



教育部高等教育司推荐
国外优秀生命科学教学用书

基因 X

LEWIN'S GENES X

JOCELYN E. KREB
ELLIOTT S. GOLDSTEIN
STEPHEN T. KILPATRICK



高等教育出版社
HIGHER EDUCATION PRESS

LEWIN'S GENES X

JOCELYN E. KREBS
ELLIOTT S. GOLDSTEIN
STEPHEN T. KILPATRICK

分子生物学与分子遗传学领域正经历着日新月异的变化，每天都会出现新的数据，那些热门的研究进程，过去每隔数年才会出现新的见解和看法，现在只要几周或几个月。在过去几十年里，对广大教学者来说，Lewin的《基因》是一本十分优秀的教材，该书对分子生物学和分子遗传学进行了精彩的论述，内容涵盖了基因的结构、序列、组织和表达。最新版的Lewin《基因X》，拥有一支崭新的知识渊博的作者队伍，21位科学家根据各自的专业研究特长，对书中内容进行了修订和更新，以保证《基因X》是本领域最新颖全面的教材。《基因X》在内容上增加了一些新的章节，结构也进行了一些调整，使得全书各个主题在排列上更加富有逻辑性。另外许多章节也重新命名，和内容更加相符。新版中还包含了一些新的教学特色，便于学生在阅读本书过程中更好地学习；增加一个在线学习导航，学生可以使用它对关键内容进行自我测试。

新版特色

- 全新的第3章——分子生物学和基因工程方法，详细介绍了分子生物学实验技术的概念和实践。
- 新插入的第8章——基因组进化，对于早期版本分散在各章节中的相关材料做了整合、扩展和更新，并介绍了一些新进展。
- 第22章——mRNA的稳定性和定位，完全更新并重写，以包含更多的前沿内容。
- 第30章——调控RNA和小RNA，特别引入了RNAi通路的相关内容。
- 大量崭新的精美插图反映了相关领域的新进展，尤其是基因组结构和功能、表观遗传学，以及原核生物中非编码和小RNA的调控。

SUPPLEMENTS:

The *Online Student Study Guide* is an interactive, electronic study aid dedicated exclusively to *Lewin's GENES X*. Students will find a variety of resources all designed to explore the concepts of molecular biology in more depth and to help them master material in the text. Activities include: chapter summaries, Web-based research links, study quizzes, a searchable glossary, interactive flashcards and crosswords, and key animations.

Jones and Bartlett Publishers also offers a suite of resources to help professors teach their course. The *Instructor's ToolKit CD-ROM* contains a PowerPoint® Image Bank and PowerPoint Lecture Outline Slides. A Test Bank is also available online, at <http://www.jbpub.com>.



Jones and Bartlett Publishers
40 Tall Pine Drive
Sudbury, MA 01776
978-443-5000
info@jbpub.com
www.jbpub.com

高等教育出版社 生命科学分社
联系电话: 010-58556441/58581445
网 址: www.hep.com.cn
E m a i l: lifescience@pub.hep.cn

ISBN 978-7-04-026961-1



定价 385.00 元

基因 X

J I Y I N X

LEWIN'S GENES X

JOCELYN E. KREBS

ELLIOTT S. GOLDSTEIN

STEPHEN T. KILPATRICK



高等教育出版社 · 北京
HIGHER EDUCATION PRESS BEIJING



图书在版编目 (CIP) 数据

基因 X=Lewin's Genes X : 英文 / (美) 克莱博斯 (Krebs), (美) 高登斯坦 (Goldstein), (美) 吉尔帕特里克 (Kilpatrick) 著. —北京: 高等教育出版社, 2010.1

ISBN 978-7-04-026961-1

I. 基… II. ①克…②高…③吉… III. 基因—理论—英文 IV. Q343.1

中国版本图书馆 CIP 数据核字 (2009) 第 236104 号

Lewin's GENES X

Jones and Bartlett Titles in Biological Science

AIDS: Science and Society, Sixth Edition
Hung Fan, Ross F. Conner, & Luis P. Villarreal

