PREFACE

Based on discussions with instructors from many institutions, I have learned that most instructors want a broad textbook that clearly explains concepts in a way that is interesting, accurate, concise, and up-to-date. *Concepts of Genetics* has been written to achieve these goals. It is intended for students who want to gain a conceptual grasp of the various fields of genetics. The content reflects current trends in genetics, and the pedagogy is based on educational research. In particular, a large amount of formative assessment is woven into the content. As an author, researcher, and teacher, I want a textbook that gets students actively involved in learning genetics. To achieve this goal, I have worked with a talented team of editors, illustrators, and media specialists who have helped me to make the third edition of *Concepts of Genetics* a fun learning tool.

FLIPPING THE CLASSROOM

A trend in science education is the phenomenon that is sometimes called "flipping the classroom." This phrase refers to the idea that some of the activities that used to be done in class are now done out of class, and vice versa. For example, instead of spending the entire class time lecturing about the textbook and other materials, some of the class time is spent engaging students in various activities, such as problem solving, working through case studies, and designing experiments. This approach is called active learning. For many instructors, the classroom has become more learner centered rather than teacher centered. A learner-centered classroom provides a rich environment in which students can interact with each other and with their instructors. Instructors and fellow students often provide formative assessment—immediate feedback that helps students understand if their learning is on the right track.

What are some advantages of active learning? Educational studies reveal that active learning usually promotes greater learning gains. In addition, active learning often focuses on skill development rather than the memorization of facts that are easily forgotten. Students become trained to "think like scientists" and to develop a skill set that enables them to apply scientific reasoning.

A common concern among instructors who are beginning to try out active learning is that they think they will have to teach their students less material. However, this may not be the case. Although students may be provided with online lectures, "flipping the classroom" typically gives students more responsibility for understanding the textbook material on their own. Along these lines, *Concepts of Genetics,* Third Edition, is intended to provide students with a resource that can be effectively used out of the classroom. Several key pedagogical features include the following:

- **Learning Outcomes** Each section of every chapter begins with a set of learning outcomes. These outcomes help students understand what they should be able to do if they have mastered the material in that section.
- **Formative Assessment** When students are expected to learn textbook material on their own, it is imperative that they are given formative assessment on a regular basis so they can gauge whether or not they are mastering the material. Formative assessment is a major feature of this textbook and is bolstered by McGraw-Hill Connect®—a state-of-the art digital assignment and assessment platform. In *Concepts of Genetics,* Third Edition, formative assessment is provided in multiple ways.

1. Each section of every chapter ends with multiple-choice questions. Formative assessment at the end of each section allows students to evaluate their mastery of the material before moving on to the next section.
2. Most figures have concept check questions so students can determine if they understand the key points in the figure.
3. Extensive end-of-chapter questions continue to provide students with feedback regarding their mastery of the material.
4. A feature called ***Genetic TIPS*** provides a consistent approach to help students solve problems in genetics. This approach has three components: First, the student is made aware of the ***T***opic at hand. Second, the question is evaluated with regard to the ***I***nformation that is available to the student. Finally, the student is guided through a ***P***roblem-Solving ***S***trategy to tackle the question.
5. Additional questions, including questions that pertain to every feature investigation, are available to the student in Connect: http://successinhighered.com/genetics-molecular-biology.
6. The textbook material is supported by digital learning tools found in Connect. Questions and activities are assignable in Connect. Assignments due before class time or following an in-class activity help students prepare or review.
7. McGraw-Hill SmartBook is an adaptive learning tool available in Connect that has been shown to strengthen recall and increase retention so that students can move beyond memorizing and truly learn the material.

