Preface

WHAT SETS THIS BOOK APART?

Creating Informed Citizens

Integrated Science is a straightforward, easy-to-read, but substantial introduction to the fundamental behavior of matter and energy in living and nonliving systems. It is intended to serve the needs of nonscience majors who must complete one or more science courses as part of a general or basic studies requirement.

Integrated Science provides an introduction to a scientific way of thinking as it introduces fundamental scientific concepts, often in historical context. Several features of the text provide opportunities for students to experience the methods of science by evaluating situations from a scientific point of view. While technical language and mathematics are important in developing an understanding of science, only the language and mathematics needed to develop central concepts are used. No prior work in science is assumed.

Many features, such as Science and Society readings, as well as basic discussions of the different branches of science help students understand how the branches relate. This allows students to develop an appreciation of the major developments in science and an ability to act as informed citizens on matters that involve science and public policy.

> *"I especially like the application of the concepts and the connections in this text. We try very hard to show that science has connections to the everyday world and why it's important to see those connections. I don't think science can be taught to nonscience majors unless this type of approach is taken."*
>
> —Richard L. Kopec, St. Edward's University

Flexible Organization

The *Integrated Science* sequence of chapters is flexible, and the instructor can determine topic sequence and depth of coverage as needed. The materials are also designed to support a conceptual approach or a combined conceptual and problem-solving approach. The *Integrated Science* ARIS Instructor's Resources offer suggestions for integrating the text's topics around theme options. With laboratory studies, the text contains enough material for the instructor to select a sequence for a one- or two-semester course.

THE GOALS OF *INTEGRATED SCIENCE*

1. **Create an introductory science course aimed at the nonscience major.** The origin of this book is rooted in our concern for the education of introductory-level students in the field of science. Historically, nonscience majors had to enroll in courses intended for science or science-related majors such as premeds, architects, or engineers. Such courses are important for these majors but are mostly inappropriate for introductory-level nonscience students. To put a nonscience student in such a course is a mistake. Few students will have the time or background to move through the facts, equations, and specialized language to gain any significant insights into the logic or fundamental understandings; instead, they will leave the course with a distaste for science. Today, society has a great need for a few technically trained people but a much larger need for individuals who understand the process of science and its core concepts.
2. **Introduce a course that presents a coherent and clear picture of all science disciplines through an interdisciplinary approach.** Recent studies and position papers have called for an interdisciplinary approach to teaching science to nonmajors. For example, the need is discussed in *Science for All Americans—Project 2061* (American Association for the Advancement of Science), *National Science Education Standards* (National Research Council, 1994), and *Science in the National Interest* (White House, 1994). Interdisciplinary science is an attempt to broaden and humanize science education by reducing and breaking down the barriers that enclose traditional science disciplines as distinct subjects.

   > *"The authors obviously feel that emphasizing the interconnectedness of nature should be studied by integrating all of the sciences into a coherent, understandable network of facts, concepts, and interpretations that lead the student to view the universe in a new and enlightened perspective. This philosophy is particularly important in the education of nonscience majors who may never again formally study science."*
   >
   > —Jay R. Yett, Orange Coast College

3. **Help instructors build their own mix of descriptive and analytical aspects of science, arousing student interest and feelings as they help students reach the educational goals of their particular course.** The spirit of interdisciplinary science is sometimes found in courses called "General Science," "Combined Science," or "Integrated Science." These courses draw concepts from a wide range of the traditional fields of science but are not concentrated around certain problems or questions. For example, rather than just dealing with the physics of energy, an interdisciplinary approach might consider broad aspects of energy—dealing with potential problems of an energy crisis—including social and ethical issues. A number of approaches can be used in interdisciplinary science, including the teaching of science in a *social, historical, philosophical,* or *problem-solving* context, but there is

no single best approach. One of the characteristics of interdisciplinary science is that it is not constrained by the necessity of teaching certain facts or by traditions. It likewise cannot be imposed as a formal discipline, with certain facts to be learned. It is justified by its success in attracting and holding the attention and interest of students, making them a little wiser as they make their way toward various careers and callings.

