DISCOVER BIOLOUGIN

SECOND EDITION

CAIN DAMMAN LUE YOON

BIOLOGY

SECOND EDITION

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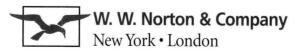
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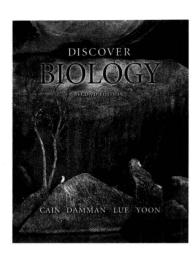
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About the cover

A Pied Cormorant (*Phalacrocorax melanoleucos*) in the Australian outback. Photograph © Art Wolfe, Photo Researchers, Inc.

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Discover Biology, Second Edition

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Preface

It was a joy to write this book, from the first planning stages to the final touches still being made as the book went off to press. This joy stems from the fact that all four authors find biology to be a gripping subject, one that is simultaneously intensely interesting and critically important. Because scientific understanding of many fundamental principles is growing by leaps and bounds, this an exciting time to write, teach, and learn about all areas of the biological sciences.

For example, researchers are beginning to unlock the secrets of the human genome, allowing us to explore in unprecedented detail both the causes of and potential treatments for a host of human genetic disorders. And ecologists have begun to make real progress in understanding and predicting events that affect all of the world's ecosystems, such as the occurrence of El Niño events and the contribution of human activities to global warming.

Discoveries such as these, along with a host of others, mean that biology is a subject of news stories on an almost daily basis. In recent weeks, for example, the news has focused on the dangers of bioterrorism; on a remarkably simple and inexpensive procedure—bubbling nitrogen into ballast water to deplete the water of oxygen—that may reduce the billions of dollars lost each year when pest species are inadvertently spread from port to port in the ballast water released by cargo and cruise ships; and on biomedical developments that may allow doctors to transplant the organs of other species, such as pigs, into humans without danger of immune system rejection. These and other aspects of biology in the news open up a world of applied issues with important ramifications not only for individuals but for all human societies. Biology touches our lives every day, and its rapid progress ensures that we will hear more, not less, about biology in the years ahead.

The Philosophy of this Book Remains "Less Is More"

Unfortunately, the very things that make biology so interesting—the rapid pace of new discoveries and the

critical uses and applications of these discoveries by human societies—can make it a difficult subject to teach and to learn. When we set out to write the Second Edition of *Discover Biology*, we asked ourselves, How can we convey biology's excitement, breadth, and relevance to students without burying them in facts and definitions? We have achieved this goal by writing clear, streamlined chapters that focus on essential concepts.

Over years of teaching, we have found that students learn best from short, focused chapters. We think this book's audience—introductory students who are not science majors—does not need to be overwhelmed with a mass of detail that is hard to sort through and place in context, nor do these students need to temporarily memorize exhaustive lists of new terms and vocabulary. We firmly believe that *less is more*: Students learn more when presented with less material (a belief well supported by the education literature).

As described in detail below, to put our "less is more" view into practice, we begin all our chapters with a single main message and a small set of key concepts. We develop the main message to a depth that only slightly exceeds what can be covered in one class period. We make heavy use of applied topics to illustrate key concepts while maintaining a focus on the overarching theoretical nature of biology, without which practical applications would not emerge.

Changes in the Second Edition: A Labor of Love

As we began to revise the successful First Edition of *Discover Biology*, we listened carefully to comments from students and instructors who were using the book. They provided invaluable help in both describing the book's strengths and pointing out places where there was room for improvement. Students were particularly helpful in identifying sentences and examples that could use a bit more elaboration to make the meaning crystal clear. Instructors helped us tackle the challenge of selecting the best possible examples with which to illustrate a wide range of concepts. During the long hours spent carefully revising each chapter, the guidance and encour-

agement we received from these comments served us extremely well. We also benefited greatly from the thoughtful responses to survey questions that dozens of instructors provided us. These instructors took the time to examine the book closely and provided us with extensive feedback on all of its features.

The message from all these comments was loud and clear: stay with the existing model of short, focused chapters that emphasize key concepts, applied examples, and breaking news stories, while adding more human examples and more of the sidebars on "Biology in Our Lives" and "The Scientific Process."

