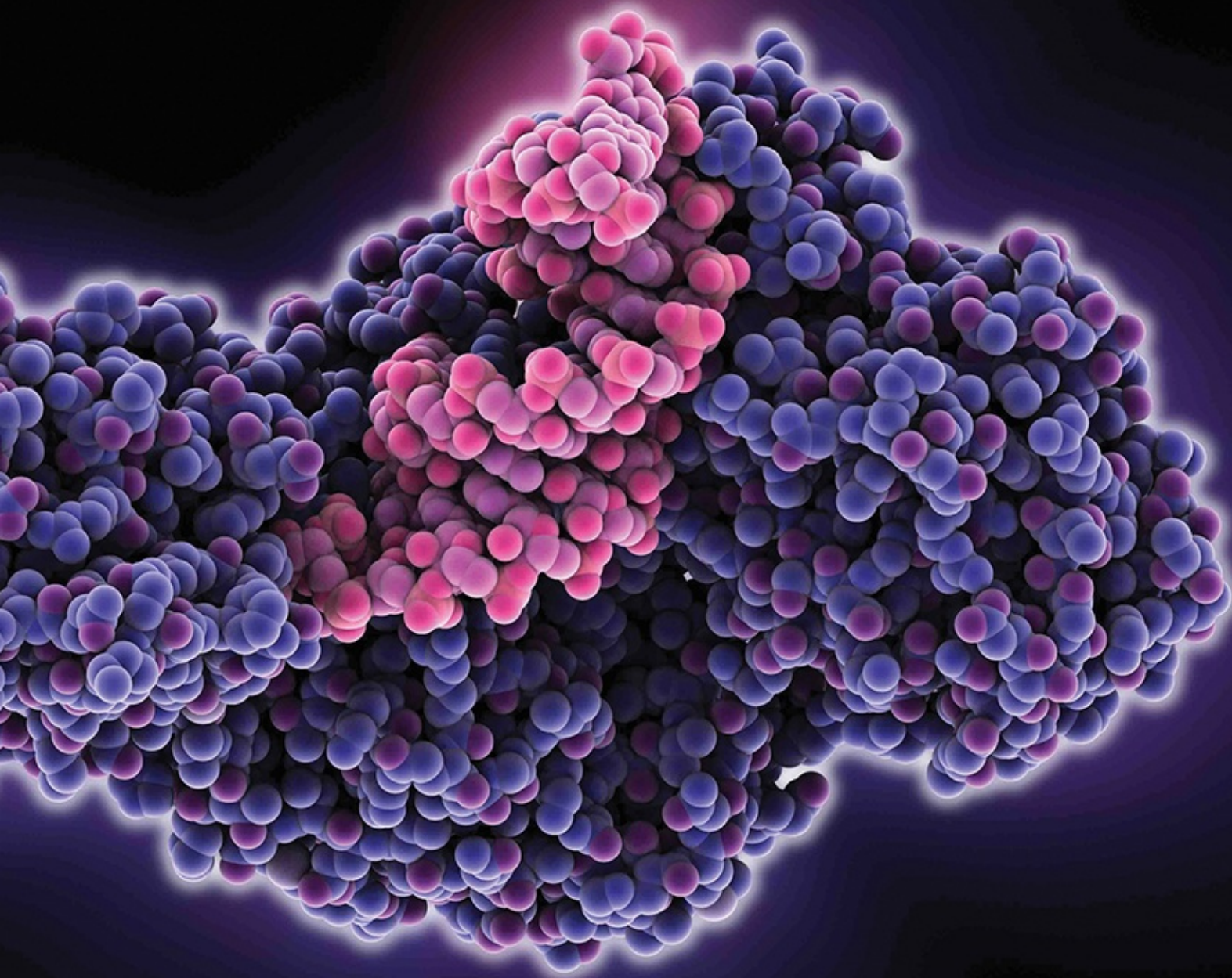


# LEWIN'S GENES XII



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# LEWIN'S GENES XII

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# 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; to my wife, Susannah Morgan, for decades of love and support; and to my young sons, Rhys and Frey, clearly budding young scientists (“I have a hypopesis”). Finally, to the memory of my Ph.D. mentor Dr. Marietta Dunaway, a great inspiration who set my feet on the exciting path of chromatin biology.

—**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 family: my wife, Lori, who reminds me what's really important in life; my children, Jennifer, Andrew, and Sarah, who fill me with great pride and joy; and my parents, Sandra and David, who inspired the love of learning in me.

—**Stephen Kilpatrick**



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*Edited by Liskin Swint-Kruse*

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## 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 a little over 20 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 leading 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 third edition of *Lewin's Essential GENES*, but there are many updates and features that are new to this book. This edition follows a logical flow of topics; in particular, discussion of chromatin organization and nucleosome structure 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. 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 RNA and microRNAs in eukaryotes.

This book is organized into four parts. **Part I (Genes and Chromosomes)** comprises **Chapters 1** through **8**. **Chapter 1** serves as an introduction to the structure and function of DNA and contains basic coverage of DNA replication and gene expression. **Chapter 2** provides information on molecular laboratory techniques. **Chapter 3** introduces the interrupted structures of eukaryotic genes, and **Chapters 4** through **6** discuss genome structure and evolution. **Chapters 7** and **8** discuss the structure of eukaryotic chromosomes.

