

BIOLOGY

A HUMAN ENDEAVOR



VERNON L. AVILA

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Vernon L. Avila

San Diego State University

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Preface

It is inevitable that over the course of twenty years of teaching general biology one should form strong opinions about how best to teach the course. My own opinions have been shaped by my varied experiences as a biologist—as a researcher, as a teacher, as a consultant, and as an administrator. To me, the essence of being a biologist is that instant of insight when all your hours of preparation pay off with the revelation of something new, something you didn't know before. It is the excitement generated by such a moment that I think holds the key to successful teaching of biology. If we can make our students feel that excitement and follow the thoughts of scientists as they work, we can make biology more than an accumulation of facts they must memorize.

This book is the manifestation of that simple idea. The idea has led me to certain conclusions about how to reach students, conclusions that I hope I have put into action here. The first is that the best way to engage students in the thinking behind the biology is to ask questions and to question answers. Throughout the book I pose problems, asking readers to anticipate a discovery or to predict a mechanism. By leading readers to think, I hope to get them to participate in what they are reading.

The second is that I believe it is important for students, especially nonmajors, to understand that scientists are not a breed apart. Each chapter of the book profiles a biologist, discussing not only his or her major contribution but also how he or she became interested in biology. The individuals profiled are a varied lot. In fact, they share only an irrepressible curiosity about living things, a curiosity I hope to awaken in students. A secondary purpose of these profiles is to provide role models to the broad scope of our varied student population.

In keeping with the human endeavor theme, Human Endeavors boxes are found in many of the chapters and are used to trace the history of experiments and observations that have enhanced our understanding of life.

No one needs to be reminded of the increasing impact of current biological research on our everyday lives. An understanding of basic biological concepts is now essential for the modern voter, consumer, parent—in fact for many of the roles our students will soon play. *Biology: A Human Endeavor* is intended to prepare them for those roles, and especially to help them become biologically literate.

ORGANIZATION

The organization of topics in the text was developed to enhance the student's ability to grasp the biological principles presented. It reflects my philosophy that an understanding of the molecular and cellular principles of biology is key to fully appreciating the many intricacies of life. These principles, then, are introduced early in the text and integrated throughout.

The thirty-three chapters have been divided into seven parts. Beginning with an introduction to the basic concepts, controversies, and wonders of biology, the text progresses to Part II, where the molecular machinery of the cell is explored. With this foundation laid, the concepts of genetics are discussed in Part III. Part IV ties the concept of evolution to the genetics of the previous unit and introduces the diversity of living organisms. The chapters in Part V (Plants) and Part VI (Animals) emphasize current research and relevant examples. The final part, Behavior and Ecology, brings the text to a close by integrating the ideas of energy transduction and evolution in a discussion of an organism's interaction with its environment.

SPECIAL FEATURES

More specifically, the features of this book that reflect my philosophy of teaching are as follows:

1. *Clear and direct writing style.* The first requirement of textbook writing is that it be clear. Concepts must be explained in a logical, step-by-step progression that allows students to follow the thinking. But writing that is clear need not be dry. I have tried in this book to speak directly to students, making connections for them between what they are learning and what they already know, without draining the life out of the science.
2. *Asking questions.* Part of this direct approach, as I've already mentioned, is using questions to lead the reader through the logical relationships of the concepts presented.
3. *Profiles.* Each chapter profiles one or more scientists, introducing students to the people who are biologists. Students see the human side of biology: the curiosity that led these men and women to study biology and the challenges they face.
4. *Human Endeavors Boxes.* These essays or visuals provide students with the opportunity to follow the thinking and experiments that have led scientists to the development of particular concepts.
5. *Focuses.* Each chapter contains one or more focus boxes that highlight current applications of biology, present recent research, discuss current controversies—all relating biology to our lives. More and more we are all asked to form opinions on issues requiring some understanding of biology. We cannot of course teach our students all the facts they will need to know to understand the issues they will face during their lifetimes, but we can teach them the underlying principles and the general approaches that will allow them to assimilate the new knowledge they acquire.
6. *Photosynthesis and Respiration*—overview chapter. As a result of classroom testing, it was determined that an overview chapter on photosynthesis and respiration followed by more in-depth chapters on these topics is the optimal approach. This gives instructors the flexibility to choose the level of detail they want to emphasize in their coverage of this material.
7. *Strong pedagogy.* Each chapter includes pedagogical aids that will help the student, especially the nonmajor, master the increasing complexity of today's biology:

The spot summaries accompanying headings guide the reader through the chapter and later serve as a review as the student prepares for exams.