AIDS: The Biological Basis, Fifth Edition
Benjamin S. Weeks & I. Edward Alcamo

Alcamo's Fundamentals of Microbiology: Body Systems Edition
Jeffrey C. Pommerville

Alcamo's Fundamentals of Microbiology, Ninth Edition
Jeffrey C. Pommerville

Aquatic Entomology
W. Patrick McCafferty & Arwin V. Provonsha

Bioethics: An Introduction to the History, Methods, and Practice, Second Edition
Nancy S. Jecker, Albert R. Jonsen, & Robert A. Pearlman

Bioimaging: Current Concepts in Light and Electron Microscopy
Douglas E. Chandler & Robert W. Roberson

Biomedical Graduate School: A Planning Guide to the Admissions Process
David J. McKean & Ted Johnson

Biomedical Informatics: A Data User's Guide
Jules J. Berman

Botany: An Introduction to Plant Biology, Fourth Edition
James D. Mauseth

Case Studies for Understanding the Human Body
Stanton Braude, Deena Goran, & Shelley Maxfield

Clinical Information Systems: Overcoming Adverse Consequences
Dean F. Sittig

Defending Evolution: A Guide to the Evolution/Creation Controversy
Brian J. Alters

The Ecology of Agroecosystems
John H. Vandermeer

Electron Microscopy, Second Edition
John J. Bozzola & Lonnie D. Russell

Encounters in Microbiology, Volume 1, Second Edition
Jeffrey C. Pommerville

Encounters in Microbiology, Volume 2
Jeffrey C. Pommerville

Equilibria and Kinetics of Biological Macromolecules
Jan Hermans & Barry R. Lentz

Essential Genetics: A Genomics Perspective, Fifth Edition
Daniel L. Hartl

Essentials of Molecular Biology, Fourth Edition
George M. Malacinski

Evolution: Principles and Processes
Brian K. Hall

Exploring Bioinformatics: A Project-Based Approach
Caroline St. Clair & Jonathan E. Visick

Exploring the Way Life Works: The Science of Biology
Mahlon Hoagland, Bert Dodson, & Judy Hauck

Genetics: Analysis of Genes and Genomes, Seventh Edition
Daniel L. Hartl & Elizabeth W. Jones (late)

Genetics of Populations, Fourth Edition
Philip W. Hedrick

Guide to Infectious Diseases by Body System
Jeffrey C. Pommerville

Human Biology, Sixth Edition
Daniel D. Chiras

Human Biology Laboratory Manual
Charles Welsh

Introduction to the Biology of Marine Life, Ninth Edition
John Morrissey & James L. Sumich

Laboratory and Field Investigations in Marine Life, Ninth Edition
James L. Sumich

Laboratory Fundamentals of Microbiology, Eighth Edition
Jeffrey C. Pommerville

Laboratory Investigations in Molecular Biology
Steven A. Williams, Barton E. Slatko, & John R. McCarrey

Laboratory Textbook of Anatomy and Physiology: Cat Version, Ninth Edition
Anne B. Donnersberger

Lewin's CELLS, Second Edition
Lynne Cassimeris, Vishwanath R. Lingappa, & George Plopper

Lewin's Essential GENES, Second Edition
Jocelyn E. Krebs, Elliott S. Goldstein, & Stephen T. Kilpatrick

Mammalogy, Fifth Edition
Terry A. Vaughan, James M. Ryan, & Nicholas J. Czaplewski

Microbes and Society, Second Edition
Benjamin S. Weeks & I. Edward Alcamo

The Microbial Challenge: Science, Disease, and Public Health, Second Edition
Robert I. Krasner

Microbial Genetics, Second Edition
Stanley R. Maloy, John E. Cronan, Jr., & David Freifelder

Microbiology Pearls of Wisdom, Second Edition
S. James Booth

Molecular Biology: Genes to Proteins, Third Edition
Burton E. Tropp

Neoplasms: Principles of Development and Diversity
Jules J. Berman

Perl Programming for Medicine and Biology
Jules J. Berman

Plant Cell Biology
Brian E. S. Gunning & Martin W. Steer

Plants, Genes, and Crop Biotechnology, Second Edition
Maarten J. Chrispeels & David E. Sadava

