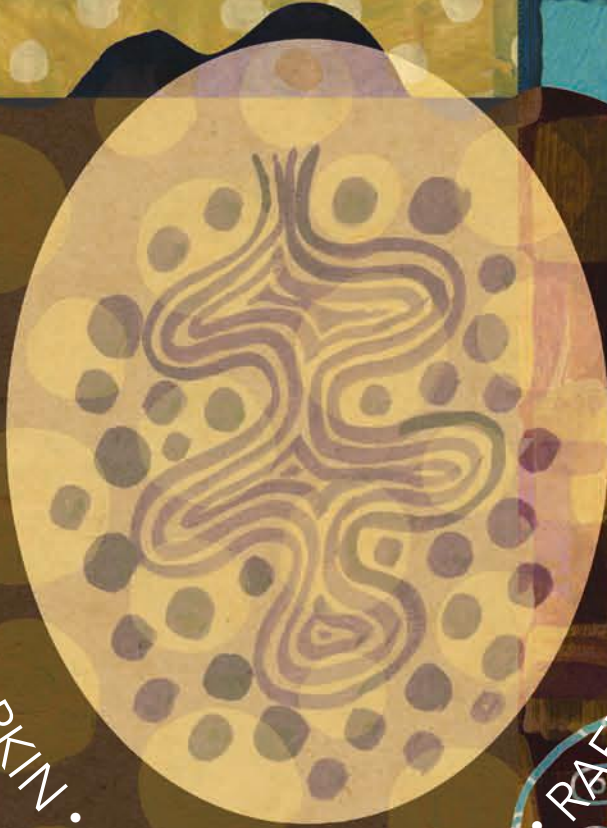


FOURTH EDITION ESSENTIAL CELL BIOLOGY



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Essential Cell Biology Website

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Preface

In our world there is no form of matter more astonishing than the living cell: tiny, fragile, marvelously intricate, continually made afresh, yet preserving in its DNA a record of information dating back more than three billion years, to a time when our planet had barely cooled from the hot materials of the nascent solar system. Ceaselessly re-engineered and diversified by evolution, extraordinarily versatile and adaptable, the cell retains a complex core of self-replicating chemical machinery that is shared and endlessly repeated by every living organism on the face of the Earth—in every animal, every leaf, every bacterium in a piece of cheese, every yeast in a vat of wine.

Curiosity, if nothing else, should drive us to study cell biology; we need to understand cell biology to understand ourselves. But there are practical reasons, too, why cell biology should be a part of everyone's education. We are made of cells, we feed on cells, and our world is made habitable by cells. The challenge for scientists is to deepen our knowledge of cells and find new ways to apply it. All of us, as citizens, need to know something of the subject to grapple with the modern world, from our own health affairs to the great public issues of environmental change, biomedical technologies, agriculture, and epidemic disease.

Cell biology is a big subject, and it has links with almost every other branch of science. The study of cell biology therefore provides a great scientific education. However, as the science advances, it becomes increasingly easy to become lost in detail, distracted by an overload of information and technical terminology. In this book we therefore focus on providing a digestible, straightforward, and engaging account of only the essential principles. We seek to explain, in a way that can be understood even by a reader approaching biology for the first time, how the living cell works: to show how the molecules of the cell—especially the protein, DNA, and RNA molecules—cooperate to create this remarkable system that feeds, responds to stimuli, moves, grows, divides, and duplicates itself.

The need for a clear account of the essentials of cell biology became apparent to us while we were writing *Molecular Biology of the Cell (MBoC)*, now in its fifth edition. *MBoC* is a large book aimed at advanced undergraduates and graduate students specializing in the life sciences or medicine. Many students and educated lay people who require an introductory account of cell biology would find *MBoC* too detailed for their needs. *Essential Cell Biology (ECB)*, in contrast, is designed to provide the fundamentals of cell biology that are required by anyone to understand both the biomedical and the broader biological issues that affect our lives.

This fourth edition has been extensively revised. We have brought every part of the book up to date, with new material on regulatory RNAs, induced pluripotent stem cells, cell suicide and reprogramming, the human genome, and even Neanderthal DNA. In response to student feedback, we have improved our discussions of photosynthesis and DNA

repair. We have added many new figures and have updated our coverage of many exciting new experimental techniques—including RNAi, optogenetics, the applications of new DNA sequencing technologies, and the use of mutant organisms to probe the defects underlying human disease. At the same time, our “How We Know” sections continue to present experimental data and design, illustrating with specific examples how biologists tackle important questions and how their experimental results shape future ideas.

As before, the diagrams in *ECB* emphasize central concepts and are stripped of unnecessary details. The key terms introduced in each chapter are highlighted when they first appear and are collected together at the end of the book in a large, illustrated glossary.