**Part II (DNA Replication, Repair, and Recombination)** comprises **Chapters 9** through **16**. **Chapters 9** through **12** provide detailed discussions of DNA replication in plasmids, viruses, and prokaryotic and eukaryotic cells. **Chapters 13** through **16** cover recombination and its roles in DNA repair and the human immune system, with **Chapter 14** discussing DNA repair pathways in detail and **Chapter 15** focusing on different types of transposable elements.

**Part III (Transcription and Posttranscriptional Mechanisms)** includes **Chapters 17** through **23**. **Chapters 17** and **18** provide more in-depth coverage of bacterial and eukaryotic transcription. **Chapters 19** through **21** are concerned with RNA, discussing messenger RNA, RNA stability and localization, RNA processing, and the catalytic roles of RNA. **Chapters 22** and **23** discuss translation and the genetic code.

**Part IV (Gene Regulation)** comprises **Chapters 24** through **30**. In **Chapter 24**, the regulation of bacterial gene expression via operons is discussed. **Chapter 25** covers the regulation of expression of genes during phage development as they infect bacterial cells. **Chapters 26** through **28** cover eukaryotic gene regulation, including epigenetic modifications. Finally, **Chapters 29** and **30** cover 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: **Chapter 1**

Gene and Genome Structure: **Chapters 4–6**

DNA Replication: **Chapters 9–12**

Transcription: **Chapters 17–20**

Translation: **Chapters 22–23**

Regulation of Gene Expression: **Chapters 7–8** and **24–30**

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



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# THE STUDENT EXPERIENCE

This edition contains several features to help students learn as they read:

- Each chapter begins with a **Chapter Outline** that clearly lays out the framework of the chapter and helps students plan their reading and study.



- Each section is summarized with a bulleted list of **Key Concepts** to assist students with distilling the focus of each section.



**6.2 Unequal Crossing-Over Rearranges Genes**

**KEY CONCEPTS**

- When a genome contains a c...
- Different thalassemias are ca...

**6.3 Genes for rRNA Form Tandem Repeats Including an Invariant Transcription Unit**

**KEY CONCEPTS**

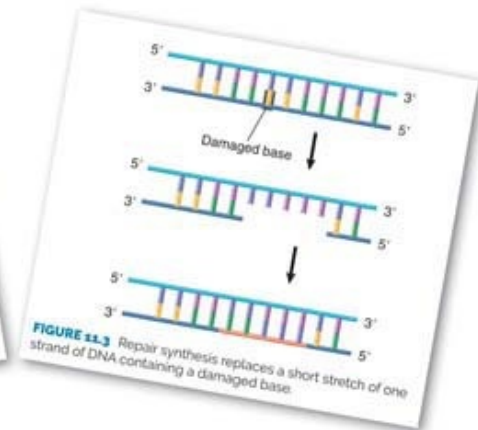
- Ribosomal RNA (rRNA) is encoded by a large number of identical genes that are tandemly repeated to form one or more clusters.
- Each ribosomal DNA (rDNA) transcription units giving a rRNAs alternate with nontr...
- The genes in an rDNA clust...
- The nontranscribed spacer units whose number varies spacers are different.

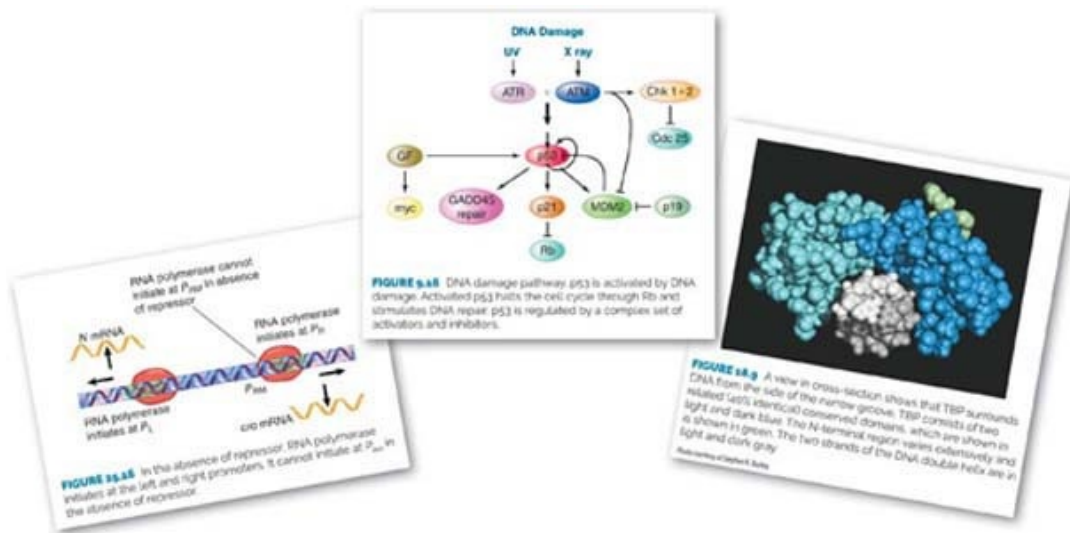
**6.4 Crossover Fixation Could Maintain Identical Repeats**

**KEY CONCEPTS**

- Unequal crossing-over changes the size of a cluster of tandem repeats.
- Individual repeating units can be eliminated or can spread through the cluster.