In response to this input, we wrote two new, highly relevant chapters: "Harnessing the Human Genome" (Chapter 18) and "From Birth to Death" (Chapter 38). In conjunction with revised material on genome biology in Chapter 16, the new chapter on the human genome exposes students to the revolutionary changes brewing as scientists continue to obtain and analyze the DNA sequence data of entire genomes. "From Birth to Death" offers a fresh look at what it means to be human, as it describes the human life cycle and seeks to explain why we exist in the form we do.

We applied the same principles that guided the writing of new chapters to our revision of the existing chapters. We added new boxed essays on topics such as cyanide poisoning of coral reef organisms (p. 699) and the recent discovery of a gene that could be used to genetically engineer coffee beans to produce a drink with all of the taste but none of the "jolt" of caffeinated coffee (p. 262). As we rewrote each chapter, we constantly sought new and interesting applied examples to illustrate key concepts. For instance, in revising Chapter 45, "Global Change," we incorporated the most recent examples of how people affect global ecosystems and added a new section on one of the greatest challenges faced by human societies: How to change our behaviors, laws, and economies so that the impact of Homo sapiens on our planet becomes sustainable (see p. 749).

Our obsession with incorporating applied examples was matched only by our obsession that key concepts be conveyed in a clear and accessible manner. We revised and polished many aspects of the writing, including the order in which material is presented within and between chapters, the figures, and the text prose. To give just one of many possible examples, in Unit I, "The Diversity of Life," we rearranged the material and order of Chapters 2 and 3, including the discussion of the Linnaean classification system, so that now students learn first how organisms are classified into groups and how the groups relate to each other in the new Chapter 2, "Understanding and Organizing the Diversity of Life." The vast diversity of life forms is then described in the revised

Chapter 3, "Major Groups of Living Organisms." To help students keep the context provided by Chapter 2 in perspective, we added small, iconic evolutionary trees to Chapter 3, to remind students where each group fits in on the "tree of life."

Features of the Second Edition: Approaches and Tools to Improve Learning

A primary goal of the Second Edition is to improve the biological literacy of our readers

Topics such as genetic engineering, new cancer treatments, the disappearance of rain forests, and global warming are increasingly in the news. We think it is critical that students understand the biology behind the news; only in this way can they make informed choices when the issues involve biology—as more and more issues do.

As part of our effort to demonstrate the application of biology to day-to-day living, each chapter in *Discover Biology* includes a unique feature called **Evaluating** "The News." These sections offer a brief original article, editorial, or "letter to the editor," often based on actual news stories, and highlight how applications of biology create issues that confront all citizens. Each chapter's Evaluating "The News" includes questions that encourage students to think about the social and ethical impli-



Each chapter ends with an Evaluating "The News" feature, accompanied by thoughtful questions

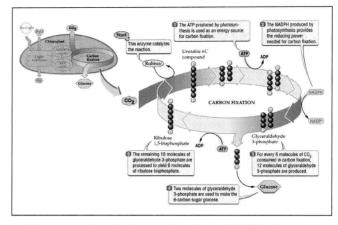
cations of many biological issues, providing a forum for students to develop critical thinking skills and apply what they learn in the textbook to very real problems.

Each of the book's six units ends with a chapter devoted to a significant issue confronting society: biodiversity, cancer, genomics, human evolution, the human lifespan, and global change. These **capstone chapters** draw on the biological concepts introduced earlier in the unit and give an in-depth consideration of how biology is connected to the rest of our lives.

The illustration program: An opportunity and a challenge

Biology is certainly the most visual of all academic disciplines. In creating the First Edition of *Discover Biology*, we were overwhelmed by the vast number of gorgeous photographic images available to illustrate biological phenomena. The Second Edition provides the opportunity to improve on an already stunning array of photographs.

The line art in an introductory biology book does much of the "heavy lifting" of making new and challenging concepts clear. For the First Edition, we worked closely with a team of talented biological illustrators. Employing "balloon" captions that place explanatory copy directly on the art, we feel we succeeded in creating illustrations that are simple and effective. For the Second Edition, we used the advice from adopters and reviewers to hone and refine a large number of figures, making them even clearer.