A central feature of the book is the many questions that are presented in the text margins and at the end of each chapter. These are designed to provoke students to think carefully about what they have read, encouraging them to pause and test their understanding. Many questions challenge the student to place the newly acquired information in a broader biological context, and some have more than one valid answer. Others invite speculation. Answers to all the questions are given at the end of the book; in many cases these provide a commentary or an alternative perspective on material presented in the main text.

For those who want to develop their active grasp of cell biology further, we recommend *Molecular Biology of the Cell, Fifth Edition: A Problems Approach*, by John Wilson and Tim Hunt. Though written as a companion to *MBoC*, this book contains questions at all levels of difficulty and contains a goldmine of thought-provoking problems for teachers and students. We have drawn upon it for some of the questions in *ECB*, and we are very grateful to its authors.

The explosion of new imaging and computer technologies continues to provide fresh and spectacular views of the inner workings of living cells. We have captured some of this excitement in the new *Essential Cell Biology* website, located at www.garlandscience.com/ECB4-students. This site, which is freely available to anyone in the world with an interest in cell biology, contains over 150 video clips, animations, molecular structures, and high-resolution micrographs—all designed to complement the material in individual book chapters. One cannot watch cells crawling, dividing, segregating their chromosomes, or rearranging their surface without a sense of wonder at the molecular mechanisms that underlie these processes. For a vivid sense of the marvel that science reveals, it is hard to match the narrated movie of DNA replication. These resources have been carefully designed to make the learning of cell biology both easier and more rewarding.

Those who seek references for further reading will find them on the *ECB* student and instructor websites. But for the very latest reviews in the current literature, we suggest the use of web-based search engines, such as PubMed (www.ncbi.nlm.nih.gov) or Google Scholar (scholar.google.com).

As with *MBoC*, each chapter of *ECB* is the product of a communal effort, with individual drafts circulating from one author to another. In addition, many people have helped us, and these are credited in the Acknowledgments that follow. Despite our best efforts, it is inevitable that there will be errors in the book. We encourage readers who find them to let us know at science@garland.com, so that we can correct these errors in the next printing.

Acknowledgments

The authors acknowledge the many contributions of professors and students from around the world in the creation of this fourth edition. In particular, we are grateful to the students who participated in our focus groups; they provided invaluable feedback about their experiences using the book and our multimedia, and many of their suggestions were implemented in this edition.

We would also like to thank the professors who helped organize the student focus groups at their schools: Nancy W. Kleckner at Bates College, Kate Wright and Dina Newman at Rochester Institute of Technology, David L. Gard at University of Utah, and Chris Brandl and Derek McLachlin at University of Western Ontario. We greatly appreciate their hospitality and the opportunity to learn from their students.

We also received detailed reviews from many instructors who used the third edition, and we would like to thank them for their contributions: Devavani Chatterjea, Macalester College; Frank Hauser, University of Copenhagen; Alan Jones, University of North Carolina at Chapel Hill; Eugene Mesco, Savannah State University; M. Scott Shell, University of California Santa Barbara; Grith Lykke Sørensen, University of Southern Denmark; Marta Bechtel, James Madison University; David Bourgaize, Whittier College; John Stephen Horton, Union College; Siern Lim, Nanyang Technological University; Satoru Kenneth Nishimoto, University of Tennessee Health Science Center; Maureen Peters, Oberlin College; Johanna Rees, University of Cambridge; Gregg Whitworth, Grinnell College; Karl Fath, Queens College, City University of New York; Barbara Frank, Idaho State University; Sarah Lundin-Schiller, Austin Peay State University; Marianna Patrauchan, Oklahoma State University; Ellen Rosenberg, University of British Columbia; Leslie Kate Wright, Rochester Institute of Technology; Steven H. Denison, Eckerd College; David Featherstone, University of Illinois at Chicago; Andor Kiss, Miami University; Julie Lively, Sewanee, The University of the South; Matthew Rainbow, Antelope Valley College; Juliet Spencer, University of San Francisco; Christoph Winkler, National University of Singapore; Richard Bird, Auburn University; David Burgess, Boston

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We are very grateful, too, to the readers who alerted us to errors they had found in the previous edition.

Many staff at Garland Science contributed to the creation of this book and made our work on it a pleasure. First of all, we owe a special debt to Michael Morales, our editor, who coordinated the whole enterprise. He organized the initial reviewing and the focus groups, worked closely with the authors on their chapters, urged us on when we fell behind, and played a major part in the design, assembly, and production of *Essential Cell Biology* student website. Monica Toledo managed the flow of chapters through the book development and production process, and oversaw the writing of the accompanying question bank. Lamia Harik gave editorial assistance. Nigel Orme took original drawings created by author Keith Roberts and redrew them on a computer, or occasionally by hand, with great skill and flair. To Matt McClements goes the credit for the graphic design of the book and the creation of the chapter-opener sculptures. As in previous editions, Emma Jeffcock did a brilliant job in laying out the whole book and meticulously incorporating our endless corrections. Adam Sendroff and Lucy Brodie gathered user feedback and launched the book into the wide world. Denise Schanck, the Vice President of Garland Science, attended all of our writing retreats and orchestrated everything with great taste and diplomacy. We give our thanks to everyone in this long list.