4. **Humanize science for nonscience majors.** Each chapter presents historical background where appropriate, uses everyday examples in developing concepts, and follows a logical flow of presentation. A discussion of the people and events involved in the development of scientific concepts puts a human face on the process of science. The use of everyday examples appeals to the nonscience major, typically accustomed to reading narration, not scientific technical writing, and also tends to bring relevancy to the material being presented. The logical flow of presentation is helpful to students not accustomed to thinking about relationships between what is being read and previous knowledge learned, a useful skill in understanding the sciences.

VALUED INPUT WENT INTO STRIVING TO MEET YOUR NEEDS

Text development today involves a team that includes authors and publishers and valuable input from instructors who share their knowledge and experience with publishers and authors through reviews and focus groups. Such feedback has shaped this edition, resulting in reorganization of existing content and expanded coverage in key areas. This text has continued to evolve as a result of feedback from instructors actually teaching integrated science courses in the classroom. Reviewers point out that current and accurate content, a clear writing style with concise explanations, quality illustrations, and dynamic presentation materials are important factors considered when evaluating textbooks. Those criteria have guided the revision of the *Integrated Science* text and the development of its ancillary resources.

New to This Edition

Chapter 1: A discussion of "Scientific Communication" was added in order to add detail to the discussion of the scientific method, making the topic more appropriate for nonscience majors.

Chapter 3: A discussion of "Simple Machines" and also a new Myths, Mistakes, and Misunderstandings on recycling were added.

Chapter 4: A discussion of "efficiency" was included at a level of depth and detail appropriate for nonscience majors.

Chapter 8: Discussions of potential energy of electrons and uses for semiconductors as well as an Example on frequency and energy of electrons were added.

Chapter 11: The discussion of high-level nuclear waste was updated, and a discussion of what happened at Fukushima I was added.

Chapter 19: A new People Behind the Science biography on polymer chemist, Roy J. Plunkett (inventor of Teflon), was included. Section 19.2, Extraterrestrial Origin for Life on Earth, was rewritten. Also, the Closer Look discussion on enzymes was moved into the main text, while new information on ways to increase the level of 'good' cholesterol was added. These changes improved the relevance of this material for nonscience majors.

Chapter 21: New information on "Goldilocks planets" was added. Also, the material on selection and herbicides was heavily revised, with new material also added.

Chapter 22: This chapter was heavily revised: references to Usher and "theist" were removed; the section on Paleontology and Archaeology was revised, with more emphasis on definite statements and findings; the section on Genus Homo was revised; discussion of the Multiregional Hypothesis was removed; and a cladogram and expanded sense of history were added to the section on Hominin Origins.

Chapter 23: The nitrogen cycle description and diagram were revised. A new People Behind the Science on Jane Lubchenco was also added.

Chapter 24: This chapter was revised to make it more relevant to the nonscience major: medical-related information on and more discussion of eating disorders was added; the use of technical terms in the introduction to the nervous system were eliminated; Concepts Applied on Check Out the Nutrition Labels, Taste versus Smell, and Antagonistic Muscles were added; Science and Society, What Happens When You Drink Alcohol, was added; a new People Behind the Science on Henry Molaison and William Beecher Scoville was added; new information of tanning, gastric reflux, and probiotics was added; and the section on Guidelines for Obtaining Adequate Nutrients and the information on the new MyPlate food guide from the USDA were updated.

Chapter 25: The coverage on sexually transmitted diseases was expanded; a new Myths, Mistakes, and Misunderstandings, Is It Sex?, was added; and the sections on Hormonal Control Methods, Changes in Sexual Function with Age, and fraternal twins were all rewritten in chapter 25.

Chapter 26: Information on stem cells was moved into the main text of the chapter in order to improve the relevancy of this material for nonscience majors.

Appendices: The appendices have been revised and reorganized to provide improved problem-solving assistance for students. The tips and formatting for problem solving have been moved prior to the solutions in order to provide this material to students prior to their viewing of the solutions. A discussion of the methodology for solving multiple-choice type problems was also added to the problem-solving appendix. The answers to the end-of-chapter Applying the Concepts questions were also moved to the appendix.