- **Chapter Organization** In genetics, it is sometimes easy to "lose the forest for the trees." Genetics can be a dense subject. To circumvent this difficulty, the content in *Concepts of Genetics* has been organized to foster a better appreciation for the big picture of genetic principles. The chapters are divided into several sections, and each section ends with a summary that touches on the main points. As mentioned, multiple-choice questions at the end of each section are also intended to help students grasp the broader concepts in genetics. Finally, the end of each chapter contains a summary, which allows students to connect the concepts that were learned in each section.
- **Interactive Exercises** Working with education specialists, the author has crafted interactive exercises in which the students can make their own choices in problem-solving activities and predict what the outcomes will be. Many of these exercises are focused on inheritance patterns and human genetic diseases. (For example, see Chapters 5 and 22.) In addition, there are many interactive exercises for the molecular chapters. These types of exercises engage students in the learning process. The interactive exercises are found online, and the corresponding material in the chapter is indicated with an Interactive Exercise icon.

- **Animations** Our media specialists have created over 50 animations for a variety of genetic processes. These animations were made specifically for this textbook and use the art from the textbook. The animations literally make many of the figures in the textbook "come to life." The animations are found online and the corresponding material in the chapter is indicated with an Online Animation icon.

An effective textbook needs to accomplish three goals: First, it needs to provide comprehensive, accurate, and up-to-date content in its field. Second, it needs to expose students to the techniques and skills they will need to become successful in that field. And finally, it should inspire students so they want to study the material. The hard work that has gone into the third edition of *Concepts of Genetics* has been aimed at achieving all three of these goals. Furthermore, the pedagogy of *Concepts of Genetics* has been designed to foster student learning. Instead of being a collection of "facts and figures," *Concepts of Genetics,* Third Edition, by Robert Brooker, is intended to be an engaging and motivating textbook in which formative assessment allows students to move ahead and learn the material in a productive way. We welcome your feedback so we can make future editions even better!

HOW WE EVALUATED YOUR NEEDS

ORGANIZATION

In surveying many genetics instructors, it became apparent that most people fall into two camps: **Mendel first** versus **Molecular first.** I have taught genetics both ways. As a teaching tool, this textbook has been written with these different teaching strategies in mind. The organization and content lend themselves to various teaching formats.

Chapters 2 through 10 are largely inheritance chapters, whereas Chapters 23 and 24 examine population and quantitative genetics. The bulk of the molecular genetics is found in Chapters 11 through 22, although I have tried to weave a fair amount of molecular genetics into Chapters 2 through 10 as well. The information in Chapters 11 through 22 does not assume that a student has already covered Chapters 2 through 10. Actually, each chapter is written with the perspective that instructors may want to vary the order of their chapters to fit their students' needs.

For those who like to discuss inheritance patterns first, a common strategy would be to cover Chapters 1 through 10 first, and then possibly 23 and 24. (However, many instructors like to cover quantitative and population genetics at the end. Either way works fine.) The more molecular and technical aspects of genetics would then be covered in Chapters 11 through 22. Alternatively, if you like the "Molecular first" approach, you would probably cover Chapter 1, then skip to Chapters 11 through 22, then return to Chapters 2 through 10, and then cover Chapters 23 and 24 at the end of the course. This textbook was written in such a way that either strategy works well.

ACCURACY

Both the publisher and I acknowledge that inaccuracies can be a source of frustration for both the instructor and students. Therefore, throughout the writing and production of this textbook we have worked very hard to catch and correct errors during each phase of development and production.

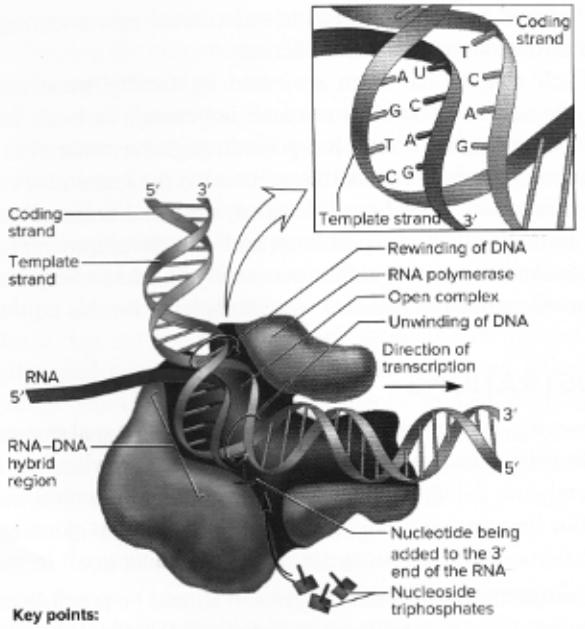
Each chapter has been reviewed by faculty members who teach the course or conduct research in genetics or both. In addition, a developmental editor has gone through the material to check for accuracy in art and consistency between the text and art. When the problem sets were first developed, we had a team of students work through all of the problems and one developmental editor also checked them. The author personally checked every question and answer when the chapters were completed for this edition.

