Preface

Transmission and Population Genetics was developed to address the needs of courses that fo solely on those topics. Like its parent text, *Genetics* 4e, this edition of *Transmission and Popula Genetics* strives to help students uncover major concepts of genetics and make connections am those concepts so as to have a fuller understanding of genetics. This conceptual and holistic appro to genetics has proved to be effective in the three preceding editions of this book. After taking pa class testing of those editions and of a sample chapter of the current edition, students say that come away with a deeper and more complete understanding of genetics, thanks to the accessible w ing style, simple and instructive illustrations, and useful pedagogical features throughout the boo

Hallmark Features

I liked the amount of concept reinforcement that is in the chapter. The concept check questions seem like they would be very useful in helping students understand the material by getting them to stop and think about what they just read. —William Seemer, Student, University of North Florida

- **Key Concepts and Connections** Throughout the book, I've included features to help dents focus on the major concepts of each topic.
  - ***Concept boxes*** throughout each chapter summarize the key points of preceding sections. ***Concept Checks*** ask students to pause for a moment and make sure that they understand the take-home message. Concept Checks are in multiple-choice and short-answer format, and answers are listed at the end of each chapter.
  - ***Connecting Concepts*** sections draw on concepts presented in several sections or several chapters to help students see how different topics of genetics relate to one another. These sections compare and contrast processes or integrate ideas across chapters to create an overarching, big picture of genetics. All major concepts listed in the ***Concepts Summary*** at the end of each chapter.

CONCEPTS

The process of transformation indicates that some substance—t transforming principle—is capable of genetically altering bacte Avery, MacLeod, and McCarty demonstrated that the transfor ing principle is DNA, providing the first evidence that DNA is t genetic material.

✔ CONCEPT CHECK 3

If Avery, MacLeod, and McCarty had found that samples of heat-kill bacteria treated with RNase and DNase transformed bacteria, b samples treated with protease did not, what conclusion would th have made?

a. Protease carries out transformation.
b. RNA and DNA are the genetic materials.
c. Protein is the genetic material.
d. RNase and DNase are necessary for transformation.

The style of writing is easy to follow and is directed at college-level students. I appreciate the use of real-world language, and examples that can be found in daily life. —Shannon Forshee, Student, Eckerd College

- **Accessibility** The welcoming and conversational writing style of this book has long been of its most successful features for both students and instructors. In addition to carefully wa ing students through each major concept of genetics, I invite them into the topic with **introductory story**. These stories include relevant examples of disease or other biolog phenomena to give students a sample of what they'll be learning in a chapter. More tha third of the introductory stories in this edition are new.

The figures and balloon dialogue really make the concepts easier to understand. Visualization is really important to me

- **Clear, Simple Illustration Program** I have worked closely with illustrators to create attr tive and instructive illustrations, which have proved to be an effective learning tool for s dents. Each illlustration was carefully rendered to highlight main points and to step the rea through experiments and processes. Most illustrations include textual content that walks s

- **Emphasis on Problem Solving** One of the things that I've learned in my 30 years of teaching is that students learn genetics best through problem solving. Working through an example, equation, or experiment helps students see concepts in action and reinforces the ideas explained in the text. In the book, I help students develop problem-solving skills in a number of ways. **Worked Problems** follow the presentation of difficult quantitative concepts. Walking through a problem and solution within the text reinforces what the student has just read. New **Problem Links** spread throughout each chapter point to end-of-chapter problems that students can work to test their understanding of the material that they have just read. I provide a wide range of end-of-chapter problems, organized by chapter section and split into Comprehension, Application Questions and Problems, and Challenge Questions. Some of these questions draw on examples from published papers and are marked by a data analysis icon.