Questions for Thought: The number of Questions for Thought was increased in all chapters without Parallel

Exercises in order to increase the number of practice questions for students and assignable homework questions for instructors.

THE LEARNING SYSTEM

To achieve the goals stated, this text includes a variety of features that should make student's study of *Integrated Science* more effective and enjoyable. These aids are included to help you clearly understand the concepts and principles that serve as the foundation of the integrated sciences.

OVERVIEW TO INTEGRATED SCIENCE

Chapter 1 provides an overview or orientation to integrated science in general and this text in particular. It also describes the fundamental methods and techniques used by scientists to study and understand the world around us.

MULTIDISCIPLINARY APPROACH

Chapter Opening Tools

Core Concept and Supporting Concepts

Core and Supporting Concepts integrate the chapter concepts and the chapter outline. The Core and Supporting Concepts outline and emphasize the concepts at a chapter level. The supporting concepts list is designed to help studets focus their studies by identifying the most important topics in the chapter outline.

Connections

The relationship of other science disciplines throughout the text are related to the chapter's contents. The core concept map, integrated with the chapter outline and supporting concepts list, the connections list, and overview, help students to see the big picture of the chapter content and the even bigger picture of how that content relates to other science discipline areas.

Chapter Overviews

Each chapter begins with an introductory overview. The overview previews the chapter's contents and what students can expect to learn from reading the chapter. It adds to the general outline of the chapter by introducing students to the concepts to be covered. It also expands upon the core concept map, facilitating in the integration of topics. Finally, the overview will help students to stay focused and organized while reading the chapter for the first time. After reading this introduction, students should browse through the chapter, paying particular attention to the topic headings and illustrations so that they get a feel for the kinds of ideas included within the chapter.

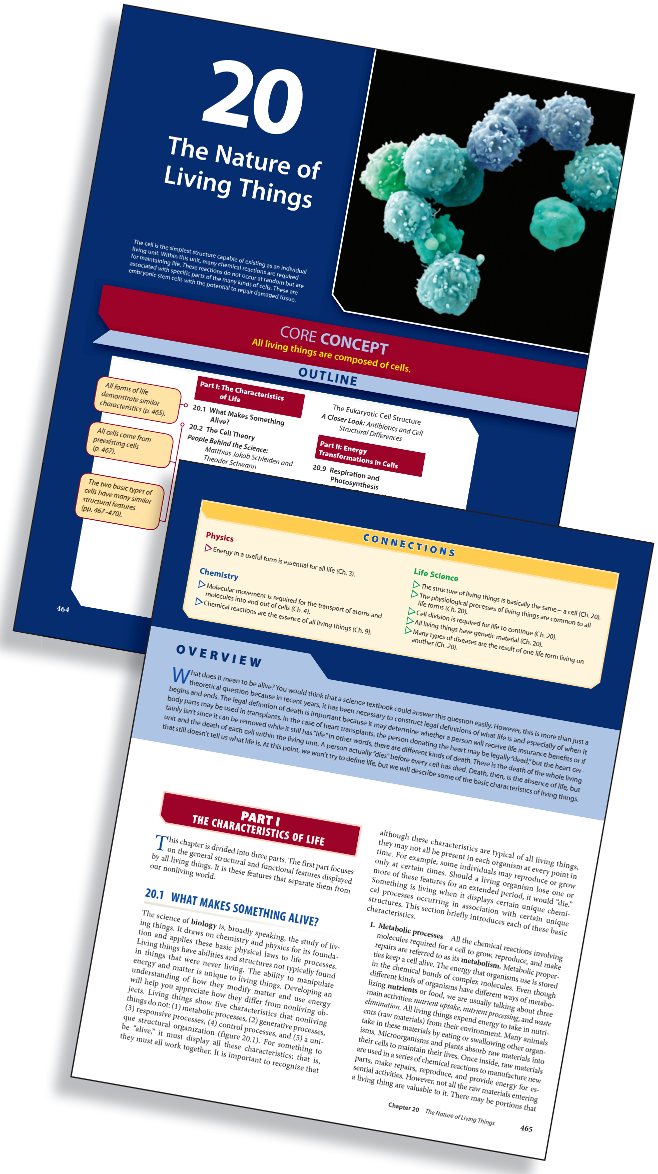
APPLYING SCIENCE TO THE REAL WORLD

Concepts Applied

As students look through each chapter, they will find one or more Concepts Applied boxes. These activities are simple exercises that students can perform at home or in the classroom to demonstrate important concepts and reinforce their understanding of them. This feature also describes the application of those concepts to their everyday lives.