ILLUSTRATIONS

In surveying students whom I teach, I often hear it said that most of their learning comes from studying the figures. Likewise, instructors frequently use the illustrations from a textbook as a central teaching tool. For these reasons, a great amount of effort has gone into the illustrations. The illustrations are created with four goals in mind:

1. **Completeness** For most figures, it should be possible to understand an experiment or genetic concept by looking at the illustration alone. Students have complained that it is difficult to understand the content of an illustration if they have to keep switching back and forth between the figure and text. In cases where an illustration shows the steps in a scientific process, the steps are described in brief statements that allow the students to understand the whole process (e.g., see Figure 17.10). Likewise, such illustrations should make it easier for instructors to explain these processes in the classroom.

2. **Clarity** The figures have been extensively reviewed by students and instructors. This has helped us to avoid drawing things that may be confusing or unclear. Aside from being unmistakably drawn, all new elements within each figure are clearly labeled.
3. **Consistency** Before we began to draw the figures, we generated a style sheet that contained recurring elements that are found in many places in the textbook. Examples include the DNA double helix, DNA polymerase, and fruit flies. We agreed on the best way(s) to draw these elements and also what colors they should be. Therefore, as students and instructors progress through this textbook, they become accustomed to the way things should look.
4. **Realism** An important emphasis of this textbook is to make each figure as realistic as possible. When drawing macroscopic elements (e.g., fruit flies, pea plants), the illustrations are based on real images, not on cartoonlike simplifications. Our most challenging goal, and one that we feel has been achieved most successfully, is the realism of our molecular drawings. Whenever possible, we have tried to depict molecular elements according to their actual structures, if such structures are known. For example, the ways we have drawn RNA polymerase, DNA polymerase, DNA helicase, and ribosomes are based on their crystal structures. When a student sees a figure in this textbook that illustrates an event in transcription, RNA polymerase is depicted in a way that is as realistic as possible (e.g., Figure 14.8 below).



FEATURE EXPERIMENTS

Many chapters have one or two experiments that are presented according to the scientific method. These experiments are integrated within the chapters and flow with the rest of the text. As you are reading the experiments, you will simultaneously explore the scientific method and the genetic principles that have been discovered using this approach. For students, I hope this textbook helps you to see the fundamental connection between scientific analysis and principles. For both students and instructors, I expect that this strategy makes genetics much more fun to explore.

WRITING STYLE

Motivation in learning often stems from enjoyment. If you enjoy what you're reading, you are more likely to spend longer amounts of time with it and focus your attention more crisply. The writing style of this book is meant to be interesting, down to earth, and easy to follow. Each section of every chapter begins with an overview of the contents of that section, usually with a table or figure that summarizes the broad points. The section then examines how those broad points were discovered experimentally, as well as explaining many of the finer scientific details. Important terms appear in the text in a boldface font. These terms are also found at the end of the chapter and in the glossary.

