

Arms / Camp
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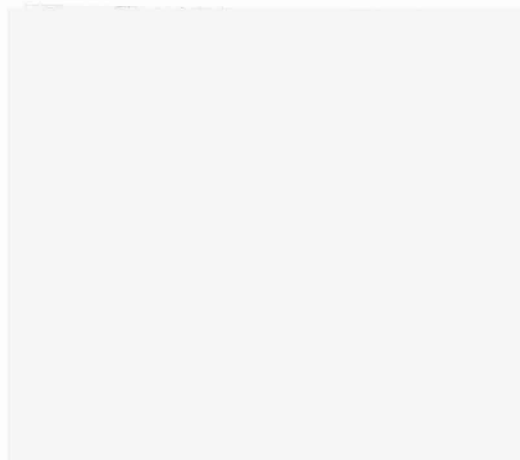


A Journey Into Life
Third Edition

BIOLOGY

THIRD EDITION

A Journey Into Life



S A U N D E R S C O L L E G E P U B L I S H I N G
H A R C O U R T B R A C E C O L L E G E P U B L I S H E R S

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To Richard, Sarah, and Patrick

K.A.

To Walter

P.C.

For all my students who, try as they might,
could never see anything through the micro-
scope but the reflection of their own eye-
lashes. . .

J.J.

To my late grandfather, John Kozlowsky, who
shared his love of life and learning, and to my
parents, Elizabeth and Miles, for nurturing
those pursuits.

E.Z.

About the Author Team



Karen Arms grew up in Oxford, England and received her doctorate in molecular embryology at Oxford University. After relocating to the United States, she taught a wide range of courses

at both Stanford and Cornell Universities and began to shift the emphasis of her work from teaching to writing, in response to the needs of introductory biology students at Cornell University. Arms now lives in Savannah, Georgia, where she sails, gardens, appears as guest lecturer at nearby schools, works as an editor and teacher with the University of Georgia Marine Extension Service, is President of Halfmoon Publishing, is an active participant of the 1996 Olympic sailboat committee, and more than anything else, writes, writes, and writes about biology, the subject she adores. Arms is married to an artist and has three children in college.



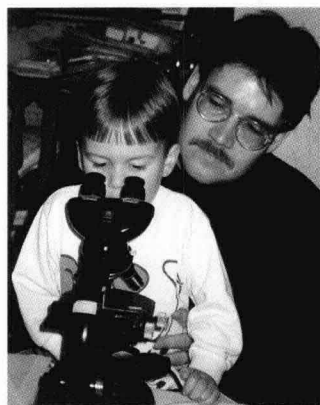
Pam Camp grew up in suburban Washington, D.C. and attended Allegheny College in Meadville, Pennsylvania and Cornell University. Subsequently she became involved in the development of the introductory biology course at Cornell with Karen Arms. The first edition of their book for majors, *Biology*, was written from the Cornell course. The highly successful author team of Arms and Camp has produced seven editions of three biology textbooks and Camp now devotes all of her time to

writing. When she's not at the computer, pressured by a deadline, she's most likely to be found behind the lens of her camera, swimming, out on a long walk, gardening, biking, traveling, or blissfully engrossed in a mystery or romance novel with one of her two cats purring at her side. Camp lives in Ithaca, New York.

Jan Jenner lived in Manhattan's Greenwich Village for many years, and most recently has been transplanted to the Alabama pine woods. She received



her doctorate in biology from New York University, specializing in herpetology, and taught introductory biology there for more years than she cares to mention. Although snakes are a particular interest, Jenner enjoys all aspects of whole animal studies, especially those that involve field work. She currently teaches introductory biology, comparative vertebrate zoology, and environmental science at Talladega College (AL) and supervises undergraduate researchers as the Director of Research at TC's Holtzclaw Wildlife Preserve. Jenner spends free time writing works of fiction and non-fiction (the novel *Sandeagozu*, as well as *A Bird Watcher's Companion* and *Backyard Birds*), birding, studying insects, painting, and tending her pet tortoises.