Plant Structure: A Color Guide, Second Edition
Bryan G. Bowes & James D. Mauseth

Precancer: The Beginning and the End of Cancer
Jules J. Berman

Principles of Modern Microbiology
Mark Wheelis

Protein Microarrays
Mark Schena

Python for Bioinformatics
Jason Kinser

R for Medicine and Biology
Paul D. Lewis

Ruby Programming for Medicine and Biology
Jules J. Berman

Strickberger's Evolution, Fourth Edition
Brian K. Hall & Benedikt Hallgrímsson

Tropical Forests
Bernard A. Marcus

20th Century Microbe Hunters
Robert Krasner

Understanding Viruses
Teri Shors

LEWIN'S GENES X

JOCELYN E. KREBS
University of Alaska, Anchorage

ELLIOTT S. GOLDSTEIN
Arizona State University

STEPHEN T. KILPATRICK
University of Pittsburgh at Johnstown



JONES AND BARTLETT PUBLISHERS
Sudbury, Massachusetts

BOSTON TORONTO LONDON SINGAPORE

Dedication

To Benjamin Lewin, for setting the bar high.

To my mother, Ellen Baker, for raising me with a love of science; to the memory of my stepfather, Barry Kiefer, for convincing me science would stay fun; and to my partner, Susannah Morgan, for always pretending my biology jokes are funny. Finally, to my son, Rhys, who may someday read a future edition of this book.

Jocelyn Krebs

To my family: my wife, Suzanne, whose patience, understanding, and confidence in me are amazing; my children, Andy, Hyla, and Gary, who have taught me so much about using the computer; and my grandchildren, Seth and Elena, whose smiles and giggles inspire me. And to the memory of my mentor and dear friend, Lee A. Snyder, whose professionalism, guidance, and insight demonstrated the skills necessary to be a scientist and teacher. I have tried to live up to his expectations. This is for you, Doc.

Elliott Goldstein

To my wife, Lori, for our many years of love, support, and sometimes tolerance; to my daughter, Jennifer, who will actually read this book; to my son, Andrew, who continually renews my faith in humanity; and to my daughter, Sarah, who brings me joy daily.

Stephen Kilpatrick

Preface

Of the diverse ways to study the living world, molecular biology has been most remarkable in the speed and breadth of its expansion. New data are acquired daily, and new insights into well-studied processes come on a scale measured in weeks or months rather than years. It's difficult to believe that the first complete organismal genome sequence was obtained less than fifteen years ago. The structure and function of genes and genomes and their associated cellular processes are sometimes elegantly and deceptively simple but frequently amazingly complex, and no single book can do justice to the realities and diversities of natural genetic systems.

This book is aimed at advanced students in molecular genetics and molecular biology. In order to provide the most current understanding of the rapidly-changing subjects in molecular biology, we have enlisted twenty-one scientists to provide revisions and content updates in their individual fields of expertise. Their expert knowledge has been incorporated throughout the text. Much of the revision and reorganization of this edition follows that of the second edition of *Lewin's Essential GENES*, but there are many updates and features that are new to this book. Most notably, there are two new chapters: Chapter 3 ("Methods in Molecular Biology and Genetic Engineering") provides an introduction to the concepts and practice of laboratory techniques in molecular biology early on in the book, and Chapter 8 ("Genome Evolution") combines, expands, and updates material that had been scattered among various chapters in previous editions, as well as introducing a number of topics new to this book. This edition is generally updated and reorganized for a more logical flow of topics, and many chapters have been renamed to better indicate their contents. In particular, discussion of chromatin organization and nucleosome structure now precedes the discussion of eukaryotic transcription, because chromosome organization is critical to all DNA transactions in the cell, and current research in the field

