

Preface

In recent years the science of genetics has been undergoing a sea change. The DNA of genomes, even large ones, can now be analyzed in great detail; the functions of individual genes can be studied with an impressive array of new techniques; and organisms can be changed genetically by introducing alien or altered genes into their genomes. All of these developments have placed genetics in the center of a technological revolution that

is affecting agriculture, medicine, and society. At a more basic level, genetics has become a key science—some would say *the* key science—in all of biology. Genetic information and genetic analysis are now crucial to research in almost every biological discipline. We have created the fifth edition of *Principles of Genetics* to provide a comprehensive, up-to-date introduction to this important science.

Goals

This edition of *Principles of Genetics* continues our efforts to offer a book that balances new information with fundamental principles. As in previous editions, we have been guided by four overarching goals:

- **To focus on the basic principles of genetics** by presenting the important concepts of classical, molecular, and population genetics carefully and thoroughly. We believe that an understanding of current advances in genetics and an appreciation for their practical significance must be based on a strong foundation. Furthermore, we believe that the breadth and depth of coverage in the different areas of genetics—classical, molecular, and populational—must be balanced, and that the ever-growing mass of information in genetics must be organized by a sturdy—but flexible—framework of key concepts.
- **To focus on the scientific process** by showing how scientific concepts develop from observation and experimentation. Our book provides numerous examples to show how genetic principles have emerged from the work of different scientists. We emphasize that genetics is an ongoing process of observation, experimentation, and discovery. For example, each chapter contains a *Milestone in Genetics*, which focuses on an important advance in genetics and discusses how that advance came about. We also present the experimental evidence for important genetic principles.
- **To focus on human genetics** by incorporating human examples and showing the relevance of genetics to societal issues. Experience has shown us that students are keenly interested in the genetics of their own species. Because of this interest, they find it easier to comprehend complex concepts when these concepts are illustrated with human examples. Consequently, we have used human examples to illustrate genetic principles wherever possible. We have also included discussions of the Human Genome Project, human gene mapping, genetic

disorders, gene therapy, and genetic counseling throughout the text. Issues such as genetic screening, DNA fingerprinting, genetic engineering, cloning, stem cell research, and gene therapy have sparked vigorous debates about the social, legal, and ethical ramifications of genetics. We believe that it is important to involve students in discussions about these issues, and we hope that this textbook will provide students with the background to engage in such discussions thoughtfully.

- **To focus on developing critical thinking skills** by emphasizing the analysis of experimental data and problems. Genetics has always been a bit different from other disciplines in biology because of its heavy emphasis on problem solving. In this text, we have fleshed out the analytical nature of genetics in many ways—in the development of principles in classical genetics, in the discussion of experiments in molecular genetics, and in the presentation of calculations in population genetics. Throughout the book we have emphasized the integration of observational and experimental evidence with logical analysis in the development of key concepts. Each chapter has two sets of worked-out problems—the *Basic Exercises* section, which contains simple problems that illustrate basic genetic analysis, and the *Testing Your Knowledge* section, which contains more complex problems that integrate different concepts and techniques. A set of *Questions and Problems* follows the worked-out problems so that students can enhance their understanding of the concepts in the chapter and develop their analytical skills. In each chapter in this edition we have also incorporated a *Focus on Problem Solving*. This feature poses a problem, lists the pertinent facts and concepts, and then analyzes the problem and presents a solution. Finally, we have added a new feature, *Genomics on the Web*, which poses questions that can be answered by going to the National Center for Biotechnology Information web site. With this feature, students can learn to use the vast repository of genetic information that is accessible via that web site, and they can apply it to specific problems.

Content and Organization of the Fifth Edition

The organization of this edition of *Principles of Genetics* is similar to that of the previous edition. However, some of the material has been consolidated and many passages have been rewritten to reflect how the science of genetics has changed in the past few years. The art program has also been completely redesigned. There are many new photographs and the illustrations have been redrawn to provide a clear, consistent style throughout the text.