There are various ways to make a genetics book interesting and inspiring. The subject matter itself is pretty amazing, so it's not difficult to build on that. In addition to describing the concepts and experiments in ways that motivate students, it is important to draw on examples that bring the concepts to life. In a genetics book, many of these examples come from the medical realm. This textbook contains lots of examples of human diseases that convey some of the underlying principles of genetics. Students often say they remember certain genetic concepts because they remember how defects in certain genes can cause disease. For example, defects in DNA repair genes cause a higher predisposition to develop cancer. In addition, I have tried to be evenhanded in providing examples from the microbial and plant world. Finally, students are often interested in applications of genetics that affect their everyday lives. Because we frequently hear about genetics in the news, it's inspiring for students to learn the underlying basis for such technologies. Chapters 20 and 21 are devoted to genetic technologies, and applications of these and other technologies are found throughout this textbook. By the end of their genetics course, students should come away with a greater appreciation for the influence of genetics in their lives.

SIGNIFICANT CONTENT CHANGES TO THE THIRD EDITION

- A new feature called ***Genetic TIPS*** was added to the second edition. Many of these problem-solving activitities have been refined based on student and instructor feedback.

Examples of Specific Content Changes to Individual Chapters

In addition to the usual updates to material based on new research information, other additions and changes to the third edition have been made, as described next.

- Chapter 5. Extensions of Mendelian Inheritance: A new section has been added that explores how development plays a role in producing certain traits. In particular, having dark fur on the back and white fur on the underside, a trait that is observed in certain breeds of dogs and other animals, is discussed in the context of the migration of melanocyte precursor cells during embryonic development (see Figure 5.13).
- Chapter 7. Genetic Linkage and Mapping in Eukaryotes: Based on student feedback, the discussion of linkage has been improved by increased emphasis on the description of how crossing over is related to the production of recombinant offspring and by the revision of certain figures (e.g., Figure 7.8).
- Chapter 10. Genetics of Viruses: New information about Zika virus has been added.
- Chapter 12. Molecular Structure of Chromosomes and Transposition: The discussion of the mechanism of bacterial chromosome compaction has been updated with a new figure (see Figure 12.3). The topic of transposable elements has been moved to this chapter because of their impact on chromosome structure and genome size.
- Chapter 13. DNA Replication and Recombination: Based on instructor feedback, the topic of homologous recombination has been added to this chapter so that it appears before many of the molecular topics in subsequent chapters.
- Chapter 14. Gene Transcription and RNA Modification: The topic of alternative splicing has been moved to this chapter so that it immediately follows the discussion of splicing.
- Chapter 17. Gene Regulation in Eukaryotes: The discussion of epigenetics has been expanded from one to three sections, which begins with an overview and then focuses on how epigenetic changes are programmed during development and how environmental factors cause epigenetic changes.
- *NEW!* Chapter 18. Non-Coding RNAs: In the past decade or so, technical advances have allowed researchers to identify and study the functions of RNA molecules that do not encode proteins. This new chapter has been added to this edition to focus on this critical topic in molecular genetics.
- Chapter 20. Molecular Technologies: Discussion of CRISPR-Cas technology for gene editing has been added to this chapter (see Figure 20.18), and the topics of reproductive cloning and stem cells have been moved to this chapter from a later chapter.
- Chapter 21. Genomics: The coverage of the topics of genomics and functional genomics has been streamlined and combined in this chapter. The relatively new method of RNA sequencing (RNA-Seq) has been added (see Figure 21.14).
- Chapter 22. Medical Genetics and Cancer: This chapter now covers the use of genome-wide association studies (GWAS) to identify genes associated with human diseases (see Figure 22.8). The section on the genetic basis of cancer has been subdivided into four sections: 22.4 Overview of Cancer, 22.5 Oncogenes, 22.6 Tumor-Suppressor Genes, and 22.7 Role of Epigenetics and Cancer.
- Chapter 24. Quantitative Genetics: The discussion of identifying genes involved in quantitative traits has been set apart in its own section.

SUGGESTIONS WELCOME!

It seems very appropriate to use the word *evolution* to describe the continued development of this textbook. I welcome any and all comments. The refinement of any science textbook requires input from instructors and their students. These include comments regarding writing, illustrations, supplements, factual content, and topics that may need greater or less emphasis. You are invited to contact me at:

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