of transcriptional regulation is heavily biased toward the study of the role of chromatin in this process. The discussion of transcriptional activation and chromatin remodeling has accordingly been combined into one chapter (Chapter 28). Two chapters on transposons and retrotransposons have been combined into one (Chapter 17). In addition, some chapters have been revised to contain extensive new material. The original introductory chapter on messenger RNA has been entirely rewritten to cover more advanced topics (Chapter 22, "mRNA Stability and Localization"), and the regulatory RNA chapter has been dramatically expanded to include material on RNAi pathways (Chapter 30, "Regulatory RNA"). Many new figures are included in this book, some reflecting new developments in the field, particularly in the topics of chromatin structure and function, epigenetics, and regulation by noncoding and microRNAs in eukaryotes.

This book is organized into four parts. **Part 1 (Genes and Chromosomes)** comprises Chapters 1 through 10. Chapters 1 and 2 serve as an introduction to the structure and function of DNA and contain basic coverage of DNA replication and gene expression. Chapter 3 provides information on molecular laboratory techniques. Chapter 4 introduces the interrupted structures of eukaryotic genes, and Chapters 5 through 8 discuss genome structure and evolution. Chapters 9 and 10 discuss the structure of eukaryotic chromosomes.

Part 2 (DNA Replication and Recombination) comprises Chapters 11 through 18. Chapters 11 to 14 provide detailed discussions of DNA replication in plasmids, viruses, and prokaryotic and eukaryotic cells. Chapters 15 through 18 cover recombination and its roles in DNA repair and the human immune system, with Chapter 16 discussing DNA repair pathways in detail and Chapter 17 focusing on different types of transposable elements.

Part 3 (Transcription and Posttranscriptional Mechanisms) includes Chapters 19 through 25.

Chapters 19 and 20 provide more in-depth coverage of bacterial and eukaryotic transcription. Chapters 21 through 23 are concerned with RNA, discussing messenger RNA, RNA stability and localization, RNA processing, and the catalytic roles of RNA. Chapters 24 and 25 discuss translation and the genetic code.

Part 4 (Gene Regulation) comprises Chapters 26 through 30. In Chapter 26, the regulation of bacterial gene expression via operons is discussed. Chapter 27 covers the regulation of expression of genes during phage development as they infect bacterial cells. Chapters 28 and 29 cover eukaryotic gene regulation, including epigenetic modifications. Finally, Chapter 30 covers RNA-based control of gene expression in prokaryotes and eukaryotes.

For instructors who prefer to order topics with the essentials of DNA replication and gene expression followed by more advanced topics, the following chapter sequence is suggested:

Introduction: Chapters 1–2

Gene and Genome Structure: Chapters 5–7

DNA Replication: Chapters 11–14

Transcription: Chapters 19–22

Translation: Chapters 24–25

Regulation of Gene Expression: Chapters 9–10 and 26–30

Other chapters can be covered at the instructor's discretion.

Pedagogical Features

This edition contains several features to help students learn as they read. Each chapter begins with a *Chapter Outline*, and each section is summarized with a bulleted list of *Key Concepts*. *Key Terms* are highlighted in bold type in the text and compiled in the *Glossary* at the end of the book. Finally, each chapter concludes with an expanded and updated list of *References*, which provides both primary literature and current reviews to supplement and reinforce the chapter content. Additional instructional tools are available online and on the Instructor's media CD-ROM.

Ancillaries

Jones and Bartlett Publishers offers an impressive array of traditional and interactive multimedia supplements to assist instructors and aid students in mastering molecular biology. Additional information and review copies of any of the following items are available through your Jones and Bartlett sales representative or by visiting <http://www.jbpub.com/biology>.

For the Student

Interactive Student Study Guide

Jones and Bartlett Publishers and Brent Nielsen of Brigham Young University have developed an interactive, electronic study guide dedicated exclusively to this title. Students will find a variety of study aids and resources at <http://biology.jbpub.com/lewin/genesx>, all designed to explore the concepts of molecular biology in more depth and to help students master the material in the book. A variety of activities are available to help students review class material, such as chapter summaries, Web-based learning exercises, study quizzes, a searchable glossary, and links to animations, videos, and podcasts, all to help students master important terms and concepts.