I liked the addition of the yellow tags telling you what problems to do that go along with the section. I also really liked that a worked problem was included in the text and not just at the end. I felt like that helped my problem-solving skills while I was reading. —Alexandra Reynolds, Student, California Polytechnic State University, San Luis Obispo

NEW Problem Link

is the probability of Y^+y ($^1/_2$) multiplied by the probability of C^+c ($^1/_2$), or $^1/_4$. The probability of each progeny genotype resulting from the testcross is:

Progeny genotype	Probability at each locus		Overall probability	Phenotype
$Y^+y\ C^+c$	$^1/_2 \times {}^1/_2$	=	$^1/_4$	red peppers
$Y^+y\ cc$	$^1/_2 \times {}^1/_2$	=	$^1/_4$	peach peppers
$yy\ C^+c$	$^1/_2 \times {}^1/_2$	=	$^1/_4$	orange peppers
$yy\ cc$	$^1/_2 \times {}^1/_2$	=	$^1/_4$	cream peppers

When you work problems with gene interaction, it is especially important to determine the probabilities of single-locus genotypes and to multiply the probabilities of *genotypes*, not phenotypes, because the phenotypes cannot be determined without considering the effects of the genotypes at all the contributing loci. TRY PROBLEM 25 →

Gene Interaction with Epistasis

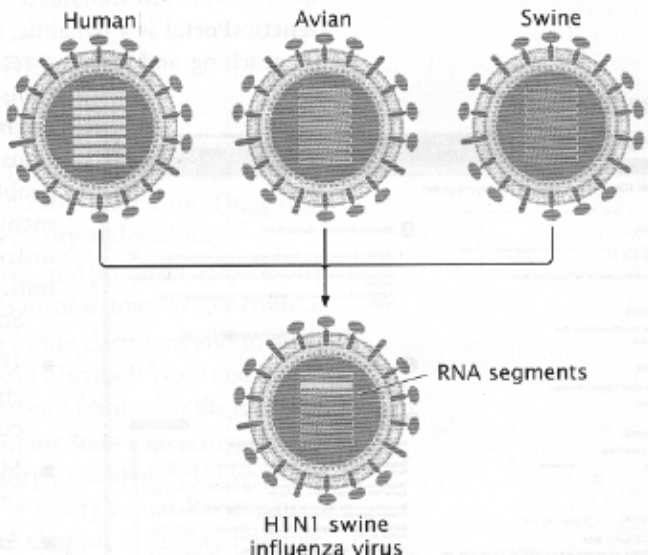
Sometimes the effect of gene interaction is that one gene masks (hides) the effect of another gene at a different locus, a phenomenon known as **epistasis**. In the examples of geni

New to the Fourth Edition

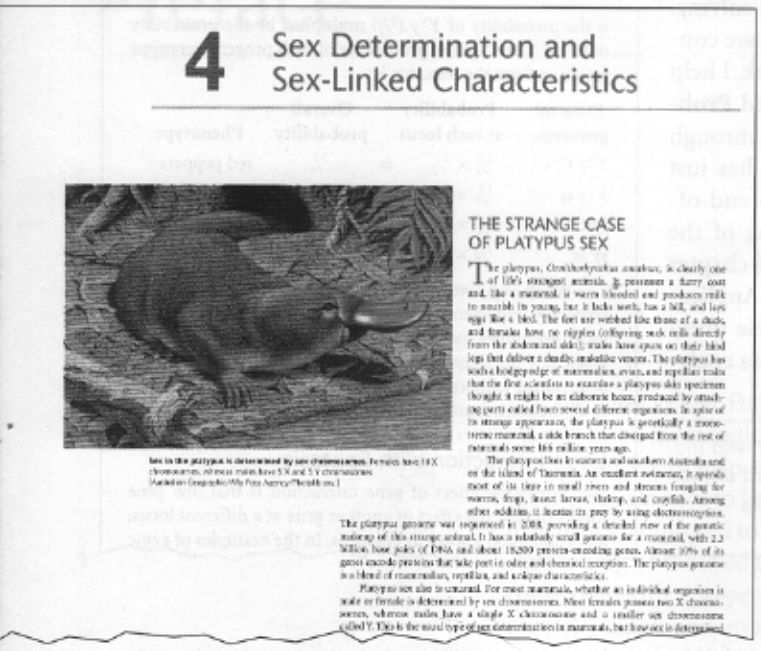
The fourth edition builds on successful features of the preceding editions of *Genetics: A Conceptual Approach* while providing an up-to-date look at the field.