Ed Zalisko was raised in East Peoria, Illinois. At Washington State University he earned a doctorate in zoology as well as a state teaching certificate in biology and chemistry. His research projects have included numerous anatomical and ecological studies of salamanders and snakes. His interests in biology stem from many outdoor

vacations and a grandfather who stimulated his natural curiosity. Zalisko uses his enthusiasm, sense of humor, and analogies to help motivate the students in the seven courses he teaches as Professor of Biology at Blackburn College in Carlinville, IL. A specialist in the methodology of science teaching, he regards his biology classes as "a chance to tell some great stories." When not in class Zalisko can be found presenting results of his research at scientific meetings, conducting research with undergraduates, or visiting local elementary schools to show off "beasts." In his spare time Zalisko reads, plays with his two small children, Benjamin and Sarah, and enjoys small town life with his wife, Amy.

PREFACE

The concepts of biology are threads in the fabric of daily life.

For example,

- Is it safe to eat genetically engineered tomatoes?
- What is a hiccup?
- Is it necessary to take megadoses of vitamins?
- Will your unborn child inherit your curly, red hair?
- Can scientists actually recover dinosaur DNA and bring *Tyrannosaurus rex* back to life?
- What are the side effects of spraying insecticides around your home and garden?
- Why should you follow your medical doctor's instructions when taking antibiotics?
- Which came first, the chicken or the egg?

Biological questions run the gamut from the silly to the sublime, but biology is the most visible, and arguably the most important science in the news. Every day each person makes many decisions centered around biological concepts. The philosophical basis of this revision of *Biology: A Journey Into Life* revolves around the goal of making the critical concepts of biology more accessible, thus enabling students, as educated citizens, to better understand the issues that confront them, both in the headlines, and in their own lives.

During the entire revision process we have consciously kept the nonmajor student, or the student with little or no knowledge of biology, in mind. We have tried to make this new edition inviting, clear, and easy to understand, without sacrificing the excellent science of the second edition. To facilitate a student's grasp of the critical concepts of biology, we have developed an array of artistic and pedagogical features designed to highlight biological concepts, enhance learning, increase comprehension, and develop critical thinking skills. In addition, we have placed an even greater emphasis, integrated throughout the text, on the environmental issues that confront us—issues that every well-educated citizen should understand from a biological perspective.

Updating the text and underscoring environmental issues were relatively easy goals to achieve; re-concepting the art and developing the pedagogical features involved integrating more ideas and thus were more difficult, but after a year and a half of intensive work that

has involved scores of people, the process has finally resulted in the book you now hold in your hands. This text is appropriate for courses taught to nonmajors, courses with a mix of majors and nonmajors, and even for courses for some majors.

Improved Illustrations

Because we know that so much of human learning is visual, a special Art Focus Group of active educators was convened to explore how students and teachers use an art program. As a result, every illustration has been scrutinized, reconsidered, redeveloped, and revised by a team of biology teachers, writers, and artists. Many of the ideas for the illustrations are completely new; all of the line drawings are new; and many new art features have been added that will facilitate learning. Context has been emphasized in all of our newly designed artwork to provide the student with a frame of reference for each figure. Context is also provided by the use of standardized icons throughout the text, such as those of the human body, and of an idealized plant and animal cell.

Biology is full of complicated processes that challenge the skills of learners and teachers alike. Respiration, photosynthesis, evolution, DNA replication, protein synthesis, mitosis, and meiosis are only a few examples. In each chapter these important pieces of the biological puzzle have been made more accessible through the use of a new illustration feature, “**A Journey Through**,” which combines multi-part artwork and photos with a unique labeling system that guides students through the figure. Examples include “A Journey Through Photosynthesis,” “A Journey Through Meiosis,” “A Journey Through An Animal Cell,” etc.

New and Improved Pedagogical Features

The following new and/or improved pedagogical features have been added:

1. **Study Techniques for Biology Classes.** Biology demands an array of study skills that are quite different from those needed in other college courses. Written by one of the text authors with 20 years of experience in teaching introductory biology, “Study Techniques for Biology Classes” gives careful, time-tested, practical advice for the beginning student on how to maximize efficiency when studying for biology.
2. **Curiosity Questions.** Each chapter begins with a few attention-grabbing questions that articulate things that students may have wondered about, or

things that they might have asked after giving the subject some thought. Curiosity Questions encourage students to dive into the chapter in search of answers. The questions are referenced to icon-marked text or specific figures within the chapter where the answer is integrated into the text or figure legend. Examples include,

- 1? Why aren't there as many bald women as bald men?
- 2? How can parents have a child who grows taller than either one of them?
- 3? Are the cells of an elephant bigger than the cells of a mouse?