Examples

Many of the more computational topics discussed within the chapters contain one or more concrete, worked **Examples** of a problem and its solution as it applies to the topic at hand. Through careful study of these Examples, students can better appreciate the many uses of problem solving in the sciences.



Follow-up Examples (with their solutions found in Appendix D) allow students to practice their problem-solving skills. The Examples have been marked as "optional" to allow instructors to place as much emphasis (or not) on problem solving as deemed necessary for their courses.

Science and Society

These readings relate the chapter's content to current societal issues. Many of these boxes also include Questions to Discuss that provide students an opportunity to discuss issues with their peers.

Myths, Mistakes, and Misunderstandings

These brief boxes provide short, scientific explanations to dispel a societal myth or a home experiment or project that enables students to dispel the myth on their own.

People Behind the Science

Many chapters also have one or two fascinating biographies that spotlight well-known scientists, past and present. From these People Behind the Science biographies, students learn about the human side of science: science is indeed relevant, and real people do the research and make the discoveries. These readings present the sciences in real-life terms that students can identify with and understand.

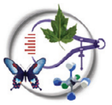
Closer Look and Connections

Each chapter of *Integrated Science* also includes one or more **Closer Look** readings that discuss topics of special human or environmental concern, topics concerning interesting technological applications, or topics on the cutting edge of scientific research. These readings enhance the learning experience by taking a more detailed look at related topics and adding concrete examples to help students better appreciate the real-world applications of science.

In addition to the **Closer Look** readings, each chapter contains concrete interdisciplinary **Connections** that are highlighted. **Connections** will help students better appreciate the interdisciplinary nature of the sciences. The **Closer Look** and **Connections** readings are informative materials that are supplementary in nature. These boxed features highlight valuable information beyond the scope of the text and relate intrinsic concepts discussed to real-world issues, underscoring the relevance of integrated science in confronting the many issues we face in our day-to-day lives. They are identified with the following icons:

> *"A Closer Look: The Compact Disc was, again, an excellent application of optics to everyday life and to something modern students thrive on—CDs and DVDs."*
>
> —Treasure Brasher, West Texas A&M University

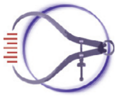
> *"Connections—wonderful!!!. . . . . . A Closer Look . . . excellent. Clear, interesting, good figures. You have presented crucial information in a straightforward and uncompromising way."*
>
> —Megan M. Hoffman, Berea College



General: This icon identifies interdisciplinary topics that cross over several categories; for example, life sciences and technology.

Life: This icon identifies interdisciplinary life science topics, meaning connections concerning all living organisms collectively: plant life, animal life, marine life, and any other classification of life.

Technology: This icon identifies interdisciplinary technology topics, that is, connections concerned with the application of science for the comfort and well being of people, especially through industrial and commercial means.



Measurement, Thinking, Scientific Methods: This icon identifies interdisciplinary concepts and understandings concerned with people trying to make sense out of their surroundings by making observations, measuring, thinking, developing explanations for what is observed, and experimenting to test those explanations.

