



# The Cell

## A Molecular Approach

Seventh Edition

*“I have enjoyed using this book because it cuts through the mountain of details flooding into this topic and presents in a simple way the techniques currently in use and some cutting-edge research. When I chose this book, it was after looking at several other books on the market —this one thoroughly covered the topics, but in a simple, easy-to-understand way for the student.”*

—Kathleen Wood, University of Mary Hardin-Baylor

Geoffrey M. Cooper • Robert E. Hausman

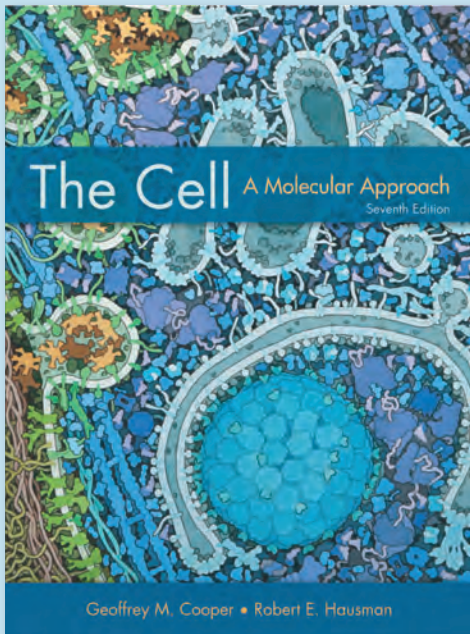
### BRAND NEW FOR THIS EDITION!

- Over 70 new Data Analysis Problems, with answers and explanations
- New online videos, referenced throughout the book

FIND OUT  
MORE INSIDE... ▶

# The Cell: A Molecular Approach, Seventh Edition

GEOFFREY M. COOPER and ROBERT E. HAUSMAN



## ABOUT THE BOOK

Teaching cell biology can be a daunting task because the field is so vast and rapidly moving, characterized by a continual explosion of new information. The challenge is how to teach students the fundamental concepts without becoming bogged down in details. Students need to understand the principles of cell biology and be able to appreciate new advances, rather than just memorizing “the facts” as we see them today. At the same time, the material must be presented in sufficient depth to thoughtfully engage students and provide a sound basis for further studies. *The Cell*, Seventh Edition provides a balance of concepts and details that meets the needs of today’s students and their teachers. Written by an active scientist and experienced educator, this textbook combines readability and cohesiveness with comprehensive and up-to-date science.

In keeping with prior editions, the new Seventh Edition:

- Is **ideally suited in length and complexity** for sophomore- and junior-level courses at the undergraduate level.

- **Can be covered in a single semester.** Students can master the material in its entirety, rather than sampling a small fraction from a much larger text.
- Is written in an **efficient and compact** style, covering a broad range of material in a **direct and pedagogically approachable** manner.
- **Focuses on the molecular biology of cells as a unifying theme**, with topics such as developmental biology, the nervous system, the immune system, and plant biology being discussed as examples of more general principles.
- Features “**Key Experiment**” and “**Molecular Medicine**” boxes that highlight the experimental nature of molecular and cellular biology and convey the excitement and medical relevance of research in this area.

October 2, 2015 • 750 pages (est.) • 650 illustrations (est.) • ISBN 978-1-60535-290-9 • casebound

**Cover illustration:** *Autophagy* (from a collaboration with Dan Klionsky), by David S. Goodsell, The Scripps Research Institute.

## AFFORDABLE VALUE OPTIONS FOR EVERY FORMAT!

### Print Edition

- Order **from our website** for a 15% discount from suggested list price.\* (**\$132.56**)
- Free standard ground shipping to U.S. addresses on orders \$40.00 and up.
- Orders usually ship in 1–4 business days.
- Offer not available to resellers.

### Looseleaf Edition

- Discounted 35% from suggested list price\* of the bound print edition. (**\$101.37**)
- Additional 15% discount with free shipping **at our website** also applies. (**\$86.16**)

### eBooks

- Suggested list discounted 55% from bound book list price\* for a 180-day subscription. (**\$70.18**)
- Suggested list discounted 15% from bound book list price\* to own permanently. (**\$132.56**)
- Formats include BryteWave, RedShelf, VitalSource CourseSmart, and YUZU.