For Instructors

Instructor's ToolKit CD-ROM

The *Instructor's Media CD-ROM* provides the instructor with the following resources:

- The **PowerPoint® Image Bank** provides all of the illustrations, photographs, and tables (to which Jones and Bartlett Publishers holds the copyright or has permission to reprint digitally) inserted into PowerPoint slides. With the Microsoft® PowerPoint program, you can quickly and easily copy individual image slides into your existing lecture slides.
- A set of **PowerPoint Lecture Outline Slides**, created by author Stephen Kilpatrick, of the University of Pittsburgh at Johnstown, provides outline summaries and relevant images for each chapter of *Lewin's GENES X*. A PowerPoint viewer is provided on the CD, and instructors with the Microsoft PowerPoint software can customize the outlines, figures, and order of presentation.

Online Instructor Resources

The **Test Bank**, updated and expanded by author Stephen Kilpatrick, is provided as a text file with 750 questions in a variety of formats. The Test Bank is easily compatible with most course management software.

Acknowledgments

The authors would like to thank the following individuals for their assistance in the preparation of this book: The editorial, production, marketing, and sales teams at Jones and Bartlett have been exemplary in all aspects of this project. Cathy Sether, Caroline Perry, Megan Turner, Kimberly Potvin, Leah Corrigan, and Lou Bruno deserve special mention. Cathy brought us

together on this project and in doing so launched an efficient and amiable partnership. She has provided able leadership and has been an excellent resource as we ventured into new territories. Caroline, Lou and Leah have handled the daily responsibilities of the writing and production phases with friendly professionalism and helpful guidance. Megan and Kimberly have made the process of choosing and revising figures very smooth.

We thank the editors of individual chapters, whose expertise, enthusiasm, and careful judgment

brought the manuscript up to date in many critical areas. We also thank Brent Nielsen of Brigham Young University for an early version of Section 8.3, and David Rand of Brown University for suggestions for improvement to Chapter 8.

Jocelyn E. Krebs
Elliott S. Goldstein
Stephen T. Kilpatrick

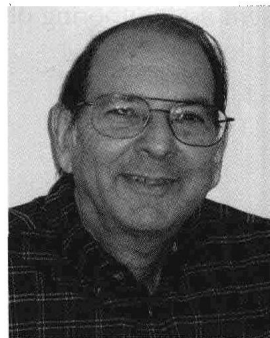
About the Authors

Benjamin Lewin founded the journal *Cell* in 1974 and was Editor until 1999. He founded the Cell Press journals *Neuron*, *Immunity*, and *Molecular Cell*. In 2000, he founded Virtual Text, which was acquired by Jones and Bartlett Publishers in 2005. He is also the author of *Essential GENES* and *CELLS*.



Jocelyn E. Krebs received a B.A. in Biology from Bard College, Annandale-on-Hudson, NY, and a Ph.D. in Molecular and Cell Biology from the University of California, Berkeley. For her Ph.D. thesis, she studied the roles of DNA topology and insulator elements in transcriptional regulation.

She performed her postdoctoral training as an American Cancer Society Fellow at the University of Massachusetts Medical School in the laboratory of Dr. Craig Peterson, where she focused on the roles of histone acetylation and chromatin remodeling in transcription. In 2000, Dr. Krebs joined the faculty in the Department of Biological Sciences at the University of Alaska, Anchorage, where she is now an Associate Professor. She directs a research group studying chromatin structure and function in transcription and DNA repair in the yeast *Saccharomyces cerevisiae* and the role of chromatin remodeling in embryonic development in the frog *Xenopus*. She teaches courses in molecular biology for undergraduates, graduate students, and first-year medical students. She also teaches a Molecular Biology of Cancer course and has taught Genetics and Introductory Biology. She lives in Eagle River, AK, with her partner and son, and a house full of dogs and cats. Her non-work passions include hiking, camping, and snowshoeing.