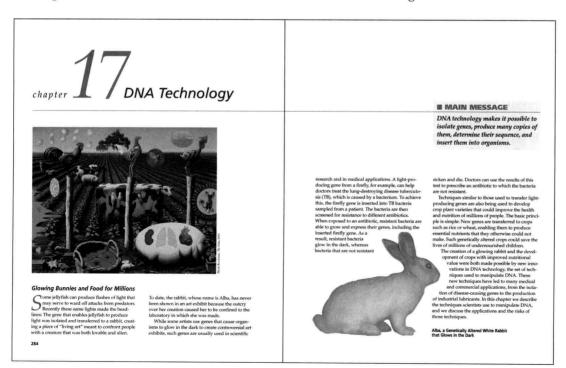


"Balloon" captions bring explanations of difficult concepts right into the art

A unique feature of *Discover Biology* is its use of fine art to introduce each chapter. By this device, we intend to help students connect biology to the rest of the liberal arts curriculum. It was so much fun selecting the paintings and sculptures that adorn the chapters that we chose many new ones for the Second Edition.

Chapters remain short and focused on a few key concepts

Along with the fine art, each chapter's **main message** appears on the chapter-opening spread. The chapter text also begins here with a **hook**—a vignette designed to



Each chapter begins with a two-page "hook" and includes a work of fine art

III THE SCIENTIFIC PROCESS

For the Extinct Elephant Bird, Was Incubation a Crushing Disaster?

The eggs of birds, when not serving as spart of a nutritious breakfast, provide a wonderful example of conflicting selection pressures at work. The shell of an egg, for example, acts both as an external skeleton and as a filter through which materials enter and leave the egg. The shell must be weak enough that a tiny chick can break it open when ready to hatch, yet strong enough that it can support the weight of an incubating adult bird. The shell must be thin and porous enough to allow in the oxygen that the developing chick needs, yet it must resist the loss of water so that the developing chick does not dry out. The largest bird in the world, the 450-kilogram elephant bird of Madagosar, liad fur biggest eggs in the world, weighing 9 kilograms. Sadly, the elephant bird went stringt in the

The largest bird in the world, the 450-kilogram elephant bird of Madagascar, faid the biggest eggs in the world, weighing 9 kilograms. Sadly, the elephant bird went extinct in the seventeenth century, leaving almost no records of its natural history in its wake. We can use what we know about the eggs of other bird species, however, to reconstruct some of the selection pressures that shaped the nesting biology of this remarkable bird. Among living birds, large species have eggshells that are thin relative to egg weight. The relatively thinner eggshells of large eggs appear to compensate for their smaller surface area-to-volume ratio as compared with small eggs. In other words, a thick shell on a large egg would keep the developing chick from getting enough oxygen.

enough oxygen.
Shell thickness, however, directly determines how much force an egg can tolerate before it breaks. We know that the eggs of small birds can support a weight many times that of the parent bird. The eggs of large birds, however, are relatively fragile. An egg of the ostrich, the largest living bird spacies, cannot quite support the weight of a single adult. Ostriches deal with this problem by laying 10 or more eggs in a nest, so that each egg supports just a fraction of the parent's weight.

Birds as big as the elephant bird, however, must have faced tremendous problems during incubation. A single elephant bird egg would break under a weight 1/200 that of an adult bird. In other words, an elephant bird nest would have to contain more than 200 eggs before a parent could safely settle in. Because the elephant bird is extinct, we may never know how this species managed to incubate its eggs.



The extinct elephant bird of Madaga car laid eggs weighing about 9 kilo-

Boxes throughout the book focus on either the process of science or how biology affects our lives

capture students' interest and lead them into the material they will be learning about in the chapter. Hook topics range from life in extreme environments to the global spread of AIDS to the use of forensic genomics to determine whether the Russian Grand Duchess Anastasia escaped execution in 1918 (she did not).

Following the hook is an **overview** of the topics to be covered and a list of the chapter's **key concepts**. Two levels of heading organize the text in a clear and straightforward fashion; second-level headings are usually in the form of a declarative sentence that conveys a key point or summarizes an important message. Each chapter closes with a **highlight** that either explores the "hook" in more depth or discusses a new topic chosen to put the chapter's material in a memorable context.

With the exception of the six capstones, every chapter includes a boxed essay that illuminates an important biological phenomenon, with either a human-interest focus ("Biology in Our Lives") or a glimpse of how scientists work ("The Scientific Process").