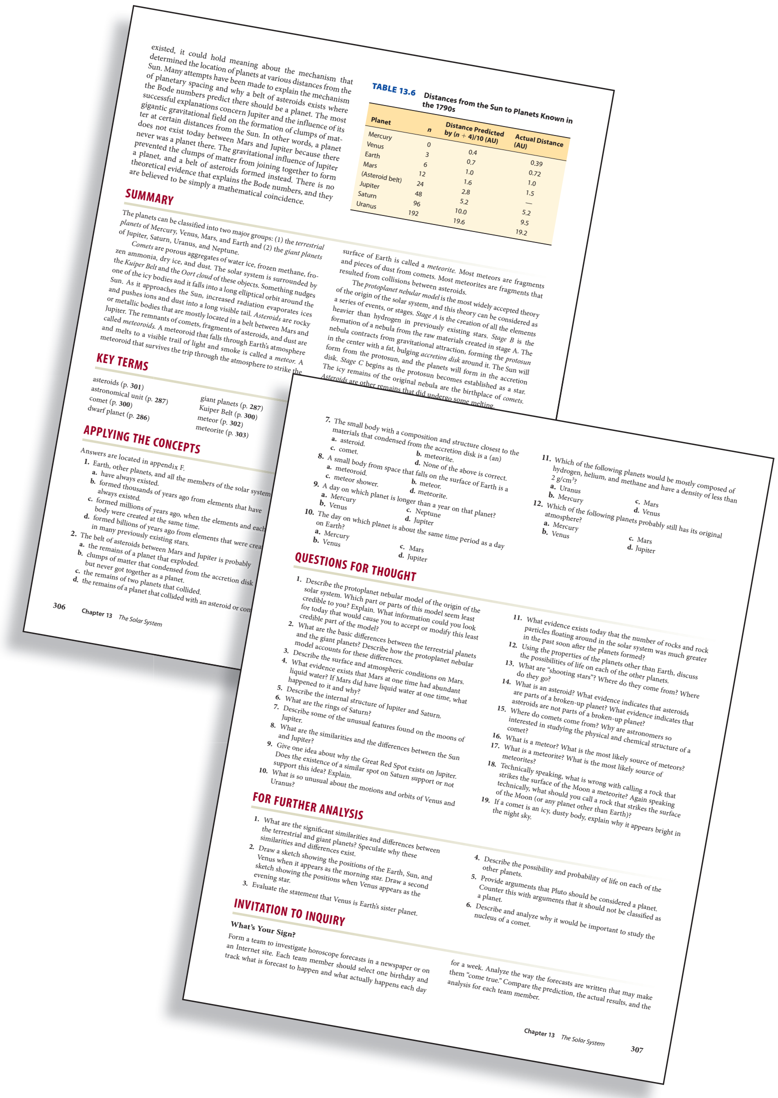
Environmental Science: This icon identifies interdisciplinary concepts and understandings about the problems caused by human use of the natural world and remedies for those problems.

END-OF-CHAPTER FEATURES

At the end of each chapter are the following materials:

- *Summary:* highlights the key elements of the chapter
- *Summary of Equations* (chapters 1–9, 11): highlights the key equations to reinforce retention of them
- *Key Terms:* page-referenced where students will find the terms defined in context
- *Applying the Concepts:* a multiple choice quiz to test students' comprehension of the material covered (Answers are included in appendix F.)
- *Questions for Thought:* designed to challenge students to demonstrate their understandings of the topic
- *For Further Analysis:* exercises include analysis or discussion questions, independent investigations, and activities intended to emphasize critical thinking skills and societal issues, and develop a deeper understanding of the chapter content
- *Invitation to Inquiry:* exercises that consist of short, open-ended activities that allow students to apply investigative skills to the material in the chapter
- *Parallel Exercises* (chapters 1–9, 11): There are two groups of parallel exercises, Group A and Group B. The Group A parallel exercises have complete solutions worked out, along with useful comments in appendix G. The Group B parallel exercises are similar to those in Group A but do not contain answers in the text. By working through the Group A parallel exercises and checking the solution in appendix G, students will gain confidence in tackling the parallel exercises in Group B and thus reinforce their problem-solving skills.

> *"I like the key terms with the page numbers with each one. I always like to see more conceptual- and synthesis-type questions, which is why I like the 'Questions for Thought' and 'For Further Analysis' parts. . . . Exercises such as 'Questions for Thought' number 7, having students think about why oxygen is in Earth's atmosphere but not in Venus or Mars' atmosphere, is a valuable sort of question, because it requires students to know something and apply it."*
>
> —Jim Hamm, Big Bend Community College



END-OF-TEXT MATERIAL

At the back of the text are appendices that give additional background details, charts, and answers to chapter exercises. Appendix E provides solutions for each chapter's follow-up Example exercises. There are also a glossary of all key terms, an index organized alphabetically by subject matter, and special tables printed on the inside covers for reference use.

