生命科学名著

# GENES IX

## BENJAMIN LEWIN

# 基因IX

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**About the cover:** DNA transcription by mRNA. Colored transmission electron micrograph of DNA and messenger RNA (mRNA) molecules forming a feather-like, transcriptionally active structure. This DNA is from the nucleus of an amphibian egg. The backbone of the feather, running down the image, is a long strand of DNA coated with protein. Numerous mRNA molecules extend in clusters from the DNA strand. Transcription of genetic information begins at one end of the gene, with the mRNA molecules growing longer as they approach completion. Transcription is the first step in protein synthesis. Magnification: approximately ×30,000.

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# Preface

Science is a wonderfully resilient venture. There are new and interesting developments to report in each revision of this book, and this revision includes much updated material to account for new findings in molecular research. The general organization of material in this edition has been revised along the same lines as *Essential Genes*, making it easier to use the two books in conjunction. With increasing size becoming a problem, the content has been more sharply focused on genes and their expression by eliminating the chapters dealing with the consequences of gene expression for cell biology. Striking changes occur in the first part of the book, dealing with genomes, resulting from the success of many genome sequencing projects. The importance of RNA as a regulator has become increasingly evident and now can be seen to extend across all levels of gene expression in both prokaryotes and eukaryotes. Somewhat of a "missing link," it casts further light on how the current apparatus for gene expression must have evolved from the early RNA world.

My policy in this book has been to cite research and review articles that I believe readers will reasonably be able to access. My preference is for articles that are free after six months; where that is not possible, the publication should be widely available.

I thank the following individuals who served as proofreaders and consultants for this revision:

| | |
|---|---|
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Benjamin Lewin
January 2007

## Organization

The new organization of *GENES IX* allows instructors and students to focus more sharply on genes and their expression with expanded coverage of key topics. The number of chapters and the order of topic coverage remains the same; however, several chapters were expanded into two or more chapters. These changes are as follows:

Chapter 1 in *GENES VIII*, Genes are DNA, is expanded to two chapters in *GENES IX*. Basic information on DNA structure, replication, and mutation remains in Chapter 1, whereas the discussion of the gene's function as the unit of heredity appears in the new Chapter 2, Genes Code for Proteins.

Chapter 3 in *GENES VIII*, The Content of the Genome, becomes two chapters in *GENES IX*.

Chapter 4, The Content of the Genome, includes information on DNA sequences, genome mapping, and DNA in organelles.

Chapter 5, Genome Sequences and Gene Numbers, now contains genome size and expression information for a number of organisms, as well as new material on genes in the Y chromosome.

The new Chapter 12, The Operon, comprises *GENES VIII* Chapter 10, as well information on regulation of transcription and translation from *GENES VIII* Chapter 11, Regulatory Circuits. Material on regulatory RNA is now found in Chapter 13.

The material in *GENES VIII* Chapter 13, The Replicon, is expanded in three chapters in *GENES IX*. Chapter 15, The Replicon, covers the structure and function of the replicon, as well as replication origins. Chapter 16, Extrachromosomal Replicons, contains material on terminal proteins, rolling circle replication, plasmids, and T-DNA. Information on how bacterial replication is connected to the cell cycle is found in Chapter 17.

Recombination and Repair, Chapter 15 in *GENES VIII*, is now covered in two chapters in *GENES IX*. Chapter 19 covers homologous and site-specific recombination, and Chapter 20 covers the repair systems, including new information on excision-repair pathways in mammalian cells.

Chapter 23, Controlling Chromatin Structure, in *GENES VIII* is now Chapter 30, discussing the relation between chromatin structure and gene expression.

Chapter 31, Epigenetic Effects are Inherited, details the causes and mechanisms of epigenetic inheritance.

## Art Program and Design

*GENES IX* has a new, contemporary look. Both the design and art program for this edition were updated and revised to facilitate student learning. In addition, the style and design for *GENES IX* intentionally matches that of Lewin's new cell biology text, *CELLS*, which allows students and instructors to easily utilize both texts.

## Supplements to the Text

*For the Student*

The web site developed exclusively for the ninth edition of this text, http://biology.jbpub.com/book/genes/, offers a variety of resources to enhance understanding of molecular biology.

*Laboratory Investigations in Molecular Biology*, by Williams, Slatko, and McCarrey, presents well-tested protocols in molecular biology that are commonly used in active research labs. The experiments are designed to guide students through realistic research projects conducted in modern research laboratories.

*For the Instructor*

Compatible with Windows and Macintosh platforms, the Instructor's ToolKit—CD-ROM provides instructors with the following traditional ancillaries:

- The *Test Bank* is available as straight text files.
- The *PowerPoint® Lecture Outline Slides* presentation package provides lecture notes, and images for each chapter of *GENES IX*. Instructors with the Microsoft PowerPoint® software can customize the outlines, art, and order of presentation.
- The *Image Bank* provides the critical art and tables in the text to which Jones and Bartlett Publishers holds the copyright or has digital reprint rights. The image library enables instructors to project images from the text in the classroom, insert images into PowerPoint® presentations, or print overhead acetates.

# Brief Contents

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# 1

# Genes Are DNA

## CHAPTER OUTLINE



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