The text comprises 25 chapters—two less than the previous edition. Chapters 1–2 introduce the science of genetics, basic features of cellular reproduction, and some of the model genetic organisms; Chapters 3–8 present the concepts of classical genetics and the basic procedures for the genetic analysis of microorganisms; Chapters 9–14 present the topics of molecular genetics, including DNA replication, transcription, translation, mutation, and definitions of the gene; Chapters 15–18 cover more advanced topics in molecular genetics and genomics; Chapters 19–22 deal with the regulation of gene expression and the genetic bases of development, immunity, and cancer; Chapters 23–25 present the concepts of quantitative, popula-

tion, and evolutionary genetics. In selecting material to be included in this edition of *Principles of Genetics*, we have tried to be comprehensive but not encyclopedic. To keep the length of the text reasonable, we had to make difficult decisions about what to include and exclude, and we had to streamline some of the older material to make room for emerging developments.

As in previous editions, we have tried to create a text that can be adapted to different course formats. Many instructors prefer to present the topics in much the same way as we have, starting with classical genetics, progressing into molecular genetics, and finishing with quantitative, population, and evolutionary genetics. However this text is constructed so that teachers can present topics in different orders. They may, for example, begin with basic molecular genetics (Chapters 9–14), then present classical genetics (Chapters 3–8), progress to more advanced topics in molecular genetics (Chapters 15–22), and finish the course with quantitative, population, and evolutionary genetics (Chapters 23–25). Alternatively, they may wish to insert quantitative and population genetics between classical and molecular genetics.

Pedagogy of the Fifth Edition

This text includes special features designed to emphasize the relevance of the topics discussed, to facilitate the comprehension of important concepts, and to assist students in evaluating their grasp of these concepts.

- **Chapter-Opening Vignette.** Each chapter opens with a brief story that highlights the significance of the topics discussed in the chapter.
- **Chapter Outline.** The main sections of each chapter are conveniently listed on the chapter's first page.
- **Section Summary.** The content of each major section of text is briefly summarized at the beginning of that section. These opening summaries serve to focus attention on the main ideas developed in a chapter.
- **Key Points.** These learning aids appear at the end of each major section in a chapter. They are designed to help students review for exams and to recapitulate the main ideas of the chapter.



Topical Focus Boxes. Throughout the text, special topics are presented in separate *Focus* boxes. The material in these boxes supports or develops concepts, techniques, or skills that have been introduced in the text of the chapter.



Focus on Problem Solving. Each chapter contains a box that guides the student through the analysis and solution of a representative problem. We have chosen a problem that involves important material in the chapter. The box lists the facts and concepts that are relevant to the problem, and then explains how to obtain the solution. Ramifications of the problem are discussed in the online feature *WileyPLUS*.



A Milestone in Genetics. Each *Milestone* explores a key development in genetics—usually an experiment or a discovery. We cite the original papers that pertain to the subject of the *Milestone*, and we include two *Questions for Discussion* to provide students with an opportunity to investigate the current significance of the subject. These questions are suitable for cooperative learning activities in the classroom, or for reflective writing exercises that go beyond the technical aspects of genetic analysis.

- **Basic Exercises.** At the end of each chapter we present several worked-out problems to reinforce each of the fundamental concepts developed in the chapter. These simple, one-step exercises are designed to illustrate basic genetic analysis or to emphasize important information.

