

Preface

Genetics: A Molecular Perspective is the newest addition to the series of textbooks designed to provide support to students as they study one of the most fascinating scientific disciplines. This book is designed specifically for courses that begin with DNA as the focal point, and where a solid foundation in molecular genetics is provided before proceeding with coverage of the more traditional areas of classical heredity.

Certainly no subject area has had a more sustained impact than Genetics on shaping our knowledge of the living condition. As a result of discoveries over the past 50 years, we now understand with reasonable clarity the underlying genetic mechanisms that explain how organisms develop into and then function as adults. We also better understand the basis of biological diversity and have greater insight into the evolutionary process.

As we edge into the new millennium, discoveries in this discipline continue to be numerous and profound. As geneticists and students of genetics, the thrill of being part of this era must be balanced by a strong sense of responsibility and careful attention to the many related issues that will undoubtedly arise. The formulation of proper laws and policies will depend on a comprehensive knowledge of genetics and measured responses to these issues. As a result, there has never been a higher premium or greater need for a useful and up-to-date genetics textbook.

In addition to the "DNA-first" approach taken, the first edition of *Genetics: A Molecular Perspective*, as with other texts in the series, has been designed to achieve six major goals. Specifically, we seek to:

- Emphasize concepts rather than excessive detail.
- Write clearly and directly to students in order to provide understandable explanations of complex, analytical topics.
- Establish a careful organization within and between chapters.
- Maintain constant emphasis on scientific analysis as the means to illustrate how we know what we know.
- Propagate the rich history of genetics that so beautifully illustrates how information is acquired and extended within the discipline as it develops and grows.
- Create inviting, engaging, and pedagogically useful full-color figures enhanced by equally helpful photographs to support concept development.

These goals serve as the cornerstones of this new text. This pedagogic foundation allows the book to accommodate courses with varied approaches and lecture formats. While we assume that adopters of this text will initiate coverage by emphasizing DNA and molecular genetic expression, all chapters in the text are nevertheless written to be as independent of one another as possible. This allows instructors to utilize them in various sequences once the molecular foundation of genetics is firmly established. We believe that the varied approaches embodied in the goals listed above together provide students with optimal support for their study of genetics.

Writing a textbook that achieves these goals has been a labor of love for us. The creation of the initial edition of this text is a reflection not only of our passion for teaching genetics, but the constructive feedback and encouragement provided over the past two decades from adopters, reviewers, and our students.

Features of this Text

- **Online Media Tutorials**—Students are guided in their understanding of important concepts by working through what are simply the best animations, tutorial exercises, and self-assessment tools available.
- **A Unique Organization**—We provide a chapter sequence designed to immediately establish the importance of genetic function at the molecular level. Then, classical heredity is presented beginning with a consideration of mitosis and meiosis followed by extensive coverage of the findings of Gregor Mendel. Once solid coverage of transmission genetics is completed, we then return to the most recent findings embodied in the study of DNA biotechnology and genomic analysis. The book concludes with modern coverage of several advanced topics in eukaryotic genetics (gene regulation, development, and cancer) as well as a thorough consideration of genes and populations.
- **Cutting Edge Topics**—Beyond the up-to-date coverage of molecular genetics early in the text, the chapter *Genomics, Bioinformatics, and Proteomics* (Chapter 17) provides students with the most recent concepts and tools necessary to understand the information explosion occurring in these cutting-edge fields. The sister chapter, *Applications and Ethics of Genetic Technology* (Chapter 18) contains

important coverage of how the era of Genomics impacts on society. Unique to this text is Chapter 23—*Chromosome Genetics: Immunoglobulins, Isochores and Chromatid Dynamics*, where these advanced topics are presented. Finally, another addition to this series of texts is the chapter entitled *Conservation Genetics* (Chapter 27). This presentation represents the first coverage of this emerging discipline in any genetics textbook. The role of molecular biology in conservation is discussed.