Elliott S. Goldstein earned his B.S. in Biology from the University of Hartford (Connecticut) and his Ph.D. in Genetics from the University of Minnesota, Department of Genetics and Cell Biology. Following this, he was awarded an N.I.H. Postdoctoral Fellowship to work with Dr. Sheldon Penman at the

Massachusetts Institute of Technology. After leaving Boston, he joined the faculty at Arizona State University in Tempe, where he is an Associate Professor in the Cellular, Molecular, and Biosciences program in the School of Life Sciences and in the Honors Disciplinary Program. His research interests are in the area of molecular and developmental genetics of early embryogenesis in *Drosophila melanogaster*. In recent years, he has focused on the *Drosophila* counterparts of the human proto-oncogenes *jun* and *fos*. His primary teaching responsibilities are in the undergraduate General Genetics course as well as the graduate level Molecular Genetics course. Dr. Goldstein lives in Tempe with his wife, his high school sweetheart. They have three children and two grandchildren. He is a bookworm who loves reading as well as underwater photography. His pictures can be found at <http://www.public.asu.edu/~elliottg/>.



Stephen T. Kilpatrick received a B.S. in Biology from Eastern College (now Eastern University) in St. Davids, PA, and a Ph.D. from the Program in Ecology and Evolutionary Biology at Brown University. His thesis research was an investigation of the population genet-

ics of interactions between the mitochondrial and nuclear genomes of *Drosophila melanogaster*. Since 1995, Dr. Kilpatrick has taught at the University of Pittsburgh at Johnstown in Johnstown, PA. His regular teaching duties include undergraduate courses in nonmajors biology, introductory majors biology, and advanced undergraduate courses in genetics, evolution, molecular genetics, and biostatistics. He has also supervised a number of undergraduate research projects in evolutionary genetics. Dr. Kilpatrick's major professional focus has been in biology education. He has participated in the development and authoring of

ancillary materials for several introductory biology, genetics, and molecular genetics texts as well as writing articles for educational reference publications. For his classes at Pitt-Johnstown, Dr. Kilpatrick has developed many active learning exercises in introductory biology, genetics, and evolution. Dr. Kilpatrick resides in Johnstown, PA, with his wife and three children. Outside of scientific interests, he enjoys music, literature, and theater and occasionally performs in local community theater groups.

Chapter Editors

Esther Siegfried completed her work on this book while teaching at the University of Pittsburgh at Johnstown. She is now an Assistant Professor of Biology at Pennsylvania State University, Altoona. Her research interests include signal transduction pathways in *Drosophila* development.

John Brunstein is a Clinical Assistant Professor with the Department of Pathology and Laboratory Medicine at the University of British Columbia. His research interests focus on the development of, validation strategies for, and implementation of novel molecular diagnostic technologies.

Donald Forsdyke, emeritus professor of biochemistry at Queen's University in Canada, studied lymphocyte activation/inactivation and the associated genes. In the 1990s he obtained evidence supporting his 1981 hypothesis on the origin of introns, and immunologists in Australia shared a Nobel Prize for work that supported his 1975 hypothesis on the positive selection of the lymphocyte repertoire. His books include *The Origin of Species, Revisited* (2001), *Evolutionary Bioinformatics* (2006), and *"Treasure Your Exceptions": The Science and Life of William Bateson* (2008).

Hank W. Bass is an Associate Professor of Biological Science at Florida State University. His laboratory works on the structure and function of meiotic chromosomes and telomeres in maize using molecular cytology and genetics.

Stephen D. Bell is the Professor of Microbiology in the Sir William Dunn School of Pathology, Oxford University. His research group is studying gene transcription, DNA replication, and cell division in the Archaeal domain of life.

Søren Johannes Sørensen is a Professor in the Department of Biology and Head of the Section of Microbiology at the University of Copenhagen. The main objective of his studies is to evaluate the extent of genetic flow within natural communities and the responses to environmental perturbations. Molecular techniques such as DGGE and high-throughput sequencing are used to investigate resilience and resist-

ance of microbial community structure. Dr. Sørensen has more than twenty years' experience in teaching molecular microbiology at both the bachelor and graduate levels.