- **Testing Your Knowledge.** Each chapter also has more complicated worked-out problems to help students hone their analytical and problem-solving skills. The problems in this section are designed to integrate different concepts and techniques. In the analysis of each problem, we walk the students through the solution step by step.
- **Questions and Problems.** Each chapter ends with a set of questions and problems of varying difficulty organized according to the sequence of topics in the chapter. The more difficult questions and problems have been designated with orange numbers. These sets of questions and problems provide students with the opportunity to enhance their understanding of the concepts covered in the chapter and to develop their analytical skills. Also, some of the questions and problems—called **GO** problems—have been selected for interactive solutions in WileyPLUS. The **GO** problems are designated with a special icon.
- **Genomics on the Web.** Information about genomes, genes, DNA sequences, mutant organisms, polypeptide sequences, biochemical pathways and evolutionary relationships is now freely available on an assortment of web sites. Researchers routinely access this information, and we believe that students should become familiar with it. To this end, we have incorporated a set of questions at the end of each chapter that can be answered by using the National Center for Biotechnology Information (NCBI) web site, which is sponsored by the U.S. National Institutes of Health.
- **Glossary.** This section of the book defines important terms. Students find it useful in clarifying topics and in preparing for exams.
- **Answers.** Answers to the odd-numbered questions and problems are given at the end of the text.

SUPPLEMENTS



Wiley PLUS

A powerful online tool that provides instructors and students with an integrated suite of teaching and learning resources in one easy-to-use web site.

These include:

TEST BANK

The test bank, by Ashley Hagler, Gaston College, is available on both the instructor companion site and within WileyPLUS. The test bank contains approximately 50 test questions per chapter and is available online as MS Word files and a computerized test bank. This easy-to-use test-generation program fully supports graphics, print tests, student answer sheets, and answer keys. The software's advanced features allow you to produce an exam to your exact specifications.

POWERPOINT PRESENTATIONS

Laurie Russell, Saint Louis University, designed these presentations to be highly visual and to convey key text concepts illustrated by imbedded text art. The presentations may be accessed on either the instructor companion site or within WileyPLUS.

PRE AND POST LECTURE ASSESSMENT

This assessment tool, created specifically for WileyPLUS by Pamela Marshall, Arizona State University, allows instructors to assign a quiz prior to lecture to assess student understanding and encourage reading and following lecture to gauge improvement and weak areas. Two quizzes are provided for every chapter.

PERSONAL RESPONSE SYSTEM QUESTIONS

These questions by Carolyn Beam, Emory University, are designed to provide readymade pop quizzes and to foster student discussion and debate in class. Available on both the instructor companion site and within WileyPLUS.

ANIMATIONS

Located within WileyPLUS, these animations illustrate key concepts from the text and aid students in grasping some of the most difficult concepts in genetics. Also included are animations that will give students a refresher in basic biology.

GO PROBLEMS

Dubear Kroening, University of Wisconsin—Fox Valley, has implemented select End of Chapter Questions and Problems within WileyPLUS in a guided tutorial format. GO Problems enhance interactivity and hone problem solving skills to give students the confidence they need to tackle complex problems in genetics.



FOCUS ON PROBLEM SOLVING DISCUSSION

Further discussion of each Focus on Problem Solving box is provided within WileyPLUS. Students may link to this discussion directly from the electronic book as they are reading the chapter. Further discussion allows students to more fully understand the problem and put it in context.

ANSWERS TO QUESTIONS AND PROBLEMS

Answers to odd numbered Questions and Problems are located at the end of the text for easy access for students. Answers to all Questions and Problems in the text are available only to instructors on the instructor companion site and within WileyPLUS.

ILLUSTRATIONS AND PHOTOS

All line illustrations and photos from *Principles of Genetics, 5th Edition*, are available on the instructor companion site and

within WileyPLUS in both jpeg files and PowerPoint format. Line illustrations are enhanced to provide the best presentation experience.

BOOK COMPANION WEB SITE

(www.wiley.com/go/global/snustad)

This text-specific web site provides students with additional resources and extends the chapters of the text to the resources of the World Wide Web.