3. **Chapter Opening Photograph.** Rather than using chapter opening photos as window dressing, a single chapter opening photograph illustrates an important point within the chapter and piques the curiosity of the reader, encouraging him or her to read further. After briefly explaining the figure and the concept it illustrates, the figure legend ends by directing students to the text section where they can "read more about this topic."
4. **Concept Guides.** These frame the objectives for each chapter as directives that have been rewritten at higher cognitive levels to encourage critical thinking skills. We consider objectives such as "list" or "name" too basic to develop critical thinking skills. Instead, Concept Guides ask the student to "explain," "describe," "compare," etc.
5. **Key Concepts.** Brief statements of the central concepts of each chapter set the stage for the development of the ideas within each chapter.
6. **Concept Capsules.** Concept Capsules are a new feature of this edition. They appear between two red lines at the end of each main section, and summarize and reinforce main concepts before the student reads on. To encourage students to read entire sections instead of just the summaries, Concept Capsules use terms presented in the section to discuss the key concepts without repeating their definitions.
7. **Bio-Bits.** Interesting, topical biological facts directly tied to the text appear in each chapter to emphasize important points and highlight biological issues that are newsworthy and/or relevant to students' lives. Examples include,

"In tundra permafrost entire, intact mammoths have been found with edible meat still clinging to their skeletons."

"It is likely that within your lifetime, nearly one-quarter of all of the species of plants, animals, and microorganisms on Earth will become extinct due to destruction of tropical rain forests. The vast majority of the species lost will never even have been studied."

"It is currently estimated that skin cancer rates increase by 6% for every 1% loss of the ozone layer. The recent thinning of the ozone layer by 3% near middle latitudes has therefore resulted in a nearly 20% increase in skin cancer."

8. **Tool Boxes.** Specially designed to look like windows on a computer screen, these are short boxes that explain some of the technicalities which are necessary for a complete understanding of the main ideas of a chapter. For example, moles as units of measurement, and surface area-to-volume ratios, are explained in Tool Boxes.
9. **Journey Boxes.** These boxed essays are aimed at providing deeper knowledge of a topic that is ancillary to material presented in a chapter. Boxes fall into one of four categories: "A Journey into Science in Process," "A Journey into Evolution," "A Journey into Healthy Living," or "A Journey into the Environment." More than one-third of the boxes are completely new, and all have been updated where necessary. In particular, "A Journey into the Environment" plays an important role in integrating environmental issues throughout the entire text.
10. **Chapter Summary.** To facilitate comprehension, the chapter summaries have been revised and changed from a paragraph format to a numbered list of the main points.
11. **Self-Quiz.** This is a series of straightforward questions that test the basic comprehension of the ideas presented in the chapter. The answers to the Self Quiz are provided at the end of the book.
12. **Thinking Critically.** These are probing questions that require additional thought and consideration. They can form the basis of class discussions, be the springboard for lectures, or be the basis for writing exercises.
13. **Selected Key Terms.** This list of key terms is new to this edition. One of the most daunting aspects of learning biology is mastering the terminology. For quick review this feature lists the chapter's new and important terms alphabetically with page references.
14. **Suggested Readings.** The list of books and articles at the end of each chapter has been edited and updated.
15. **The Educated Citizen.** These excerpts of recent *Discover* magazine articles, chosen by the authors, appear at the end of each of the book's six parts. The articles explore topical issues that are controversial and often have many sides to them. At the end of each Educated Citizen article are several questions, called **Connecting the Concepts**. These questions may be used as either essay or discussion topics and link the issues discussed in the articles with the concepts that have been

introduced and explained in the preceding Part. They are tied to the specially edited *Infinite Voyage* videos that are available as part of the supplement package.

Organization and Content Changes

A new Chapter 1 sets the tone for our revision. Emphasizing our Journey Into Life theme, this chapter gives the student an overview of the intellectual terrain that lies ahead and emphasizes the central biological concepts that each student will encounter. Our environmental emphasis is introduced and highlighted in a new Table on the “Top Ten” global environmental challenges, which will be underscored throughout the text. In Part 1, The Unity of Life: Cells, the entirely rewritten chapters on chemistry (2 and 3) make the bane of most freshman biology classes much less threatening and much easier to understand. The excellent science of the second edition’s cell membrane and cell structure and function chapters (4 and 5) has been retained, updated where necessary, and now is further clarified by improved artwork and accompanying photos. A rewritten chapter on energy (6) uses everyday analogies to explain energy transformations and the importance of energy intermediates. The chapters on cellular respiration (7) and photosynthesis (8) have been completely rewritten to present the complexities of these often daunting topics in the clearest manner. The accompanying “A Journey Through” features walk the reader through these processes in a careful, stepwise fashion.

