff**, State University of New York College, Buffalo; **Dr. Ira James**, California State University, Long Beach; **Dr. Wilmar B. Jansma**, University of Northern Iowa; **Dr. Margaret Jefferson**, California State University, Los Angeles; **Dr. Ira Jones**, California State University, Long Beach; **Dr. Patricia P. Jones**, Stanford University; **Dr. Craig T. Jordan**, University of Texas, San Antonio; **Maurice C. Kalb**, University of Wisconsin, Whitewater; **Bonnie Kalison**, Mesa College; **Judy Kandel**, California State University, Fullerton; **Arnold Karpoff**, University of Louisville; **L. G. Kavaljian**, California State University, Sacramento; **Donald R. Kirk**, Shasta College; **R. Koide**, Pennsylvania State University; **Mark Konikoff**, University of Southwestern Louisiana; **Barbara S. Lake**, Central Piedmont Community College; **Jim des Lauvérs**, Chaffey College; **Tami Levitt-Gilmarr**, Pennsylvania State University; **Daniel Linzer**, Northwestern University; **J. R. Loewenberg**, University of Wisconsin, Milwaukee; **Dr. Robert Lonard**, University of Texas, Pan American; **Sharon R. Long**, Stanford University; **Carmita E. Love**, Community College of Philadelphia; **C. E. Ludwig**, California State University, Sacramento; **Dr. Ann S. Lumsden**, Florida State University; **Dr. Bonnie Lustigman**, Montclair State College; **Edward B. Lyke**, California State University, Hayward; **Douglas Lyng**, Indiana University-Purdue University, Ft. Wayne; **George**

L. Marchin, Kansas State University; **Philip M. Mathis**, Middle Tennessee State University; **Mrs. Margaret L. May**, Virginia Commonwealth University; **Edward McCrady**, University of North Carolina, Greensboro; **Bruce McCune**, Oregon State University; **Dr. John O. Mecom**, Richland College; **Tekié Mehary**, University of Washington; **Richard L. Miller**, Temple University; **Phyllis Moore**, University of Arkansas, Little Rock; **Carl Moos**, State University of New York, Stony Brook; **Doris Morgan**, Middlesex County College; **Donald B. Morzenti**, Milwaukee Area Technical College; **Steve Murray**, California State University, Fullerton; **Robert Neill**, University of Texas, Arlington; **Paul Nollen**, Western Illinois University; **Kenneth Nuss**, University of Northern Iowa; **William D. O'Dell**, University of Nebraska, Omaha; **Dr. Joyce K. Ono**, California State University, Fullerton; **James T. Oris**, Miami University; **Clark L. Ovrebo**, Central State University, Edmond; **Charles Page**, El Camino College; **Kay Pauling**, Foothill College; **Dr. Chris E. Petersen**, College of DuPage; **Richard Petersen**, Portland State University; **Jeffrey Pommerville**, Glendale Community College; **David I. Rasmussen**, Arizona State University; **Daniel Read**, Central Piedmont Community College; **Dr. Don Reinhardt**, Georgia State University; **Louis Renaud**, Prince George's Community College; **Jackie Reynolds**, Richland College; **Jennifer H. Richards**, Florida International University; **Thomas L. Richards**, California State Polytechnic University; **Tom Rike**, Glendale Community College, California; **C. L. Rockett**, Bowling Green State University; **Hugh Rooney**, J. S. Reynolds Community College; **Wayne C. Rosing**, Middle Tennessee State University; **Frederick C. Ross**, Delta College; **A. H. Rothman**, California State University, Fullerton; **Mary Lou Rottman**, University of Colorado, Denver; **Dr. Donald J. Roufa**, Kansas State University; **Dr. Michael Rourke**, Bakersfield College; **Chester E. Rufh**, Youngstown State University; **Mariette Rupert**, Clemson University; **Charles L. Rutherford**, Virginia Polytechnic Institute and State University; **Dr. Milton Saier**, University of California, San Diego; **Lisa Sardinia**, San Francisco State University; **A. G. Scarbrough**, Towson State University; **Dan Scheirer**, Northeastern University; **Randall Schietzself**, Harper College; **Robert W. Schuhmacher**, Kean College of New Jersey; **Joel S. Schwartz**, College of Staten Island; **Roger S. Sharpe**, University of Nebraska, Omaha; **Stanley Shostak**, University of Pittsburgh; **J. Kenneth Shull, Jr.**, Appalachian State University; **C. Steven Sikes**, University of South Alabama; **Christopher C. Smith**, Kansas State University; **John O. Stanton**, Monroe Community College; **D. R. Starr**, Mt. Hood Community College; **Dr. Ruth B. Thomas**, Sam Houston State University; **Nancy C. Tuckman**, Loyola University of Chicago; **Dr. Spencer Jay Turkel**, New York Institute of Technology; **William A. Turner**, Wayne State University; **C. L. Tydings**, Youngstown State University; **John Tyson**, Virginia Polytechnic Institute and State University; **Richard R. Vance**, University of California, Los Angeles; **Harry van Keulen**, Cleveland State University; **Roy M. Ventullo**, University of Dayton; **Judith A. Verbeke**, University of Illinois, Chicago; **Dr. Ronald B. Walter**, Southwest Texas State University; **Stephen Watts**, University of Alabama, Birmingham; **Dr. Joel D. Weintraub**, California State University, Fullerton; **Marion R. Wells**,

Middle Tennessee State University; **James White**, New York City Technical College; **Joe Whitesell**, University of Arkansas, Little Rock; **Fred Whittaker**, University of Louisville; **Roberta Williams**, University of Nevada, Las Vegas; **Chuck Wimpee**, University of Wisconsin, Milwaukee; **Mala Wingerd**, San Diego State University; **Richard Wise**, Bakersfield College; **Gary Wisehart**, San Diego City College; **Dan Wivagg**, Baylor University; **Richard P. Wurst**, Central Connecticut State University; **Edward K. Yeagers**, Georgia Institute of Technology; **Linda Yasui**, Northern Illinois University

There would be no *Biology! Bringing Science to Life* without the talented leadership and steady guidance of Eirik Borge, June Smith, and Denise Schanck, as well as the support of McGraw-Hill. We are also indebted to the dedicated professionals who produced this complex work, and who assisted in various other ways: Blake Edgar, Mary Eshelman, Karen Judd, Stuart Kenter, Alice Mace Nakanishi, Pattie Myers, Phyllis Niklas, Francis Owens, Phyllis Snyder, and Lesley Walsh.

We are grateful to Professor Nancy Parker, Southern Illinois University, Edwardsville, who helped steer us to the most up-to-date information, presented in the most accurate manner possible.

We would also like to thank the following individuals who contributed material and advice, which has been incorporated in this text: Charles L. Aker, The National Autonomous University of Nicaragua; Russ Fernald, University of Oregon; Craig Heller, Stanford University; Kent Holsinger, University of Connecticut; V. Pat Lombardi, University of Oregon; Christopher Stringer, British Museum, London; Daniel Udovic, University of Oregon; and Lenny Vincent, Fullerton College.

We would like to warmly acknowledge Peter Veres for his conceptualization of the At a Glance feature.

We greatly appreciate the many scientists and artists whose photographs and drawings illustrate these pages. Their names are listed on pages iv and A-13 to A-16.

Finally, we thank each other for the spirit of cooperation, mutual respect, and support that has made every step of this project enjoyable. If our student readers enjoy it half as much, we will be well satisfied!

John Postlethwait
Janet Hopson
Ruth Veres