Lars Hestbjerg Hansen is an Associate Professor in the Section of Microbiology, Department of Biology, at the University of Copenhagen. His research interests include the bacterial maintenance and interchange of plasmid DNA, especially focused on plasmidborne mechanisms of bacterial resistance to antibiotics. Dr. Hansen's laboratory has developed and is currently working with new flow-cytometric methods for estimating plasmid transfer and stability. Dr. Hansen is the Science Director of Prokaryotic Genomics at Copenhagen High-Throughput Sequencing Facility, focusing on using high-throughput sequencing to describe bacterial and plasmid diversity in natural environments.

Barbara Funnell is a Professor of Molecular Genetics at the University of Toronto. Her laboratory studies chromosome dynamics in bacterial cells, and in particular the mechanisms of action of proteins involved in plasmid and chromosome segregation.

Peter Burgers is Professor of Biochemistry and Molecular Biophysics at Washington University School of Medicine. His laboratory has a long-standing interest in the biochemistry and genetics of DNA replication in eukaryotic cells, and in the study of responses to DNA damage and replication stress that result in mutagenesis and in cell cycle checkpoints.

Hannah L. Klein is a Professor of Biochemistry, Medicine, and Pathology at New York University Langone Medical Center. She studies pathways of DNA damage repair and recombination and genome stability.

Samantha Hoot is a postdoctoral researcher in the laboratory of Dr. Hannah Klein at New York University Langone Medical Center. She received her PhD from the University of Washington. Her interests include the role of recombination in genome stability in yeast and the molecular mechanisms of drug resistance in pathogenic fungi.

Damon Lisch is an Associate Research Professional at the University of California at Berkeley. He is interested in the regulation of transposable elements in plants and the ways in which transposon activity has shaped plant genome evolution. His laboratory investigates the complex behavior and epigenetic regulation of the *Mutator* system of transposons in maize and related species.

Paolo Casali, MD, is the Donald L. Bren Professor of Medicine, Molecular Biology & Biochemistry, and Director of the Institute for Immunology at the University of California, Irvine. He works on B lymphocyte differentiation and regulation of antibody gene expression as well as molecular mechanisms of generation of autoantibodies. He has been Editor-in-Chief of *Autoimmunity* since 2002. He is a member of the American Association of Immunologists, an elected "Young Turk" of the American Society for Clinical Investigation, and an elected Fellow of the American Association for Advancement of Science. He has served on several NIH immunology study sections and scientific panels.

Richard Gourse is a Professor in the Department of Bacteriology at the University of Wisconsin, Madison, and an Editor of the *Journal of Bacteriology*. His primary interests lie in transcription initiation and the regulation of gene expression in bacteria. His laboratory has long focused on rRNA promoters and the control of ribosome synthesis as a means of uncovering fundamental mechanisms responsible for regulation of transcription and translation.

Xiang-Dong Fu is a Professor of Cellular and Molecular Medicine at the University of California, San Diego. His laboratory studies mechanisms underlying constitutive and regulated pre-mRNA splicing in mammalian cells, coupling between transcription and RNA processing, RNA genomics, and roles of RNA processing in development and diseases.

Ellen Baker is an Associate Professor of Biology at the University of Nevada, Reno. Her research inter-

ests have focused on the role of polyadenylation in mRNA stability and translation.

Douglas J. Briant teaches at the University of Victoria in British Columbia. His research has investigated bacterial RNA processing and the role of ubiquitin in cell signalling pathways.

Cheryl Keller Capone is an Instructor in the Department of Biology at The Pennsylvania State University and teaches cell and molecular biology. Her research interests include embryonic muscle development in *Drosophila melanogaster* and the molecular mechanisms involved in the clustering and postsynaptic targeting of GABA_A receptors.

John Perona is a Professor of Biochemistry in the Department of Chemistry and Biochemistry, and the Interdepartmental Program in Biomolecular Science and Engineering, at the University of California, Santa Barbara. His laboratory studies structure-function relationships and catalytic mechanisms in aminoacyl-tRNA synthetases, tRNA-dependent amino acid modification enzymes, and tRNA-modifying enzymes.