\*\$155.95 Suggested list price • \$124.76 Net price to resellers

For detailed contents or to request an examination copy, visit our website: [sinauer.com](http://sinauer.com)

## ABOUT THE AUTHORS

**Geoffrey M. Cooper** is Professor of Biology at Boston University. Receiving a Ph.D. in Biochemistry from the University of Miami in 1973, he pursued postdoctoral work with Howard Temin at the University of Wisconsin, where he developed gene transfer assays to characterize the proviral DNAs of Rous sarcoma virus and related retroviruses. He then joined the faculty of Dana-Farber Cancer Institute and Harvard Medical School in 1975, where he pioneered the discovery of oncogenes in human cancers. Since moving to Boston University as Chair of Biology in 1998, Dr. Cooper has used *The Cell* in teaching undergraduate cell biology, as well as continuing his research on the roles of oncogene proteins in the signaling pathways that regulate cell proliferation and programmed cell death. He has authored two textbooks on cancer and published over 100 research papers in the field of cell signaling and cancer research.

**Robert E. Hausman**, our friend and colleague, passed away April 25, 2015. Rob was a Professor in the Department of Biology at Boston University. Receiving a Ph.D. in Biological Science from Northwestern University in 1971, he pursued postdoctoral work with Aron Moscona at the University of Chicago, where he investigated cell-cell interactions during early embryonic development. Dr. Hausman joined the faculty of Boston University in 1978, extending his investigations of cell surface interactions to muscle and nervous system development. He taught undergraduate cell biology with Dr. Cooper and contributed to several chapters of previous editions of *The Cell*.

# NEW CONTENT HIGHLIGHTS

## Part I. Fundamentals and Foundations

### 1. An Overview of Cells and Cell Research

- New discussion of super-resolution light microscopy
- New Key Experiment: HeLa cells

### 2. Molecules and Membranes

- Reorganized to include discussion of enzymes and catalysis

### 3. Bioenergetics and Metabolism

- Reorganized to include discussion of the mechanisms of oxidative phosphorylation and photosynthesis

### 4. Fundamentals of Molecular Biology

- Additional discussion of real-time PCR
- New discussion of the CRISPR/Cas system

### 5. Genomics, Proteomics, and Systems Biology

- New chapter focusing on genomics, proteomics, and systems biology
- Added discussion of next-generation sequencing
- New section on Synthetic Biology
- New Molecular Medicine: Malaria and Synthetic Biology

*“I adopted The Cell back in 1997 when the First Edition came out, and was extremely impressed ... Every reviewer name was immediately recognizable to anyone in the field, the chapters were extremely clearly written, and the figures were intelligently chosen and crafted to illustrate all the key points! And after adopting every single edition since that time, nothing has changed my mind: it’s still the best in the business!”*

—Dave Adams, Worcester Polytechnic Institute

## Part II. The Flow of Genetic Information

### 6. Genes and Genomes

- Updated discussion of noncoding RNAs
- New Key Experiment: The ENCODE Project

### 7. Replication, Maintenance, and Rearrangements of Genomic DNA

- New discussion of DNA rearrangement and yeast mating types

### 8. RNA Synthesis and Processing

- Discussion of the role of  $\alpha$ -ketoglutarate in catabolite repression
- Updated information on insulators and transcriptional domains
- New section on Chromatin and Epigenetics
- Updated discussion of lncRNAs

### 9. Protein Synthesis, Processing, and Regulation

- New discussion of prions
- Updated information on protein modification by ubiquitin and SUMO
- New Molecular Medicine: Alzheimer’s Disease

*“In the fast-paced discipline of cell biology, teaching The Cell provides a combination of contemporary information for students balanced with a strong historical approach necessary for conceptualizing the scientific method. The organization of the textbook and flow of information facilitates a solid grasp and appreciation from the molecular to the systematic levels of biology. And I find that the animations and videos really resonate with students to engage the higher-order cognitive skills that we are trying to foster.”*

—Jason Bush, California State University, Fresno

## Part III. Cell Structure and Function

### 10. The Nucleus

- New information on the organization of chromosome domains within the nucleus
- Updated discussion of nuclear bodies