End-of-chapter summaries, key terms, and page-referenced review questions help the student focus on the important concepts.

The glossary at the end of the book provides clear definitions of all key terms.

8. *Illustration program.* The art in this book deserves special mention, because it is the first major biology text to have most of its art rendered on the computer. The result is a full-color illustration program that has been carefully reviewed and imaginatively presented. The program provides accurate, clear, and useful figures that not only help students visualize the more difficult concepts but also convey a sense of the wonder of biology.

ANCILLARY PACKAGE

Biology: A Human Endeavor comes with a complete array of ancillary materials. A 300-page *Study Guide* contains chapter summaries, review questions, and such exercises as working with figures, tables, Greek and Latin roots, reactions—testing areas where nonmajors are likely to have difficulty.

The *Instructor's Manual* consists of two sections. The first section contains chapter outlines, teaching tips, suggested readings, and lists of films and videotapes. The second section is the test bank, with fill-in-the-blank, true/false, matching, multiple choice, and essay questions. There are about 50 questions for each chapter, for a total of about 1650 questions.

Two free educational resources will be made available to adopters of *Biology: A Human Endeavor*. First, instructors will receive fifty, author-selected, two- and four-color overhead *transparencies* of art taken directly from the text. These transparencies illustrate major concepts and are adapted for effective projection use. Secondly, adopters of *Biology: A Human Endeavor* will also receive copyright permission to use an *electronic art library* of over 200 biology art figures. Delivered on 3½" floppy disk, these electronic art files can be easily output to Macintosh laser printers for student hand-outs, quizzes, and tests, output as black and white or color transparencies, or combined with ad-

ditional text for advanced course work. This unique visual library complements the text as well as allows instructors the freedom to individualize their course emphasis, intensity, and content.

ACKNOWLEDGMENTS

Writing a manuscript for a textbook can be an individual task: take one biologist with several years experience in teaching and research, add paper and pencil, reference material, and self-discipline, and sooner or later a manuscript appears. Developing a textbook from that manuscript, on the other hand, is a team effort, which in today's textbook market has become ever more complex. It is the numerous team members that I want to thank here.

First, I thank the biologists who have reviewed this manuscript. Their comments, suggestions, and assistance played a major role in the development of this textbook. During the writing of the book, I was fortunate to work at the University of Puerto Rico, Rio Piedras campus for two years, and at the National Institutes of Health. I thank my colleagues at those institutions for their suggestions and encouragement. I also thank my colleagues at my home institution, San Diego State University, for allowing me to drop into their laboratories and ask for a photograph, or to stop them in the hallway and ask them to check this paragraph or that, to ensure accuracy of presentation.

Since the beginning of this endeavor six years ago, numerous editors have helped me through the developmental stages of this textbook. To them I am truly grateful.

I am also grateful for the experience and assistance of Gail Savage. Gail did more than just serve as the manuscript editor; she worked with me for more than three years, contributing numerous ideas and helping to ensure the logical presentation of material. She was always encouraging and enthusiastic. Her writing and editorial talents are first rate. Most important, even though I have never met

Gail, she has become one of my friends. And by the way, she makes excellent bread and butter pickles.

The production of *Biology: A Human Endeavor* was handled by a crew of extraordinarily talented people at Bookman Productions. Hal Lockwood coordinated the enormously complex project with his usual award-winning style. His energies and wealth of textbook production experience are largely responsible for the excellent quality of the textbook. For her untiring efforts with respect to all phases of the project and for her unflagging goodwill, I must thank Jane Brundage, associate production editor. Marc Deprey at Illustrious, Inc., and the rest of the art team have pioneered a new direction in the preparation of textbook illustrations: computer-rendered art. The developmental and traditional artists included Cecile Duray-Bito, Wayne Clark, Linda McVay, Elizabeth Morales-Denney, Paula MacKenzie, Sandy MacMahon, and Carla Simmons; the electronic artists were Mary Ann Tenario, Chris Hayden, Tom Webster, Greg O'Leary, Lin Teishman, and Tim Krasnansky. For providing the excellent photographs that truly enhance the visual impact of this text, I would also like to thank Stuart Kenter, photo researcher, Don Martin and Darin Norfleet, photographers, and my colleagues around the world. And to all those others whose efforts are often not acknowledged but absolutely essential to the process of producing a quality textbook, I express my gratitude.