- **More Help with Problem Solving** I encourage students to practice applying the concepts that they've just learned with new **Problem Links**, spread throughout each chapter. Each link points to an end-of-chapter problem that addresses the concept just discussed, so that students can immediately test their understanding of the concept. These problem links, in addition to the Concept Check questions, provide valuable just-in-time practice, enabling students to monitor their own progress.
- **Updated Coverage** The fourth edition addresses recent discoveries in the field of genetics, corresponding to our ever-changing understanding of inheritance, the molecular nature of genetic information, and genetic evolution. **Epigenetics**, an exciting new area of genetics, has been given extended and updated coverage in this edition. Additional updates include:

- genetic-conflict hypothesis of genomic imprinting (Chapter 5)
- epigenetics and the development of queen bees (Chapter 5)
- interpreting genetic tests (Chapter 6)
- direct-to-consumer genetic tests (Chapter 6)
- genomewide association studies (Chapter 7)
- horizontal gene transfer (Chapter 8)
- rapid evolution of influenza viruses (Chapter 8)
- segmental duplications (Chapter 9)
- copy-number variations (Chapter 9)
- repair of double-strand breaks (Chapter 11)



NEW Introductory Stories



4 Sex Determination and Sex-Linked Characteristics

THE STRANGE CASE OF PLATYPUS SEX

The platypus, *Ornithorhynchus anatinus*, is clearly one of life's strangest animals. It possesses a furry coat and, like a mammal, is warm blooded and produces milk to nourish its young, but it lacks teeth, has a bill, and lays eggs like a bird. The feet are webbed like those of a duck, and females have no nipples (offspring suck milk directly from the abdominal skin); males have spurs on their hind legs that deliver a deadly, snakelike venom. The platypus has sealed a bridge-edge of mammalian, avian, and reptilian traits that the first scientists to examine a platypus skin specimen thought it might be an elaborate hoax, produced by attaching parts culled from several different organisms. In spite of its strange appearance, the platypus is genetically a monotreme mammal, a side branch that diverged from the rest of mammals some 166 million years ago.

The platypus lives in eastern and southern Australia and on the island of Tasmania. An excellent swimmer, it spends most of its time in small rivers and streams foraging for worms, frogs, insect larvae, shrimp, and crayfish. Among other additions, it locates its prey by using electroreception.

The platypus genome was sequenced in 2004, providing a detailed view of the genetic makeup of this strange animal. It has a relatively small genome for a mammal, with 2.3 billion base pairs of DNA and about 18,800 protein-encoding genes. Almost 10% of its genes encode proteins that take part in odor and chemical reception. The platypus genome is a blend of mammalian, reptilian, and unique characteristics.

Platypus sex also is unusual. For most mammals, whether an individual organism is male or female is determined by sex chromosomes. Most females possess two X chromosomes, whereas males have a single X chromosome and a smaller sex chromosome called Y. This is the usual type of sex determination in mammals, but how sex is determined

- **More Flexibility** Model genetic organisms are now presented at end of the book in a **Reference Guide to Model Genetic Organis** Each model organism is presented in a two-page spread that sum rizes major points about the organism's life cycle, genome, and us a model organism. This new organization makes it easier to t model genetic organisms as a single unit at any time in the cours to cover individual organisms in the context of particular stu throughout the course.
- **More Connections** New **summary tables** throughout the book students make connections between concepts. I use tables to m side-by-side comparisons of similar processes, to summarize steps and players in complex biological pathways, and to help visu organize important genes, molecules, or ideas.
- **More Relevance** Each chapter begins with a brief **introductory st** that illustrates the relevance of a genetic concept that students learn in the chapter. These stories—a favorite feature of past tions—give students a glimpse of what's going on in the field of ge ics today and help to draw the reader into the chapter. New introc tory topics are "The Strange Case of Platypus Sex," "Linked Genes Bald Heads," "Life in a Bacterial World," and "Corn Oil and Quant tive Genetics." New end-of-chapter problems specifically address cepts discussed in most introductory stories, both old and new.