### 11. Protein Sorting and Transport: The Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes

- Updated discussion of the insertion of membrane proteins in the ER
- New information on protein trafficking through the Golgi
- Updated discussion of vesicle docking and fusion

### 12. Mitochondria, Chloroplasts, and Peroxisomes

- Updated discussion of chloroplast genomes and protein import
- New information on peroxisome biogenesis
- New Molecular Medicine: Peroxisome Biogenesis Disorders

### 13. The Cytoskeleton and Cell Movement

- Updated discussion of actin filament remodeling at the leading edge

### 14. The Plasma Membrane

- Updated discussion of plasma membrane domains, lipid rafts and caveolae
- New information on clathrin-independent endocytosis
- Updated Molecular Medicine to include new information on drug treatment of cystic fibrosis

### 15. Cell Walls, the Extracellular Matrix, and Cell Interactions

- New discussion of the role of bacterial cytoskeletal proteins in cell wall synthesis and cell shape
- Updated information on  $\alpha$ -catenin linkage to actin

## Part IV. Cell Regulation

### 16. Cell Signaling

- Chapter reorganized to focus on integrated signaling pathways

### 17. The Cell Cycle

- Expanded discussion of the initiation of DNA synthesis and role of APC/C
- New information on the spindle assembly checkpoint

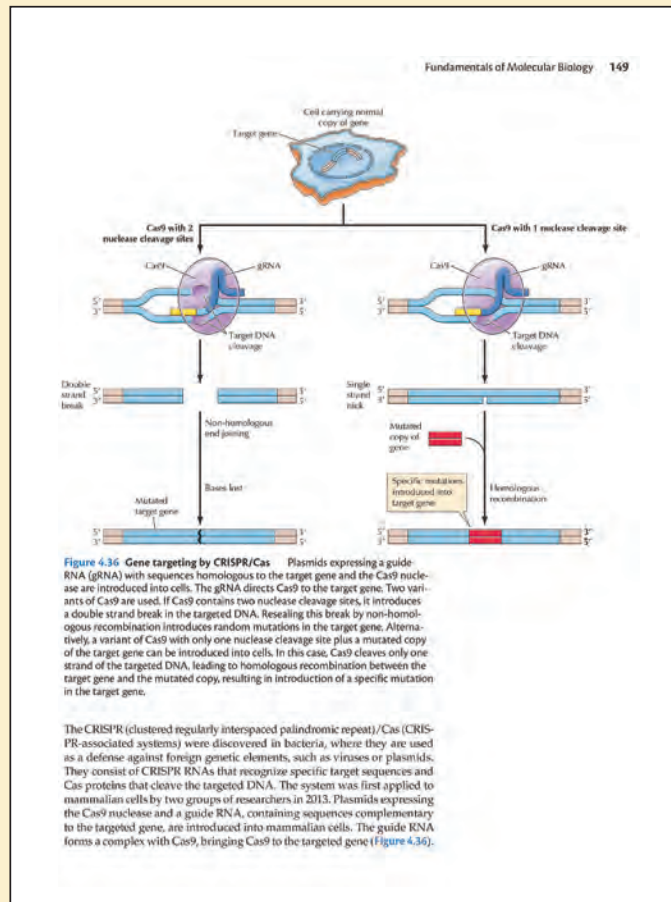
### 18. Cell Death and Cell Renewal

- Expanded discussion of programmed cell death by autophagy and necroptosis
- New information on stem cell niches

### 19. Cancer

- Updated discussion of cancer genomics
- New information on targeted therapies

## Sample pages



180 Chapter 5

### Molecular Medicine

#### Malaria and Synthetic Biology

**The Disease**  
Malaria is caused by a parasite transmitted by infected mosquitoes and is the most significant human parasitic disease. Symptoms are severe chills, vomiting and fever, resembling flu. If the disease is left untreated, it may lead to severe complications and death. The World Health Organization estimates that there were 198 million cases of malaria and 584,000 deaths in 2013, with 90% of the deaths occurring in Africa.