> *". . . many books addressing similar disciplines have a tendency to talk over a student's head, making a student frustrated further in a class they do not want to be attending. . . . Personally, I would admit that* Integrated Science *has a slight edge. The glossary seems up-to-date and centers in on words many nonscience majors may not understand."*
>
> —David J. DiMattio, St. Bonaventure University

MULTIMEDIA SUPPLEMENTS

McGraw-Hill Connect Physical Science

McGraw-Hill Connect Physical Science is a web-based assignment and assessment platform that gives students the means to better connect with their coursework, with their instructors, and with the important concepts that they will need to know for success now and in the future. With Connect Physical Science, instructors can deliver assignments, quizzes, and tests easily online. Students can practice important skills at their own pace and on their own schedule. Connect Physical Science includes all Parallel Exercises from the text (in open-ended, numerical entry, and algorithmic format whenever possible) as well as all Questions for Thought in multiple-choice format (written by the authors of the text).

With the *Integrated Science* companion site, instructors also have access to PowerPoint lecture outlines, an Instructor's Manual, an Instructor's Edition Lab Manual, electronic images from the text, clicker questions, quizzes, animations, and many other resources directly tied to text-specific materials in *Integrated Science*. Students have access to self-quizzing, animations, and more.

Presentation Tools

Presentation Tools offer the ultimate multimedia resource center for the instructor. Graphics from the textbook are available in electronic format to create customized classroom presentations, visually based tests and quizzes, dynamic course website content, or attractive printed support materials.

The following assets are available in digital formats, for full-text download and also grouped by chapter:

- **Art and Photo Library:** Full-color digital files of all of the illustrations and many of the photos in the text can be readily incorporated into lecture presentations, exams, or custom-made classroom materials.
- **Worked Example Library and Table Library:** Access the worked examples and tables from the text in electronic format for inclusion in your classroom resources.
- **Animations Library:** Files of animations and videos covering various topics are included so that you can easily make use of these animations in a lecture or classroom setting.
- **Lecture Outlines:** Lecture notes, incorporating illustrations and animated images, have been written to the sixth edition text. They are provided in PowerPoint format so that you may use these lectures as written or customize them to fit your lecture.

Personal Response Systems

Personal response systems bring interactivity into the classroom or lecture hall. A wireless response system gives the instructor and students immediate feedback from the entire class. The wireless response pads are essentially easy-to-use remotes that engage students, allowing instructors to motivate student preparation, interactivity, and active learning. Instructors receive immediate feedback to gauge which concepts students understand. Questions covering the content of the *Integrated Science* text and formatted in PowerPoint are available on the *Integrated Science* companion site.

Computerized Test Bank Online

A comprehensive bank of over nine hundred test questions written by the authors of the text, in multiple-choice format at a variety of difficulty levels is provided within a computerized test bank powered by McGraw-Hill's flexible electronic testing program—EZ Test Online (www.eztestonline.com). EZ Test Online allows you to create the paper and online tests or quizzes in this easy-to-use program!

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PRINTED SUPPLEMENTARY MATERIALS

Laboratory Manual

The laboratory manual, written and classroom-tested by the authors, presents a selection of laboratory exercises specifically written for the interest and abilities of nonscience majors. Each lab begins with an open-ended ***Invitations to Inquiry,*** designed to pique student interest in the lab concept. This is followed by laboratory exercises that require measurement and data analysis for work in a more structured learning environment. When the laboratory manual is used with *Integrated Science,* students will have an opportunity to master basic scientific principles and concepts, learn new problem-solving and thinking skills, and understand the nature of scientific inquiry from the perspective of hands-on experiences. There is also an **instructor's edition lab manual** available on the *Integrated Science* companion site.