Media and Supplements

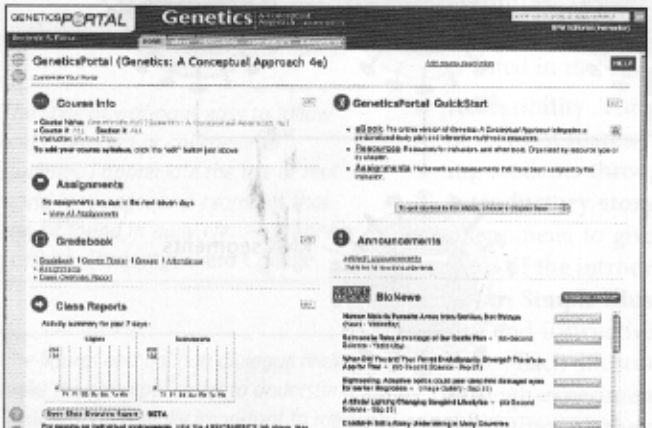
The complete package of media resources and supplements is designed to provide instruc and students with the most innovative tools to aid in a broad variety of teaching and learn approaches—including e-learning. All the available resources are fully integrated with the textbo style and goals, enabling students to connect concepts in genetics and think like geneticists as as develop their problem-solving skills. Students and instructors using *Transmission and Popula Genetics* will have access to all of the supplements that accompany the parent text *Genetics* 4e.

GENETICS PORTAL

http://courses.bfwpub.com/pierce4e

GeneticsPortal is a dynamic, fully integrated learning environment that brings together al our teaching and learning resources in one place. It features problem-solving videos, ani tions of difficult-to-visualize concepts, and our new **problem-solv engine**—an engaging tool that contains all of the end-of-chapter qu tions and problems in the textbook, converted into multiple-ch problems, including illustrations from the textbook and drop-d menus. Easy-to-use assessment tracking and grading tools en instructors to assign problems for practice, as homework, quizzes tests.

NEW Genetics Portal



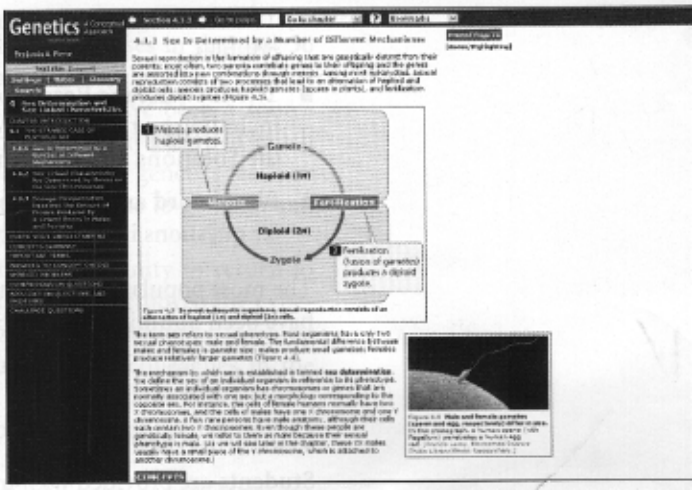
Some of the GeneticsPortal features are as follows:

- Hundreds of self-graded end-of-chapter practice problems al students to fill in Punnett Squares, construct genetic maps, and culate probabilities in multiple-choice versions.
- Step-by-step problem-solving videos walk through the specific p cess to solve select problems.
- Animations and activities to help students visualize genetics.