In Part 2, The Unity of Life: Genetic Information and Its Expression, the focus of the revision is on the artwork. In Chapter 9 we highlight the experimental work that established DNA as the genetic material, explain the structure of the DNA molecule, and build a chromosome from a strand of DNA. Much of Chapter 10 has been rewritten, including a new Journey box, entitled, “Smart Genes.” The artwork for “A Journey Through Protein Synthesis” clarifies this challenging topic. In Chapter 11 two new two-page spreads, “A Journey Through Mitosis” and “A Journey Through Meiosis” detail these processes in both the plant and animal cell, and match explanatory artwork with photographs similar to microscope slides the student may encounter in laboratory exercises. The artwork in Chapters 12 and 13 brings new clarity to Punnett squares. Not only are the results of the various genetic crosses clearly shown, but each Punnett square figure reminds students of the context with a small, accompanying icon.

In Part 3, Evolution and the Diversity of Life, the introductory and initial sections of Chapter 14, Evolution and Natural Selection, have been rewritten, with the comments of many veteran teachers in mind. The unique Table 14–1 directly addresses and dispels many

of the major misconceptions students have about the theory of evolution. The art of Chapter 15 has also been carefully revised. Concepts such as Hardy-Weinberg equilibrium and the founder effect were especially challenging design problems, and we believe our illustrations are exceptionally clear. Reflecting the environmental emphasis of this revision, Chapter 16 has an especially important new Journey box on overpopulation and Chapter 17 has a new Journey box on ozone depletion. New students are often mystified by the emphasis that biology places on correct scientific names. In a new Journey box “The Name Game” (Chapter 18), we explore the utility of scientific names. Chapters 19–21 have been updated and trimmed and in all of these chapters, new artwork displays the diversity and beauty of living organisms.

The emphasis of the revision in Part 4, Animal Biology was twofold: improved, more inviting artwork and reworking, clarifying, and tightening of the text. Special attention has been paid to Chapter 25, Defenses Against Disease and in Chapter 27 a new section on Fertilization and Implantation clarifies these topics. New findings, such as those in the treatment of cystic fibrosis and PKU have been incorporated into the text. In each chapter in Part 4 (Chapters 22–31) a special, large-format Journey Through figure integrates details of human anatomy with details of physiology, presenting the student with a new visual summary of the workings of each of the organ systems.

The emphasis in the revision of Part 5, Plant Biology (Chapters 32–35), was on the development of the artwork. A new Journey box “Tropical Rain Forest Canopy” continues the environmental theme, highlighting the importance and uniqueness of this new biological frontier.

In Part 6, The World of Life: Ecology, the fundamental concepts of ecology, such as energy flow, biogeochemical cycles, niche, community structure, biomes, are explained and developed. New illustrations and new photographs make these important chapters even more vivid. The content of Chapter 39, Human Impact On The Environment, has been completely revised, and much of it newly written to reflect our environmental concerns and suggest appropriate responses to the environmental crises that confront us.

Supplements

We are pleased to be able to offer more ancillary teaching aids with this edition of *Journey*.

Six **videos** in the critically acclaimed *The Infinite Voyage* series have been chosen by the authors and specially edited to augment the text and the Educated Citizen articles in the book.

***Infinite Voyage* Videodisc Series:** The Year in Review examines various biological topics in a collection

of eight 1-hour video programs, including "Secrets from a Frozen World" and "Insects: The Ruling Class."

Saunders General Biology Videodisc offers live action and still images from six Saunders biology textbooks, including *Biology: A Journey Into Life*, Third Edition. Features include random access, light scanner/barcode access, and extensive lecture presentation capabilities through LectureActive™ Software (see description below). A Directory with descriptions, barcode labels, and reference numbers for each image accompanies the Videodisc.