Last but not least, we are grateful, yet again, to our colleagues and our families for their unflagging tolerance and support.

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Resources for Instructors and Students

The teaching and learning resources for instructors and students are available online. The instructor's resources are password protected and available only to qualified instructors. The student resources are available to everyone. We hope these resources will enhance student learning, and make it easier for instructors to prepare dynamic lectures and activities for the classroom.

INSTRUCTOR RESOURCES

Instructor Resources are available on the Garland Science Instructor's Resource Site, located at www.garlandscience.com/instructors. The website provides access not only to the teaching resources for this book but also to all other Garland Science textbooks. Qualified instructors can obtain access to the site from their sales representative or by emailing science@garland.com.

Art of Essential Cell Biology, Fourth Edition

The images from the book are available in two convenient formats: PowerPoint® and JPEG. They have been optimized for display on a computer. Figures are searchable by figure number, figure name, or by keywords used in the figure legend from the book.

Figure-Integrated Lecture Outlines

The section headings, concept headings, and figures from the text have been integrated into PowerPoint presentations. These will be useful for instructors who would like a head start creating lectures for their course. Like all of our PowerPoint presentations, the lecture outlines can be customized. For example, the content of these presentations can be combined with videos and questions from the book or "Question Bank," in order to create unique lectures that facilitate interactive learning.

Animations and Videos

The 130+ animations and videos that are available to students are also available on the Instructor's Resource site in two formats. The WMV-formatted movies are created for instructors who wish to use the movies in PowerPoint presentations on Windows® computers; the QuickTime-formatted movies are for use in PowerPoint for Apple computers or Keynote® presentations. The movies can easily be downloaded to your computer using the "download" button on the movie preview page.

Question Bank

Written by Linda Huang, University of Massachusetts, Boston, and Cheryl D. Vaughan, Harvard University Division of Continuing Education, the revised and expanded question bank includes a variety of question formats: multiple choice, fill-in-the-blank, true-false, matching, essay, and challenging "thought" questions. There are approximately 60–70 questions per chapter, and a large number of the multiple-choice questions will be suitable for use with personal response systems (that is, clickers). The *Question Bank* was created with the philosophy that a good exam should do much more than simply test students' ability to memorize information; it should require them to reflect upon and integrate information as a part of a sound understanding. It provides a comprehensive sampling of questions that can be used either directly or as inspiration for instructors to write their own test questions.

References

Adapted from the detailed references of *Molecular Biology of the Cell*, and organized by the table of contents for *Essential Cell Biology*, the "References" provide a rich compendium of journal and review articles for reference and reading assignments. The "References" PDF document is available on both the instructor and student websites.

Medical Topics Guide

This document highlights medically relevant topics covered throughout the book, and will be particularly useful for instructors with a large number of premedical, health science, or nursing students.

Media Guide

This document overviews the multimedia available for students and instructors and contains the text of the voice-over narration for all of the movies.

Blackboard® and LMS Integration

The movies, book images, and student assessments that accompany the book can be integrated into Blackboard or other learning management systems. These resources are bundled into a "Common Cartridge" that facilitates bulk uploading of textbook resources into Blackboard and other learning management systems. The LMS Common Cartridge can be obtained on a DVD from your sales representative or by emailing science@garland.com.

STUDENT RESOURCES

The resources for students are available on the *Essential Cell Biology* Student Website, located at www.garlandscience.com/ECB4-students.

Animations and Videos

There are over 130 movies, covering a wide range of cell biology topics, which review key concepts in the book and illuminate the cellular microcosm.

Student Self-Assessments

The website contains a variety of self-assessment tools to help students.

- Each chapter has a multiple-choice quiz to test basic reading comprehension.
- There are also a number of media assessments that require students to respond to specific questions about movies on the website or figures in the book.
- Additional concept questions complement the questions available in the book.
- “Challenge” questions are included that provide a more experimental perspective or require a greater depth of conceptual understanding.

Cell Explorer

This application teaches cell morphology through interactive micrographs that highlight important cellular structures.

Flashcards

Each chapter contains a set of flashcards, built into the website, that allow students to review key terms from the text.

Glossary

The complete glossary from the book is available on the website and can be searched or browsed.

References

A set of references is available for each chapter for further reading and exploration.

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