GeneticsPortal also includes the fully interactive **eBook** and all of the Student and Instructor Resources that are on the **Book Companion Website.** The GeneticsPortal is included with all new copies of the fourth edition of *Genetics: A Conceptual Approach.*

eBook

http://ebooks.bfwpub.com/pierce4e



The eBook is a completely integrated electronic version of the textbook—the ultimate hybrid of textbook and media. Problems and resources from the printed textbook are incorporated throughout the eBook along with Check Your Understanding questions that are linked to specific sections of the textbook, to ensure that students can easily review specific concepts. The eBook is available as a stand-alone textbook (sold for approximately 60% of the retail price of the printed textbook) or packaged with the printed textbook at a discounted rate. The eBook version that accompanies *Transmission and Population Genetics* includes all 26 chapters of the parent text, *Genetics* 4e. The eBook enables students to:

- Access the complete book and its electronic study tools from any internet-connected computer by using a standard Web browser;
- Navigate quickly to any section or subsection of the book or any page number of the printed book;
- Add their own bookmarks, notes, and highlighting;
- Access all the fully integrated media resources associated with the book, including the Interactive Animations and the Problem-Solving Videos (described on p. xx);
- Review quizzes and personal notes to help prepare for exams; and
- Search the entire eBook instantly, including the index and spoken glossary.

Instructors teaching from the eBook can assign either the entire textbook or a **custom version** that includes only the chapters that correspond to their syllabi. They can choose to add notes to any page of the eBook and share these notes with their students. These notes may include text, Web links, animations, or photographs. Also available is a **CourseSmart eBook.**

Instructor Resources

Instructors are provided with a comprehensive set of teaching tools, carefully developed to support lecture and individual teaching styles.

On the Book Companion Site

www.whfreeman.com/pierce4e

- All **Textbook Images and Tables** are offered as high-resolution JPEG files in PowerPoint. Each image has been fully optimized to increase type sizes and adjust color saturation. These images have been tested in a large lecture hall to ensure maximum clarity and visibility.
- **Layered or Active PowerPoints** deconstruct key concepts, sequences, and processes, step-by-step in a visual format, allowing instructors to present complex ideas in clear, manageable chunks.
- **Clicker Questions** allow instructors to integrate active learning in the classroom and to assess students' understanding of key concepts during lectures. Available in Microsoft Word and PowerPoint, numerous questions are based on the Concepts Check questions featured in the textbook.
- The **Test Bank** has been prepared by Brian W. Schwartz, Columbus State University; Bradley Hersh, Allegheny College; Paul K. Small, Eureka College; Gregory Copenhaver, University of North Carolina at Chapel Hill; Rodney Mauricio, University of Georgia; and Ravinshankar Palanivelu, University of Arizona. It contains 50 questions per chapter, including multiple-

the Book Companion Site as chapter-by-chapter Microsoft Word files that are easy to do load, edit, and print. A computerized test bank also is available.

- **Lecture Connection PowerPoint Presentations** for each chapter have been develope minimize preparation time for new users of the book. These files offer suggested lect including key illustrations and summaries that instructors can adapt to their teaching sty
- The **Solution and Problem-Solving Manual** (described below) is available to downloa pdf files.
- The **Instructor's Resource DVD** contains all of the resources on the Book Companion including text images in PowerPoint slides and as high-resolution JPEG files, all animati the Solutions and Problem-Solving Manual, and the Test Bank in Microsoft Word form
- **Blackboard** and **WebCT** cartridges are available and include the Test Bank and end-of-ch ter questions in multiple-choice and fill-in-the-blank format.

The most popular images in the textbook are also available as **Overhead Transparencies**, wh have been optimized for maximum visibility in large lecture halls.

Student Resources

Students are provided with media designed to help them fully understand genetic concepts improve their problem-solving ability.