**Molecular and Cellular Basis**  
The parasites that cause malaria are protozoans belonging to the genus *Plasmodium*. Five species, *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax* and *P. knowlesi*, cause malaria in humans. Approximately 75% of cases and almost all deaths are caused by *P. falciparum* (see figure). The disease is transmitted by a bite of an *Anopheles* mosquito. The parasite then travels to the liver and replicates in liver cells, producing thousands of progeny. These progeny then infect and replicate in red blood cells, which live to release more parasites that infect additional red blood cells and undergo additional rounds of replication. The blood stage parasites cause the symptoms of the disease, and can also be picked up by a mosquito for further transmission.

**Prevention and Treatment**  
Development of a vaccine against malaria is a major public health research priority, but no anti-malaria vaccine is currently available. Instead, efforts at disease prevention

focus on measures to prevent mosquito bites, such as using insect repellents, sleeping under mosquito nets, or spraying insecticides. People traveling to areas where malaria is prevalent can take a variety of anti-malarial drugs, most of which are also used for treatment. However, prevention with these drugs is not practical for residents of areas where malaria exists because of their cost and the side effects of long term use.

The first effective treatment for malaria was quinine, which was replaced by chloroquine in the 1940s. Unfortunately, strains of *P. falciparum* that were resistant to chloroquine developed in the 1950s and have now become widespread. The most effective current therapy for *P. falciparum* malaria is artemisinin, which was discovered by the Chinese scientist Tu Youyou in the 1970s. It is administered as combination therapy with other antimalarial drugs.

in order to prevent the development of strains of *P. falciparum* that are resistant to artemisinin.

Artemisinin was discovered in the leaves of *Artemisia annua* (sweet wormwood), which unfortunately provides a limited supply of the drug. The plants take about eight months to grow to full size and, because of instability in its availability, the market price for artemisinin has fluctuated over a tenfold range in recent years. The work of synthetic biologists has made an important contribution to this problem by engineering a strain of yeast that produces high levels of artemisinin acid, which can be efficiently converted chemically to artemisinin. Based on the efficient production of artemisinin by the engineered yeast, the pharmaceutical company Sanofi established a new production facility for artemisinin in 2013 and has produced more than 16 million treatments since 2014.

*P. falciparum* in a blood smear

**FYI**  
The team that engineered the first yeast synthetic chromosome consisted largely of undergraduate researchers.

cellular proteins are specified by that genome, with the proteins present in the original recipient cell diluted out during replication, these mycoplasmas also represent the first synthetic cells. Current efforts are under way to engineer a synthetic yeast genome as a model for design of a eukaryotic cell. Given the steadily decreasing costs of DNA synthesis, the possibility of engineering plant and animal genomes may also become feasible undertakings in the foreseeable future.

# MEDIA AND SUPPLEMENTS

## For the Student

### Companion Website

([sites.sinauer.com/cooper7e](http://sites.sinauer.com/cooper7e))

*The Cell*, Seventh Edition Companion Website provides students with a wide range of study and review materials, rich multimedia resources, and online quizzing. The site is available free of charge (no access code required) and includes the following resources:

**NEW! Videos:** A new collection of online videos (referenced throughout the book) helps students visualize complex cellular and molecular structures and processes.

- **Online Quizzes:** Two sets of online quiz questions are available for each chapter, both of which are assignable by the instructor. (Adopting instructors must register online in order for their students to access the quizzes.)
  - Multiple-choice quizzes test comprehension of the chapter's key material.
  - Free-response questions ask students to apply what they have learned from the chapter.
- **Animations:** Narrated animations help students better grasp key complex topics and processes.
- **Micrographs:** Interactive versions of the many micrographs in the book, illustrating cellular structure.
- **Flashcards & Key Terms:** A great way for students to learn and review the key terminology introduced in each chapter.
- Chapter Summaries
- Web Links
- Complete glossary

### Test File (available in the Instructor's Resource Library)

Revised and updated for the Seventh Edition, the Test File includes a collection of over 1,300 multiple-choice, fill-in-the-blank, true/false, and short-answer questions covering the full range of content in every chapter. New for the Seventh Edition, all questions are referenced to Bloom's Taxonomy, making it easier for instructors to select the specific types of questions they want when building an assessment.