- **Modern Presentation of Topics**—In addition to the cutting edge topics discussed above, modern coverage is particularly evident in the discussions of recombinant DNA technology (Chapter 16), as well as in the coverage of the organization of repetitive DNA sequences in the human genome (Chapter 4), the TRAP protein that functions during regulation of the trptophan operon (Chapter 19), and the role of genetics in the origin of cancer (Chapter 22). Coverage of conservation genetics, and in particular, the genetic assessment of diversity in endangered species (Chapter 27), is also at the forefront of genetic studies.
- **A New Art Program**—The design of an entirely new art program will be evident to past users of the alternative edition, *Concepts of Genetics*. To all users, the pedagogic value of the well-designed and beautifully executed figures will become apparent, and constitutes one of the cornerstones of this new text.
- **Excellent Photographs**—A large number of photographs beautifully illustrate and enhance this textbook. Whenever possible, organisms that are subjects of genetic analysis are shown. Often, photographs are present as part of presentations in important figures, e.g., Taylor, Woods, and Hughes autoradiograms showing replication in *Vicia faba*, (Figure 3-5), the electron micrographs directly capturing transcription of rDNA in *Notophthalmus* and transcription and translation in *E. coli* (Figure 5-15), etc.
- **Section Numbers**—All major section titles are numbered making it easy for instructors to assign topics and for students to find topics within chapters
- **Modern "Genetics, Technology, and Society" Essays**—Short essays that link genetics and society accompany most chapters. The most modern topics pursued include consideration of stem cells, the genetic identification of anthrax strains, the attempts to create HIV vaccines, and emerging societal issues surrounding human sex selection. These are in addition to essays that consider genetically modified foods, completion of the Human Genome Project, and endangered species--the Florida panther, among many others. These may be assigned even if they are not part of the formal lecture coverage.
- **Extensive Problems to Solve**—There are many entries in the "Problems and Discussion Questions" at the end of each chapter from which instructors may choose as student assignments are determined. These problems are written at various levels of difficulty, with those that are most challenging found in the "Extra Spicy Problems" sections. Students also can gain insights into different an-

alytical approaches illustrated in each chapter by utilizing the "Insights and Solutions" section at the conclusion of each chapter (see below).

Emphasis on Concepts

Genetics: A Molecular Perspective emphasizes the conceptual framework of genetics. Our experience with this approach shows that students more easily comprehend and take with them to succeeding courses the most important ideas in genetics as well as an analytic view of biological problems. To aid students in identifying conceptual aspects of a major topic, each chapter begins with a section called "Key Concepts," which outlines the most important ideas about to be presented. Then, each chapter ends with a "Chapter Summary," which enumerates the five to ten key points that have been covered. These two features help to ensure that students focus on concepts and are not distracted by the many, albeit important, details of genetics. Specific examples and carefully designed figures support this approach throughout the book.

Problem Solving and Insights and Solutions

In order to optimize the opportunities for student growth in the important areas of problem solving and analytical thinking, each chapter concludes with an extensive collection of "Problems and Discussion Questions." These represent various levels of difficulty, with the most challenging problems located at the end of each section (the Extra Spicy entries). Brief answers to half the problems are in Appendix C. The Student Handbook is available when faculty wish to expose their students to detailed discussions and answers to all problems and questions.

As an aid to students in their development of analytical thinking skills, the Problems and Discussion Question section of each chapter is preceded by what has become an extremely popular and successful section called "Insights and Solutions." In this section we stress:

- Problem solving
- Quantitative analysis
- Analytical thinking
- Experimental rationale

Problems or questions are posed and detailed solutions or answers are provided. This feature primes students for moving on to the "Problems and Discussion Questions" section that concludes each chapter.

Acknowledgments

All comprehensive texts are dependent on the valuable input provided by many reviewers and colleagues. While we take full responsibility for any errors in this book, we gratefully acknowledge the help provided by those individuals who

reviewed or otherwise contributed to the content and pedagogy of this and previous editions.

In particular, we thank Sarah Ward at Colorado State University for creating Chapter 27—Conservation Genetics and Jon Herron at the University of Washington for his input into Chapter 25—Population Genetics and Chapter 26—Genetics and Evolution. Charlotte Spencer at the Cross Cancer Institute in Alberta wrote or revised most of the Genetics, Technology, and Society essays. Others essays were previously contributed by Mark Shotwell at Slippery Rock University. We have also received extensive input from several colleagues who are deserving of special recognition for their writing efforts throughout the various editions in this series of texts. In particular, Elliott Goldstein at Arizona State University has provided valuable input in many areas of molecular genetics. We also express our thanks to Harry Nickla at Creighton University. In his role as author of the Student Handbook and the Instructor's Manual, he has reviewed and edited the problems at the end of each chapter. He also provided the brief answers to selected problems that appear in Appendix C. Additionally, Ruth Ballard at California State University, Sacramento has provided a number of new problems that appear in the Problem and Discussion Questions sections throughout the text. We appreciate the contributions of all of these geneticists and, particularly, the pleasant manner and dedication to this text displayed during our many interactions. We are forever grateful to them for their efforts.