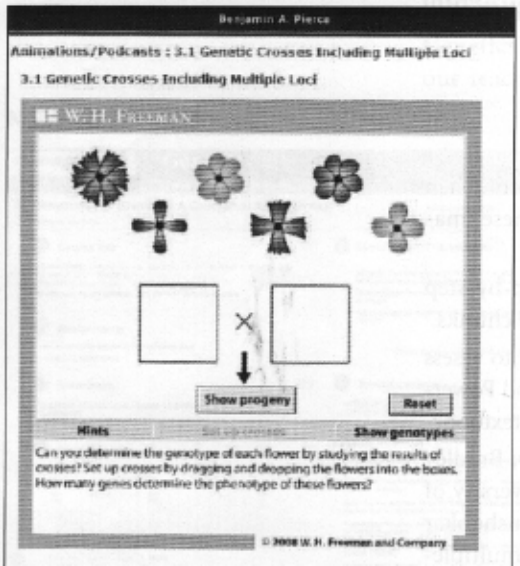
- **Solutions and Problem-Solving Manual** by Jung Choi, Georgia Institute of Technology, Mark McCallum, Pfeiffer University, contains complete answers and worked-out solution all questions and problems in the textbook. The manual has been found to be an indispe able tool for success by students and has been reviewed extensively by instructors for fourth edition. (ISBN: 1-4292-3254-4)

On the Book Companion Site

www.whfreeman.com/pierce4e

- **Problem-Solving Videos** developed by Susan Elrod, California Polytechnic S University, San Luis Obispo, offer students valuable help by reviewing b problem-solving strategies. Students learn first-hand how to deconstruct d cult problems in genetics by using a set of questioning techniques. The probl solving videos demonstrate in a step-by-step manner how these strategies ca applied to the in-text worked problems and selected end-of-chapter problem many of the chapters.

Interactive Animations



- **Interactive Animations/Podcasts** illuminate important concepts in genetics. Th tutorials help students understand key processes in genetics by outlining these p cesses in a step-by-step manner. The tutorials are also available on the eBook. P casts adapted from the tutorial presentations in the following list are available download from the Book Companion Site and from the eBook. Students review important genetics processes and concepts at their convenience by do loading the animations to their MP3 players. The major animated concepts are

2.1 Cell Cycle and Mitosis	7.1 Determining Gene Order by Three-Point Cross
2.2 Meiosis	
2.3 Genetic Variation in Meiosis	8.1 Bacterial Conjugation
3.1 Genetic Crosses Including Multiple Loci	18.1 DNA Mutations
4.1 X-Linked Inheritance	25.1 The Hardy–Weinberg Law an the Effects of Inbreeding and

Also available for students is *Genetics: A Conceptual Approach*, Fourth Edition (ISBN: 1-4292-3250-1). *Genetics*, Fourth Edition, is also available in looseleaf (ISBN: 1-4292-3251-X) at a reduced cost.

Acknowledgments

I am indebted to the thousands of genetics students who have filled my classes in the past 30 years, first at Connecticut College, then at Baylor University, and now at Southwestern University. The intelligence, enthusiasm, curiosity, and humor of these students have been a source of motivation and pleasure throughout my professional life. From them I have learned much about the art of teaching and the subject of genetics. I am also indebted to my genetics teachers and mentors, Dr. Raymond Canham and Dr. Jeffry Mitton, for introducing me to genetics and encouraging me to be a lifelong learner and scholar.

Five years ago, Southwestern University provided me with the opportunity to return to teaching and research at a small undergraduate university, and I have greatly enjoyed the experience. The small classes, close interaction of students and faculty, and integration of teaching and research have made working at Southwestern fun and rewarding. My colleagues in the Biology Department continually sustain me with friendship and advice. I thank James Hunt, Provost of Southwestern University and Dean of the Brown College, for valued friendship, collegiality, and support.

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