LectureActive™ Software contains all video clip and still images from Saunders Videodisc, allowing instructors to create custom lectures quickly and easily. Lectures can be read from the computer screen or printed with accompanying barcodes for all Videodisc instructions.

Study Guide written by author Ed Zalisko includes questions keyed to text sections, Concept Guides and "Journey" boxes. In addition, each chapter offers specific study advice, additional challenging questions, a key to word roots, and a crossword puzzle which includes key terms and word roots.

Overhead Transparency Acetates feature 250 pieces of lustrous art from the text, using labels with large type for easy classroom viewing.

Slides feature the same 250 images in a 35-mm format.

Sequence Overhead Transparencies are a separate set of 25 sequential overhead transparencies, containing topics displayed in a series of stages of layers. Each overhead transparency includes four to six overlays held together with removable plastic pins.

Bio-Art reproduces 150 selected pieces of art from the text as black-and-white unlabeled line drawings, encouraging students to learn the labeling process and take notes. Bio-Art also provides a handy study tool or can be used as a test item.

Instructor's Manual contains key words, an overview, lecture outline, suggested readings, and teaching suggestions.

Lecture Outline on Disk, an ASCII version of the lecture outline, is available for IBM and Macintosh computers. Instructors are able to edit, expand the outline, and create study guideline handouts for students.

Test Bank provides 3,000 printed test questions in several formats and levels of difficulty. Instructors can add to, alter, or edit to develop their own tests.

ExaMaster+™ Computerized Test Bank offers instructors a software version of the printed Test Bank, complete with the same capabilities.

BIO-XL, a unique, computer-assisted tutorial software package, is available in two modes. Test Mode quizzes students about chapter material and assesses students' knowledge; Tutor Mode adds pedagogical support through immediate feedback to responses. Corresponds to specific page references in the text.

SimLife™, an advanced biological simulation, enables students to design creatures and plants from a genetic level and manipulate the environment in which they live, testing their ability to survive. The software is based on the latest advances in Artificial Life research, and is accompanied by a Teacher's Guide and Sample Lab Book.

Acknowledgments

We thank the artists at **J/B Woolsey Associates** for their superb efforts in revising the illustrations for this new edition. The entire art team has been seemingly tireless in the production and execution of our art and we thank them especially for giving a 110 percent effort. Patrick Lane, John Woolsey, and Dave McShane were responsible for the conceiving and development of illustrations, while Patrick Lane, Regina Hollister, Greg Gambino, Mark Desman, Tom Sincak, Dawn Derosa and Todd Smith executed the illustrations. We think they are beautiful as well as functional and feel confident that our readers will concur.

Laurel Anderson and the staff at **Photosynthesis, Inc.** were our photo researchers on this revision. Laurel and her staff were able to find photos to match nearly all of our excruciatingly obscure requests and we thank Photosynthesis for their superb attention to detail and eye for beauty.

The entire staff at **Saunders College Publishing** has cooperated to make the revision process as amiable and pleasant as possible. We thank them for their “can-do” attitude and the cheerful goodwill they have extended to this author team. **Elizabeth Widdicombe**, Publisher, was always supportive of our efforts. She and **Julie Levin Alexander** brought the team together, and got the process started. Many of the original ideas for this revision were Julie’s and her synthetic perspective, unfailing support, and guidance have been greatly appreciated. As Developmental Editor, **Gabe Goodman** was the mastermind behind this revision. Gabe’s impeccable ear for language and dogged attention to detail enabled her to coordinate efforts of authors, artists, and reviewers, and prepare the manuscript for production. In addition to her professional tasks, Gabe provided much-needed reassurance to the authors when the pressures of deadlines seemed unbearable. The authors could not have asked for a better editor than Gabe Goodman. **Laura Coaty**, Field Product Manager, was one of our essential links to the needs of teachers and students. Laura was closely involved in the initial planning stages of this revision, conducting the Art Focus Group, preparing invaluable reviewer data bases, and relaying her knowledge to the revision team. We greatly appreciate her buoyant dedication to making this the best of all possible books. **Christine Rickoff**, Associate Developmental Editor, coordinated the development of the ancillary package

and Study Guide. As Project Editor, **Margaret Mary Anderson** shepherded the manuscript through all the various incarnations that have resulted in this finished textbook. We thank her for tying up all of our loose ends and for her careful coordination of the work of copy editor, author team, and artists. **Carol Bleistine**, Manager of Art and Design, supervised both the creation of the design of our book and the completion of the beautiful artwork. We thank her for making *Journey*, Third Edition a stunning example of book design. **Joanne Cassetti**, Production Manager, worked with an impossible schedule, and like everyone else associated with this revision, did the impossible, and got our book off the presses on time.