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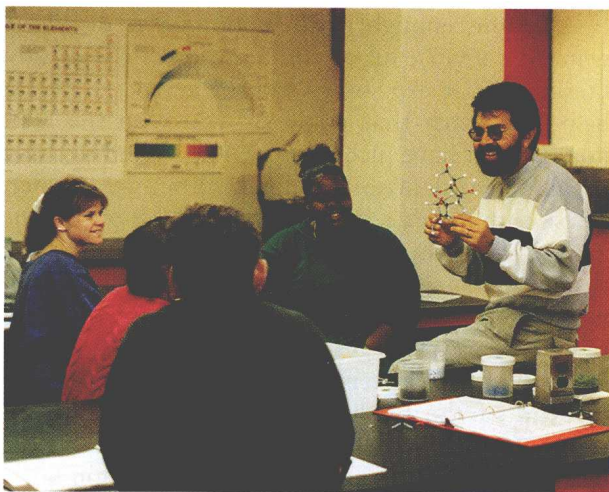
Reviewers for *Biology*

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Note to the Student

This biology text is written for you. I have attempted to share my joy and enthusiasm for biology with you by guiding you in a logical manner to biological literacy. To me, a textbook should be the primary learning device: a student in complete isolation (imagine being stranded on a tropical island) should be able to gain a fundamental understanding of the subject after reading the text. I have assumed that you have a limited background in chemistry and biology and that many of you are not aware of the relevance of biology to your everyday lives. Therefore, in the early chapters, biological vocabulary is held to a minimum, and a logical, step-by-step approach leads you to basic biological and chemical principles required to understand life.

We have all heard about cancer genes, AIDS research, genetic engineering, and so on. Current developments in these areas—what you read about in the newspapers—are based on the molecular level of biology. Thus one of my aims is to help you understand the basic concepts underlying this approach. I am also aware that the student population is changing: not everyone is from the same background or has the same interests. This is also true of scientists, as you will see from the profiles of scientists in the chapters. As you read the profiles you can see that scientists are human, subject to all the strengths and weaknesses of the human condition. To me there is nothing worse than taking the approach that all science is absolute, that biology is just a collection of facts to be recalled for an examination. Biology is alive and growing and thus subject to change and controversy. Biologists don't just answer questions, they question answers, and you should, too. I have tried to share the vitality of biology with you by discussing the excitement and controversy in the field.

All right, enough of the rationale as to why I want to convince all of you to become biologically literate. What are some of the ways that I try to help you reach that goal? As you read the text, notice that I have included preview summaries that accompany the major headings within the chapter. These summaries tell you what the section will be about. Later, you can skim these summaries as you review the material for exams. Also, I have provided summaries at the end of the chapters, page-referenced review questions, with answers in the appendix, and key terms (defined in the glossary at the end of the book) that reinforce your understanding of the material. After you have read the chapter, see if you can answer the discussion questions; they will help you determine which sections of the chapter you understand and which you might want to review. When a term is first introduced it is defined to ensure that you understand the material. In the early chapters, I have made the vocabulary light, but as your understanding and confidence with the subject increases, the chapters become more detailed. The focus boxes provide interesting, current topics that will demonstrate the relevance and just plain fun of biology. The Human Endeavors boxes allow you to follow the logic, observation, and experimentation that have made some of the major biological advances possible.

This textbook is your friend. Use it, write notes in the margins, highlight important passages. After all, it should be by your side as a reference source throughout your college education. If you get the chance, I would appreciate hearing from you. Let me know if my text did what I intended it to do—provide you with the opportunity to share in the joy I find in the study of biology.

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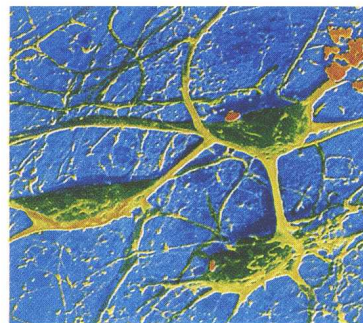
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