At Prentice Hall, we express appreciation and high praise for the editorial guidance of Sheri Snavely and Gary Carlson, whose ideas and efforts have helped to shape and refine the features of this text. They have worked tirelessly to provide us with reviews from leading specialists who are also dedicated teachers, and to ensure that the pedagogy and design of the book are at the cutting edge of a rapidly changing discipline. We also appreciate the production efforts of Aksen Associates, whose quest for perfection is reflected throughout the text. In particular, Howard Aksen has provided an essential measure of sanity to the otherwise chaotic process of production. Without his work ethic and dedication, the text would never have come to fruition. Marketing is being handled with talent and enthusiasm by Jennifer Welchans and Marty McDonald. Karen Horton, biology project manager, worked to ensure that the book, supplements, and cutting-edge interactive media all work together seamlessly. Finally, the beauty and consistent presentation of the art work is the product of Imagineering, the Toronto-based company whose input is so much appreciated.

Finally, special thanks are due to those individuals who undertook the arduous task of proofing the manuscript. Mike Hoopman and Vince Heinrich examined the entire manuscript. At The College of New Jersey, a team of 15 students collectively agreed to undertake this task and together proofed most of the manuscript for errors. We thank Chris Regen, Sarah Jewell, Jagruti Patel, Melissa Greisemer, Shayna Davis, Susan Garfield, Keith Ritson, Subha Sundararajan, Arsalan Ahmad, Joe Balasius, Leanne Johnson, Rose Arone, Vijay Bhoj, Molly Sheridan, and Donna Morales for their dedication to this task. While it seems impossible to

ever produce the "perfect" text, the efforts of all of these individuals have gone a very long way to meeting that goal.

Media reviewers for Genetics include:

Peggy Brickman, University of Georgia
David Kass, Eastern Michigan University
John Kemner, University of Washington
Arlene Larson, University of Colorado
John C. Osterman, University of Nebraska, Lincoln
Cheryl Ingram-Smith, Clemson University

Print reviewers for Genetics include:

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As the above acknowledgments make clear, a text such as this is a collective enterprise. All of the above individuals deserve to share in any success this text enjoys. We want

them to know that our gratitude is equaled only by the extreme dedication evident in their many efforts. Many, many thanks to you all.

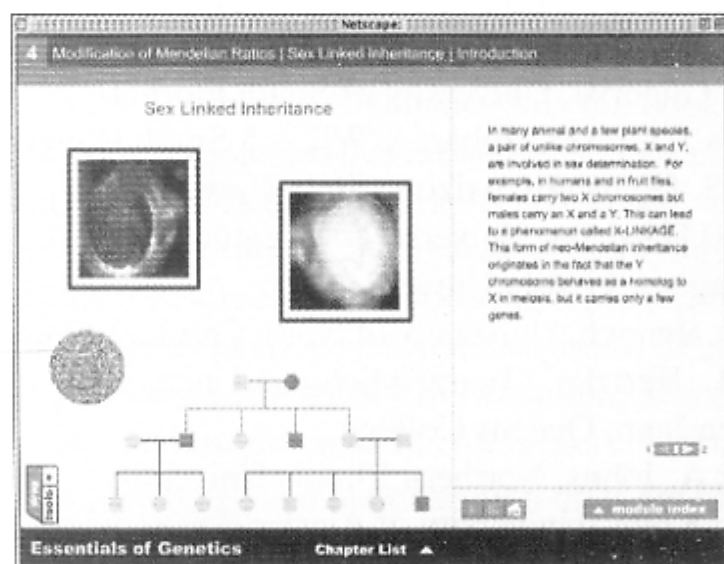
For the Student

All New Media Tutorials (CD-ROM)

The most sophisticated learning and tutorial package available for students of genetics, the new Student CD-ROM addresses students' most difficult concepts. Each concept or process begins with an overview that includes animations, proceeds to one or a series of interactive exercises, followed by self-quizzes. Each chapter contains a glossary, help function, search function, web links, plus additional problem-solving questions. Students who experience difficulty are directed to specific sections of the text for review. Look for the icon on the outside margin of this page to identify media tutorials that appear on the CD-ROM.

The following topics are addressed in the interactive media tutorials:

Mitosis
Meiosis
Monohybrid Cross
Independent Assortment
Probability



Analysis of Human Pedigrees
Extensions of Mendelian Inheritance
X-linked Inheritance
Linkage and Recombination
Linked Genes
Mapping a Three-Point Cross
More Three-Point Crosses
Virtual Crossover Laboratory
Chromosome Aberrations
Nondisjunction
DNA Structure
DNA Replication
DNA Recombination
Chromosome Structure

Transcription
Protein Translation
Mutation, Gene/Protein Colinearity
Mutations at the DNA Level
DNA Repair
Chemical Mutagenesis: Ames Test
Phage Genetics
Bacterial Genetics
Gene Expression: Prokaryotes
Restriction Enzymes and Vectors
Polymerase Chain Reaction
Restriction Mapping
Cloning Libraries
DNA Sequencing
RFLP
DNA Fingerprinting
Gene Expression: Eukaryotes
Population Genetics

Student Handbook and Solutions Manual



Harry Nickla, Creighton University
(0-13-100510-3)

This valuable handbook provides a detailed step-by-step solution or lengthy discussion for every problem in the text. The handbook also features additional study aids including extra study problems, chapter outlines, vocabulary exercises and an overview of how to study genetics.