Reviewers

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Study Techniques for Biology Classes

Students take introductory biology classes for different reasons. You may be genuinely interested in the subject and *want* to take the course to learn more about it. Or you may not be especially interested but *have* to take the course to fulfill graduation requirements. You may be taking introductory biology to find out whether you like it well enough to consider a biology-related career. Whatever your reasons for taking biology, you should know that it is very different from any other college course you will take.

For one thing, biology has a separate, technical language, that is quite precise and thus is slightly different from everyday English. Second, although biological concepts have many practical applications, the concepts themselves are quite abstract. Finally, the information of biology is cumulative and full understanding of the subject requires a view that builds from biological molecules to encompass all living and nonliving systems on Earth. Unlike some other college subjects, opinion has little place in biology. Your task as a student is to learn and correlate the new vocabulary and new concepts, integrating them into personal mental pictures that build as the course progresses.

But, just as biology is a challenging subject, it is rewarding in unique and wonderful ways. Once you have mastered introductory biology, your perceptions of the world change and expand. You begin to understand all the life around you, as well as your own life, too. But introductory biology does not give up its secrets easily. Learning this subject takes work, in and out of class. Here are some suggestions on how to tailor your study skills so that you learn more biology and learn biology more meaningfully. These are techniques that have worked for many of our students, and we hope they work for you.

Step One: Getting Organized

You need to organize both your time and your workspace to study efficiently. Start by making a chart of your schedule. It will show you how much time you

actually have to devote to studying biology. Schedule your classes, travel time, and time devoted to job or family, as well as any extra-curricular activities that are important to you. By making this simple schedule, you have already helped yourself to succeed, because you can see how much time you actually have to devote to study each day. Now you're ready to schedule your studying time.

How much studying is necessary to succeed in biology? This depends upon how strong your pre-college training has been, and upon how efficient your work habits are. A good rule of thumb is that college classes require between 2 and 3 hours of private study for each hour spent in class. (Some professors even suggest 4 hours.) For example, if your biology class meets for 3 hours of lecture and 4 hours of laboratory per week, you should put in between 14 and 21 hours of study time per week, or between 2 and 3 hours of study per day. This may sound like an incredible amount of study time, especially as you will be carrying other demanding courses, but we suggest that you try 2 to 3 hours each day. After the first exam you will be better able to judge the appropriate amount of time for private study. Until then, spending 2 to 3 hours is a safe bet. Don't be discouraged if you find yourself "off schedule" from time to time. When other pressures out compete your studying priorities, try to remember that your study schedule is an ideal that may require revision as the semester progresses. Try to get back on track as soon as you can.

Schedule study time for all of your classes. Try to use all of your time wisely. If, for example, you commute to class by public transportation, use your travel time for studying. Students have reported success when they have used their commutes for review of class notes, for review of flash cards (see below), and for review of the day's class lecture using a portable cassette recorder.

Everyone has different biological rhythms that cause them to feel more alert at different times in the day. As much as possible, schedule your hardest tasks when you are most alert. If you are a "morning person," wake up an hour earlier than normal and devote this time to your studies. "Night owls," on the other hand, will benefit more from intensive study sessions scheduled later in the day.

You might want to make several copies of your daily schedule. Put one on the wall that faces your workspace; put another in the front of your biology notebook. Now that your daily schedule is made, it's

time to look ahead and schedule the entire semester. By this time, your professors will have distributed their syllabi and course schedules. Enter reading assignments and exam dates on your calendar. You might want to use a different color of ink for each course you are taking. Two weeks before each exam, write a note that will remind you to begin reviewing for it. By the time you have finished filling in all of the information for all of your courses, your calendar will look very full. Hang it on the wall near your desk where you can glance up and see what you need to do each day as well as the deadlines that you must meet. You might want to reduce-photocopy your calendar and tape a miniature copy in your biology notebook.