### Computerized Test Bank

(available in the Instructor's Resource Library)

The entire test file plus all of the online quiz questions are provided in Blackboard's Diploma software. Diploma makes it easy to assemble quizzes and exams

## For the Instructor (available to qualified adopters)

### Instructor's Resource Library

The Seventh Edition Instructor's Resource Library includes a wide range of digital resources to aid instructors in planning the course, presenting lectures, and assessing students. The IRL includes the following resources:

**NEW! Data Analysis Problems:** New for the Seventh Edition, this set of over 70 problems presents students with real-world analysis exercises. Each problem is built around figures and data from published papers, and students are challenged to interpret the figures, analyze data, and explain methods and results. Complete answers and explanations are provided. Ideal for use as in-class exercises or as homework assignments.

- **Textbook Figures & Tables:** All available as both high- and low-resolution JPEGs
- **PowerPoint Resources:**
  - Figures and tables
  - Complete lecture presentations
  - Supplemental photos
- **Animations:** The entire collection of animations from the Companion Website, for use in lecture
- **Supplemental Photos:** Over 100 additional micrographs
- **Online Quiz Questions:** Multiple-choice and free-response questions from the Companion Website, with answers and feedback
- The complete **Test File**, in Microsoft Word and Diploma formats (see below for details)
- **Chapter Outlines and Key Terms**

from any combination of publisher-provided and instructor-created questions. In addition, quizzes and exams can be exported to many different course management systems, such as Blackboard and Moodle.

### Online Quizzes

*The Cell's* Companion Website features pre-built chapter quizzes (see above) that report into an online gradebook. Adopting instructors have access to these quizzes and can choose to either assign them or let students use them for review. (Instructors must register in order for their students to be able to take the quizzes.) Instructors also have the ability to add their own questions and create their own quizzes.



**Sinauer Associates, Inc., Publishers**

23 Plumtree Road

PO Box 407

Sunderland, MA 01375-0407

**sinauer.com**

PRSR STD  
U. S. Postage Paid  
Greenfield, MA  
Permit No. 183

## ALSO OF INTEREST



### JUST PUBLISHED

#### **Ecological Developmental Biology, Second Edition**

Scott F. Gilbert and David Epel

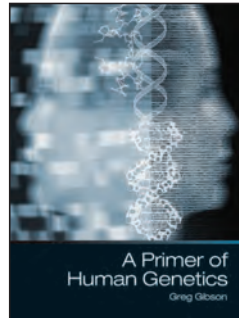
The revolution in molecular technologies has created a revolution in our perception of the living world. It is life, but not as we knew it. The science studying this new world—uncovering the

relationships between genes, developing organisms, and their environments—is called **ecological developmental biology**. This book presents the data for ecological developmental biology, integrating it into new accounts of medicine, evolution, and embryology. The new evolutionary science created by this approach to nature is called **ecological evolutionary developmental biology** (eco-evo-devo). *Ecological Developmental Biology*, Second Edition documents the evidence for a new, extended, evolutionary synthesis, a synthesis that confounds the creationist belief that evolution can't be described above the species-level; integrates aging and “Western” diseases such as diabetes, atherosclerosis, cancer, and obesity into an evolutionary context; and sees interspecies interactions both within the organism and between organisms as being critical for evolution, development, and fitness.

August 2015 • 576 pages • 224 illustrations

ISBN 978-1-60535-344-9 • paper

\$69.95 Suggested list price • \$55.96 Net price to resellers



#### **A Primer of Human Genetics**

Greg Gibson

*A Primer of Human Genetics* is an upper undergraduate textbook designed to give students the foundation they need to understand and appreciate the extraordinary shifts in human genetics that have accompanied the arrival of genomics. The book lays out the key

concepts of human evolution, quantitative genetics, and personalized medicine before describing the tools that are missing from most contemporary textbooks: genome-wide association studies, whole-genome resequencing, gene expression and epigenome profiling, and integrative genomics. The final section provides an up-to-date survey of specific findings in six major domains of human disease: immunological, metabolic, cardiovascular, cancer, neuropsychological, and aging disorders. After reading this book, students should have a sense of the major contemporary trends of human genetics research and of how genomics has revolutionized our understanding of the human condition. Students are assumed to have a prerequisite understanding of genetics such as would be obtained in a general genetics class.

2015 • 442 pages • 130 illustrations

ISBN 978-1-60535-313-5 • paper

\$64.95 Suggested list price • \$51.96 Net price to resellers