- *GENES XII* includes the high-quality **illustrations and photographs** that instructors and students have come to expect in this classic title.





- **Key Terms** are highlighted in bold type in the text and compiled in the **Glossary** at the end of the book.



- 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 online study tools are available for students and instructors, including practice activities, prepopulated quizzes, and an interactive eBook with **Web Links** to relevant sites, including animations and other media.

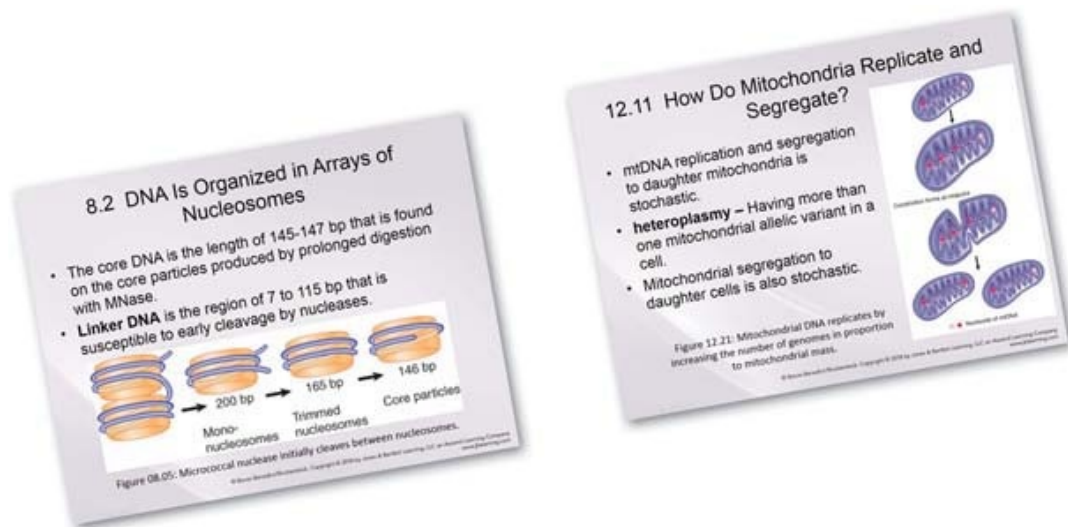


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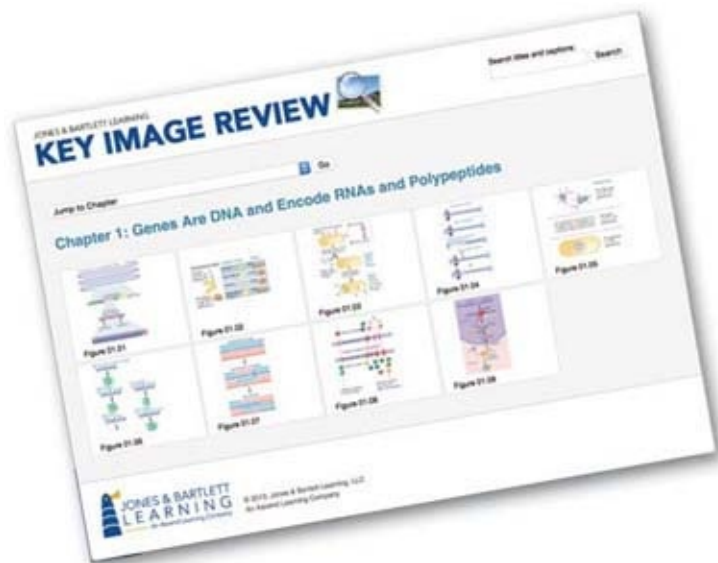
## TEACHING TOOLS

A variety of teaching tools are available via digital download and multiple other formats to assist instructors with preparing for and teaching their courses with *Lewin's GENES XII*:

- The **Lecture Outlines in PowerPoint format** presentation package developed by author Stephen Kilpatrick of the University of Pittsburgh at Johnstown provides outline summaries and relevant images for each chapter of *Lewin's GENES XII*. Instructors with Microsoft PowerPoint software can customize the outlines, art, and order of presentation.



- The **Key Image Review** provides the illustrations, photographs, and tables to which Jones & Bartlett Learning holds the copyright or has permission to reprint digitally. These images are not for sale or distribution but may be used to enhance existing slides, tests, and quizzes or other classroom material.



- The **Test Bank** has been updated and expanded by author Stephen Kilpatrick to include over 1,000 questions, in addition to the 750 questions and activities that are included in the online study and assessment tools.
- Hand-selected **Web Links** to relevant websites are available in a list format or as direct links in the interactive eBook.
- The publisher has prepared a **Transition Guide** to assist instructors who have used previous editions of the text with conversion to this new edition.



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