An organized workspace is another key that will help you to study efficiently. Ideally it should have nothing to distract you from the task at hand. Here are some suggestions that may help you get better organized:

1. Organize your books so that they are close at hand. Ideally, you should be able to put out your hand and grasp the spine of any book that you need.
2. Get the dictionary habit. A standard collegiate dictionary is one of the tools you should have on your desk top. Form the habit of referring to it whenever you come to a new word, rather than trying to guess the meaning from context. Some words will not be in this dictionary and a dictionary of biology (look for an inexpensive, paperback version at your college bookstore) is extremely useful and highly recommended. All of the boldface terms in this textbook are defined in the Glossary at the back of the book. Form the habit of using it, too.
3. Treat yourself to a selection of your favorite pens, pencils, markers, and papers. A supply of "post-its," blank 3" x 5" and 5" x 8" cards, an eraser, a bottle of white-out, some transparent tape, a stapler, a ruler, scissors, and a wastebasket are other minimal supplies.
4. You will be spending hundreds of hours at your workspace. Consider investing in a light that illuminates it properly and find a chair that comfortably supports your back, yet allows you to sit at the right height, with your feet planted firmly on the floor.
5. Give yourself some inspiration. Find a quotation, a photograph, or a cartoon that pleases you and tape it to the wall before you.

Assuming that you began with a quiet room, you have now created a workspace that will enhance, rather than hinder, your studying efforts.

Step Two: Reading This Textbook

A biology book is not a normal book and should be read in a different way from a novel. Although you may be an excellent reader in other subjects, you may be unfamiliar with the technique called "reading to learn content." You will need a separate notebook, a supply of post-its, a pencil, and a highlighter marker to try this technique.

Familiarize Yourself with the Chapter Organization

The Third Edition of *Biology: A Journey Into Life* has been designed to aid "reading to learn content." Each chapter has the following sections:

1. Curiosity Questions. These are real life, not merely academic questions, designed to pique your interest in the topics covered in the chapter. Ideally, the curiosity questions will make you think, "Yeah! I've always wondered about that."
2. Concept Guides. These are our suggested objectives for the chapter. Some students skip over these and hurry into the body of the text, anxious to get the reading assignment finished as quickly as possible. In so doing, they are like motorists who don't read maps or ignore road signs, relying, instead on dead reckoning to get them to their destinations. Sometimes it works; mostly, though, they get lost. Form the habit of reading the "openers" (Curiosity Questions and Concept Guides) and "closers" (Summary and Self-Quiz) *before* leaping into the text. This way you'll organize your thoughts before delving into details and you'll have an idea of what's important in the 20—odd pages of text and illustration that lie ahead.
3. Every chapter is subdivided into sections, each of which treats a slightly different aspect of the topic. Each section ends with a Concept Capsule that restates the most important concepts of the section. *Before* beginning to read a chapter, page through it, reading each Concept Capsule to get an idea of the main ideas that you will encounter.
4. Each chapter contains many figures and some tables. As you are browsing through, reading the Concept Capsules, examine each figure and table. Now you are reinforcing the ideas in the chapter with visual representations. You've already been studying a great deal, and yet, it will seem as though you haven't really started working yet. So far, "reading to learn content" should have been nearly as painless as reading a murder mystery.

There is one simple thing left to do before you read the chapter in detail: find the last page of the chapter and mark it with a book mark. Now you won't have to waste time trying to estimate when the chapter will be done. As you work, you'll see the thickness of pages that remain between your place and the book-mark steadily decrease.

You now have a real overview of the task ahead. All of this should have taken you about an hour of study time, perhaps less. Depending upon how quickly you work, it should take you another 1 to 2 hours to tackle the body of the text. Read actively, not passively. As you read each section, you may want to make marginal notes with your pencil and jot down separate notes into your notebook. The act of physically writing down notes involves more of your senses and more parts of your brain and enhances learning. Make a 3" x 5" flash card for every key (boldfaced) term (with the term on one side and its definition on the other). Alternatively, use a 5" x 8" card and write all key terms and definitions on it. Important concepts (those in Concept Capsules) should be noted down, either on 5" x 8" cards or in your notebook. Use post-its to flag anything that you cannot understand. Work through each section, reading, noting key terms and concepts, and examining each illustration.

Pay special attention to the figure legends. Read them carefully and make sure you understand each illustration. Many students don't know that figure legends in biological texts are different from those in other illustrated books in that they usually give additional information that supplements the text. Most of this information is not duplicated in the body of the text, so it is important to read every figure legend.