Chapters end with a summary of important points, a list of key terms, a self-quiz, and a set of review questions, along with the Evaluating "The News" feature mentioned earlier. Answers to the self-quizzes and review questions are in the back of the book, along with "Suggested Readings" for further exploration, a glossary, and the index.

Student Website/CD

No textbook about a subject as broad as biology can stand alone. Some topics require additional information



More than 200 media icons identify activities and tutorials on the Student Website/CD

or hands-on practice. In these cases, alternative media such as animation and video can be used in activities designed to help students understand difficult material. For the Second Edition, *Discover Biology* offers an improved and comprehensive **student media resource** that is available online at www.discoverbiology.com and as a CD.

More than 200 concepts that are covered on the Student Website/CD are referenced in the book with an **icon** that directs the reader to a specific media activity. A description of the Student Website/CD and a list of these activities is provided at the front of the book. Of special interest is the addition of more than 40 new **animated tutorials**, including "Anthrax Bacteria Release Deadly Toxins," "Sequencing the Human Genome," "T Pressure Flow in Plants," and "The Carbon Cycle."

This Book is a Work in Progress

Like the field of biology itself, any textbook aiming to describe it is a work in progress. We hope you will contact us with your comments, questions, and ideas as you use the book. You can reach any or all of the authors with an email message to discoverbiology@sinauer.com, or

by writing to us at Discover Biology, Sinauer Associates, 23 Plumtree Road, Sunderland, MA 01375 U.S.A.

We Thank the Many People Who Helped Us with this Revision

As we revised *Discover Biology*, each of us contacted scientists from around the world to ask about their research or about breaking stories in their field of expertise. We are grateful for the time they spent answering our many questions. We are also grateful for the scientific papers, illustrations, and photos they provided. We have communicated with many more scientists than we can thank individually, but collectively we thank them here. We are deeply in their debt.

As discussed above, a great many individuals provided critiques of the First Edition, answered a daunting questionnaire between editions, and reviewed the Second Edition manuscript. These colleagues are listed on the next page, and we thank them all. Thanks also to Susan McGlew for coordinating all of this invaluable feedback.

Our copublishers again made writing this book a stimulating experience. At Sinauer Associates, Andy Sinauer put together the team and coordinated all the major decisions. Kerry Falvey, our production editor, handled that complex task magnificently. Norma Roche is a gifted manuscript editor and we were most fortunate to have her work on our words. David McIntyre again served as photo editor and again provided an abundance of superb images for us to choose from. Christopher Small coordinated art and production with authority, and Jeff Johnson again led the team that produced alluring page spreads. Jason Dirks, with lots of help from Gayle Sullivan and Mara Silver, put together the excellent media and supplements package for the Second Edition.

At W.W. Norton, John Byram and Margaret Barrett provided the eyes and ears to bring us significant feedback from the marketplace. They both participated in the myriad decisions that go into shaping the publishing plan for a new edition. Dan Bartell, National Sales Manager, and Roby Harrington, Director of the College Department, provided continuous support and enthusiasm.

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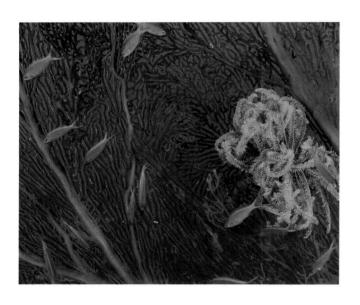
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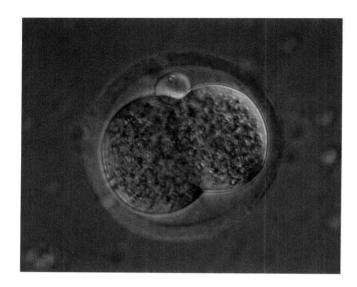
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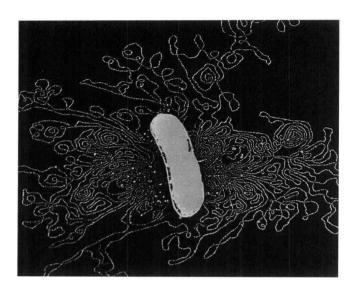
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