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Christine McCreary, *University of Pittsburgh–Greensburg*
Jeffrey J. Miller, *Metropolitan State College of Denver*

MEET THE AUTHORS

Bill W. Tillery

Bill W. Tillery is professor emeritus of Physics at Arizona State University. He earned a bachelor's degree at Northeastern State University (1960) and master's and doctorate degrees from the University of Northern Colorado (1967). Before moving to Arizona State University, he served as director of the Science and Mathematics Teaching Center at the University of Wyoming (1969–1973) and as an assistant professor at Florida State University (1967–1969). Bill has served on numerous councils, boards, and committees and was honored as the "Outstanding University Educator" at the University of Wyoming in 1972. He was elected the "Outstanding Teacher" in the Department of Physics and Astronomy at Arizona State University in 1995.

During his time at Arizona State, Bill has taught a variety of courses, including general education courses in science and society, physical science, and introduction to physics. He has received more than forty grants from the National Science Foundation, the U. S. Office of Education, private industry (Arizona Public Service), and private foundations (Flinn Foundation) for science curriculum development and science teacher inservice training. In addition to teaching and grant work, Bill has authored or co-authored more than sixty textbooks and many monographs, and has served as editor of three newsletters and journals between 1977 and 1996.

Eldon D. Enger

Eldon D. Enger is professor emeritus of biology at Delta College, a community college near Saginaw, Michigan. He received his B.A. and M.S. degrees from the University of Michigan. Professor Enger has over thirty years of teaching experience, during which he has taught biology, zoology, environmental science, and several other courses. He has been very active in curriculum and course development.

Professor Enger is an advocate for variety in teaching methodology. He feels that if students are provided with varied experiences, they are more likely to learn. In addition to the standard textbook assignments, lectures, and laboratory activities, his classes are likely to include writing assignments, student presentation of lecture material, debates by students on controversial issues, field experiences, individual student projects, and discussions of local examples and relevant current events. Textbooks are very valuable for presenting content, especially if they contain accurate, informative drawings and visual examples. Lectures are best used to help students see themes and make connections, and laboratory activities provide important hands-on activities.

Professor Enger has been a Fulbright Exchange Teacher to Australia and Scotland, received the Bergstein Award for Teaching Excellence and the Scholarly Achievement Award from Delta College, and participated as a volunteer in Earthwatch Research Programs in Costa Rica, the Virgin Islands and Australia. During 2001, he was a member of a People to People delegation to South Africa.

Professor Enger is married, has two adult sons, and enjoys a variety of outdoor pursuits such as cross-country skiing, hiking, hunting, kayaking, fishing, camping, and gardening. Other interests include reading a wide variety of periodicals, beekeeping, singing in a church choir, and preserving garden produce.

Frederick C. Ross

Fred Ross is professor emeritus of biology at Delta College, a community college near Saginaw, Michigan. He received his B.S. and M.S. from Wayne State University, Detroit, Michigan, and has attended several other universities and institutions. Professor Ross has thirty years' teaching experience, including junior and senior high school, during which he has taught biology, cell biology and biological chemistry, microbiology, environmental science, and zoology. He has been very active in curriculum and course development. These activities included the development of courses in infection control and microbiology, and AIDS and infectious diseases, and a PBS ScienceLine course for elementary and secondary education majors in cooperation with Central Michigan University. In addition, he was involved in the development of the wastewater microbiology technician curriculum offered by Delta College.

He was also actively involved in the National Task Force of Two Year College Biologists (American Institute of Biological Sciences) and in the National Science Foundation College Science Improvement Program, and has been an evaluator for science and engineering fairs, Michigan Community College Biologists, a judge for the Michigan Science Olympiad and the Science Bowl, a member of a committee to develop and update blood-borne pathogen standards protocol, and a member of Topic Outlines in Introductory Microbiology Study Group of the American Society for Microbiology.

Professor Ross involves his students in a variety of learning techniques and has been a prime advocate of the writing-to-learn approach. Besides writing, his students are typically engaged in active learning techniques including use of inquiry-based learning, the Internet, e-mail communications, field experiences, classroom presentation, as well as lab work. The goal of his classroom presentations and teaching is to actively engage the minds of his students in understanding the material, not just memorization of "scientific facts." Professor Ross is married and recently a grandfather. He enjoys sailing, horseback riding, and cross-country skiing.