Liskin Swint-Kruse is an Assistant Professor in Biochemistry and Molecular Biology at the University of Kansas School of Medicine. Her research utilizes bacterial transcription regulators in studies that bridge biophysics of DNA-binding and bioinformatics analyses of transcription repressor families to advance the principles of protein engineering.

Trygve Tollefsbol is a Professor of Biology at the University of Alabama at Birmingham and a Senior Scientist of the Center for Aging, Comprehensive Cancer Center, and Clinical Nutrition Research Center. He has long been involved with elucidating epigenetic mechanisms, especially as they pertain to cancer, aging, and differentiation. He has been the editor and primary contributor of numerous books including *Epigenetic Protocols*, *Cancer Epigenetics*, and *Epigenetics of Aging*.

Brief Table of Contents

Contents viii

Preface xx

Part 1. GENES AND CHROMOSOMES 1

Chapter 1. Genes Are DNA 2

Chapter 2. Genes Code for Proteins 26

Edited by Esther Siegfried, Pennsylvania State University, Altoona

Chapter 3. Methods in Molecular Biology and Genetic Engineering 42

Edited by John Brunstein, University of British Columbia

Chapter 4. The Interrupted Gene 79

Edited by Donald Forsdyke, Queens University

Chapter 5. The Content of the Genome 98

Chapter 6. Genome Sequences and Gene Numbers 118

Chapter 7. Clusters and Repeats 139

Chapter 8. Genome Evolution 159

Chapter 9. Chromosomes 189

Edited by Hank W. Bass, Florida State University

Chapter 10. Chromatin 220

Part 2. DNA REPLICATION AND RECOMBINATION 262

Chapter 11. The Replicon 263

Edited by Stephen D. Bell, Oxford University

Chapter 12. Extrachromosomal Replicons 282

Edited by Søren Johannes Sørensen & Lars Hestbjerg Hansen, University of Copenhagen

Chapter 13. Bacterial Replication Is Connected to the Cell Cycle 299

Edited by Barbara Funnell, University of Toronto

Chapter 14. DNA Replication 320

Edited by Peter Burgers, Washington University Medical School

Chapter 15. Homologous and Site-Specific Recombination 348

Edited by Hannah L. Klein & Samantha Hoot, New York University Langone Medical Center

Chapter 16. Repair Systems 391

Chapter 17. Transposable Elements and Retroviruses 419

Edited by Damon Lisch, University of California, Berkeley

Chapter 18. Somatic Recombination and Hypermutation in the Immune System 458

Edited by Paolo Casali, Institute for Immunology, University of California, Irvine

Part 3. TRANSCRIPTION AND POSTTRANSCRIPTIONAL MECHANISMS 503

Chapter 19. Prokaryotic Transcription 504

Edited by Richard Gourse, University of Wisconsin, Madison

Chapter 20. Eukaryotic Transcription 546

Chapter 21. RNA Splicing and Processing 573

Edited by Xiang-Dong Fu, University of California, San Diego, School of Medicine

Chapter 22. mRNA Stability and Localization 618

Edited by Ellen Baker, University of Nevada, Reno

Chapter 23. Catalytic RNA 642

Edited by Douglas J. Briant, University of Victoria

Chapter 24. Translation 665

Edited by Cheryl Keller Capone, Pennsylvania State University

Chapter 25. Using the Genetic Code 704
*Edited by John Perona, University of California,
Santa Barbara*

Part 4. GENE REGULATION 734

Chapter 26. The Operon 735
*Edited by Liskin Swint-Kruse, University of Kansas
School of Medicine*

Chapter 27. Phage Strategies 767

**Chapter 28. Eukaryotic Transcription
Regulation 795**

**Chapter 29. Epigenetic Effects Are
Inherited 828**
*Edited by Trygve Tollefsbol, University of
Alabama, Birmingham*

Chapter 30. Regulatory RNA 861

Glossary 881

Index 905