Acknowledgments

As with previous editions, this edition of *Principles of Genetics* has been influenced by the genetics courses we teach. We thank our students for their constructive feedback on both content and pedagogy, and we thank our colleagues at the University of Minnesota for sharing their knowledge and expertise. Genetics professors at other institutions also provided many helpful suggestions. In particular, we acknowledge the help of the following reviewers and focus group participants:

5th Edition Reviewers

Scott Baird, Wright State University; Jay Brewster, Pepperdine University; Jeff DeJong, University of Texas, Dallas; Charles B. Fenster, University of Maryland; Gary Kuleck, Loyola Marymount University; Paul F. Lurquin, Washington State University; Mark Meade, Jacksonville State University; Jessica L. Moore, University of South Florida; David H. Reed, University of Mississippi; Valery Soyfer, George Mason University; Mark Sturtevant, University of Michigan, Flint; Ted Weinert, University of Arizona

5th Edition Focus Group Participants

Aaron Cassill, University of Texas, San Antonio; Nestor DeOcampo, Michigan State University; Robert G. Fowler, San Jose State University; Maria Gallo, University of Florida; Michael Gilchrist, University of Tennessee, Knoxville; Adam W. Hrinkevich, Louisiana State University; David Kass, Eastern Michigan University; Gregory J. Podgorski, Utah State University; Inder M. Saxena, University of Texas, Austin

Reviewers of Previous Editions

Colleen Belk, University of Minnesota, Duluth; John Belote, Syracuse University; Paul Bottino, University of Maryland; Jay Brewster, Pepperdine University; Joan Burnside, University of Delaware; Pat Calie, Eastern Kentucky University; David Carroll, Florida Institute of Technology; Glen Collier, University of Tulsa; Jon Coren, Elizabethtown College; Stephen J. D'Surney, University of Mississippi; David S. Durica, University of Oklahoma; Larry Eckroat, Pennsylvania State University—Erie; Bert Ely, University of South Carolina; David W. Foltz, Louisiana State University; Matthew Gilg, University of North Florida; Patrick Guilfoile, Bemidji State

Resources include:

For Students: web quizzes, by Carolyn Beam, covering key concepts for each chapter of text, flashcards, and the Biology NewsFinder.

For Instructors: Test Bank, PowerPoint Presentations, line art and photos in jpeg and PowerPoint formats, personal response system questions, and all answers to end of chapter Questions and Problems.

University; Linda Hensel, Mercer University; Tim Ho, University of Wisconsin, Eau Claire; Margaret Hollingsworth, SUNY at Buffalo; Robert Karn, Butler University; Jeffrey M. Marcus, Western Kentucky University; Deb McDonough, University of New England; Michael Polymenis, Texas A & M University; Michael Shintaku, University of Hawaii; Lisa Timmons, University of Kansas; Xiaofei Wang, Tennessee State University; Dan Wells, University of Houston Marvin Whiteley, University of Oklahoma; Mark S. Wilson, Humboldt State University

Many people contributed to the development and production of this edition. Kevin Witt, Senior Editor initiated the project and provided ideas about some of the text's features. Merillat Staat, Associate Editor, worked tirelessly—and enthusiastically—at all stages of the project. We deeply appreciate her guidance and input. Alissa Etrheim, Editorial Assistant, helped with many of the logistical details, while Teri Stratford, Photo Researcher, and Hilary Newman, Photo Manager, researched and obtained many new photographs for this edition. Kathleen Naylor, Developmental Art Editor, heroically analyzed the art in the previous edition, expertly laid out specifications for new illustrations, and made many suggestions for new photographs. We are very grateful for all their contributions. We thank Kevin Murphy, Senior Designer, for creating a fresh text layout and Sigmund Malinowski for executing the new, complex illustration program. Elizabeth Swain, Senior Production Editor superbly coordinated the production of this edition, Betty Pessagno faithfully copyedited the manuscript, Julie Nemer did the final proofreading, and Steve Ingle prepared the index. We greatly appreciate the excellent work of all these people. We also thank Clay Stone, Marketing Manager, for helping to get this edition into the hands of prospective users. With an eye toward the next edition, we encourage students, teaching assistants, instructors, and other readers to send us comments on this edition in care of Merillat Staat at John Wiley & Sons, Inc., 111 River Street, 6-01, Hoboken, NJ, 07030.

Wiley Publishers would like to thank Ashley Hagler, M.S., M.A.T., Gaston College, for her contribution to this International Student Version.