Use a highlighting marker sparingly, and try to avoid using it at all until you've read a section and can judge what's important. This will help prevent "yellow page syndrome."

Keep in mind that if this is your first college-level science course, you are encountering a species apart from literature, arts, and philosophy courses. In these, evaluation by opinion and conjecture are important and the task of the professor is to aid you in developing educated, discriminating, thoughtful, clear, even bold and controversial views. While biologists are some of the most opinionated individuals on the planet, opinion and taste are of small importance in biology. Facts, observations, data, correlations, conclusions, and prediction of events are important. Vocabulary is important to describe events with precision.

When you've finished each section, you should have:

- a set of cards of key terms and definitions,

- a set of cards with key concepts,
- a firm idea of the main points made in the text, amplified visually through illustrations,
- notes of important ideas in your notebook,
- any hard-to-understand sections flagged with post-its.

Work your way through each section until you have reached the end of the chapter. Allow yourself a break every hour. Get up and stretch, but don't be away from your desk for too long. This method of studying will take longer at first, but you will gain speed as you become more familiar with it and your ability to concentrate grows. The benefits of this method are that it automatically gets you ready for review and preparation for exams.

When the chapter is finished, turn back to the Concept Guide and see how well you can accomplish these objectives. Test yourself with the Self-Quiz. Once all of this is completed, turn back to the difficult sections that you marked. Some of your problems will have been cleared up. If questions remain, ask your professor for help.

Preparing for Exams

Everyone dreads exams. It is an open secret that many teachers dislike preparing, administering, and grading them almost as much as students loathe taking them. Yet, even though neither teachers nor students look forward to exams, they are an integral part of most courses. Here are suggestions for studying to succeed on exams:

1. *Start early.* One week of intense studying is usually a minimum for a biology exam.
2. *Make and use flash cards.* Start to make and use your flash cards the first week of classes. Keep them in your book bag and review them whenever you have a chance: supermarket lines, commuting time, any waiting time can be used in productive review.
3. *Try to understand, not merely memorize.* Learning becomes real and much easier when you try to think of mental hooks to hang new information from. Get in the habit of making mental pictures and visually associate the terms and concepts of biology. There are many levels of biological knowledge and simple memorization results in only the most short-lived knowledge. Understanding biological principles and being able to apply your understanding involves higher mental processes and results in longer-lasting learning.
4. *Form a study group.* If you can teach the material, you really know it. Use study groups for support and reinforcement of what you've learned. Avoid

study groups that wander away from the work at hand or degenerate into The Dating Game.

5. *Ask for professional help.* Your professor(s) and laboratory instructor(s) weren't born with an innate understanding of biology. Each was once enrolled in introductory biology, just as you are now. Ask for their suggestions about how best to study. Some professors offer copies of old exams as guides. Others don't believe this is an effective teaching tool, fearing that many students will limit their study to the set of questions offered, rather than using them as a means to allay pre-test jitters.
6. *Ask other students.* Upperclassmen may have had your same professor and may give you suggestions of what to expect on examinations and how best to study.
7. *Rest before an exam.* Studies have demonstrated that students who are well-rested perform better on exams than students who've stayed up all night studying.

Has This Helped?

We'd like some feedback.

We're establishing **Postcards!**, a user's newsletter and bulletin board for *Biology: A Journey Into Life*. Send us your favorite studying strategies and the tricks that help you learn. Clever mnemonic devices or mental hooks that helped you learn respiration, meiosis, etc. will be shared with users all over the country and we'll see that you and your school get credit for your ideas.

Send your ideas to:

Journey Postcards
C/O Saunders College Publishing
The Public Ledger Building
620 Chestnut Street
Suite 560
Philadelphia, PA 19106



CHAPTER 1

CONCEPT GUIDE

After reading this chapter, you should be able to:

1. Discuss the recent changes in our knowledge of biology. (Section 1-A)
2. Describe the major features common to all living organisms. (Section 1-B)
3. Explain how humans affect the rate of extinction of other species. (Section 1-C)

Scientists are only beginning to describe the life that exists in our tropical rain forests. Deforestation of this vital resource will dramatically impact the diversity of life on Earth and have implications for global climate as well. Read more about how human attitudes are changing in Section 1-C.

(C. Pringle/Biological Photo Service)

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