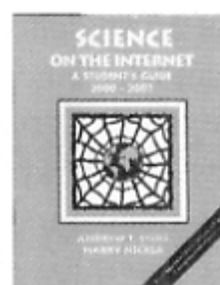
New York Times Themes of the Times: Genetics and Molecular Biology



Compiled by Harry Nickla, Creighton University
(0-13-060462-3)

This exciting newspaper-format supplement brings together recent genetics and molecular biology articles from the pages of the New York Times. This free supplement, available through your local representative, encourages students to make the connections between genetic concepts and the latest research and breakthroughs that are making headlines in the field. This resource is updated regularly.

Science on the Internet: A Student's Guide



Andrew T. Stull
(10-13-021308-X)

The perfect tool to help your students take advantage of the Concepts of Genetics Companion Website. This informative resource helps students locate and explore the myriad of science resources on the Web. It also provides an overview of the Web, general navigational

strategies, and brief student activities. It is available FREE when packaged with the text.

Companion Website—www.prenhall.com/klug

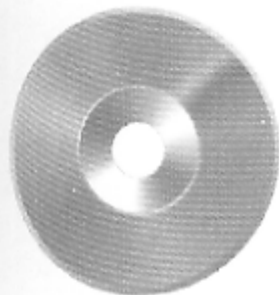
Navigating the Website is as easy as opening the textbook—all of the features are organized by text chapters. The Companion Website provides study aid tools, guided explorations, and updates on current topics relevant to genetics courses. Other features for the student include: Self-grading Chapter Problems; Chapter Search Terms; and Syllabus Manager.

In addition to providing resources for the student, the Companion Web site offers unique tools and support that make it easy to integrate Prentice Hall's on-line resources into the course.

For the Instructor

Instructor's CD-ROM (0-13-047350-2)

For adopters of the *Genetics: A Molecular Perspective*, this CD-ROM contains



- A replicate version of the Student CD-ROM
- All animations from the Student CD-ROM in a separate file
- All text illustrations in PowerPoint format

- The complete Instructor's Manual

Instructors will be able to coordinate lecture presentations with the textbook knowing students will be studying using the same animations based upon the text. No more searching for the Instructor's Manual. It is on the CD-ROM.

Instructor's Resource Manual with Testbank

(0-13-009675-X)

This manual and test bank contains over 1000 questions and problems an instructor can use to prepare exams. The manual also provides optional course sequences, a guide to audiovisual supplements, and a section on searching the web. The testbank portion of the manual is also available in electronic format.

TestGen EQ Computerized Testing Software

(0-13-009677-6)

In addition to the printed volume, the test questions are also available as part of the TestGen EQ Testing Software, a text-specific testing program that is networkable for administering tests. It also allows instructors to view and edit questions, export the questions as tests, and print them out in a variety of formats.

Transparencies

(0-13-009678-4)

275 figures from the text are included in the transparency package: 200 four-color transparencies from the text plus 75 transparency masters. The font size of the labels has been increased for easy viewing from the back of the classroom.

WebCT Course for Genetics: A Molecular Perspective

(0-13-047367-7)



The Prentice Hall WebCT course content for *Genetics: A Molecular Perspective* helps you meet the challenge of creating robust, interactive, and educationally rich online courses. Our WebCT course material provides you with high quality, class-tested material pre-programmed and fully functional in the WebCT environment. Whether used as an online supplement to either a campus-based or distance learning course, our pre-assembled course content gives you a tremendous head start in developing your own online courses.

Blackboard Course for Genetics: A Molecular Perspective

(0-13-047363-4)



The *Genetics: A Molecular Perspective* Blackboard course contains web-based content and resources such as online study guides, assessment databanks, and lecture resource material. The abundant online content, combined with Blackboard's popular tools and easy-to-use interface, result in a robust web-based course that is easy to implement, manage, and use—taking your courses to new heights in student interaction and learning. The Blackboard course management solution enables you to quickly add an online component to your campus-based course to provide you with a sophisticated technology base for total customization, scalability, and integration into your distance learning course.

CourseCompass Course for Genetics: A Molecular Perspective

(0-13-047364-2)



The *Genetics: A Molecular Perspective* CourseCompass™ course is the perfect course management solution that combines quality content with state-of-the-art Blackboard technology! CourseCompass™ is a dynamic, interactive online course management tool powered by Blackboard but hosted by Pearson Education. This exciting product allows you to teach with market-leading *Concepts of Genetics* content in an easy-to-use customizable format.