PREFACE

Based on our 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 second edition of *Concepts of Genetics* a fun learning tool.

FLIPPING THE CLASSROOM

A relatively recent 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 over 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,* Second 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:

- ***NEW!* 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,* Second Edition, formative assessment is provided in multiple ways.

1. Each section of every chapter ends with multiple choice questions. Also, compared to the 1st edition, many chapters in the second edition are divided into more sections, which are shorter in length. 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. ***NEW!*** A new 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-***S***olving ***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. ***NEW!*** McGraw-Hill LearnSmart and SmartBook are adaptive learning tools available in Connect that have been proven 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 is oftentimes 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 24.) In addition, we have 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 second 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,* Second 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 25 and 26 examine population and quantitative genetics. The bulk of the molecular genetics is found in Chapters 11 through 24, 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 24 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 25 and 26. (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 24. Alternatively, if you like the "Molecular first" approach, you would probably cover Chapter 1, then skip to Chapters 11 through 24, then return to Chapters 2 through 10, and then cover Chapters 25 and 26 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.

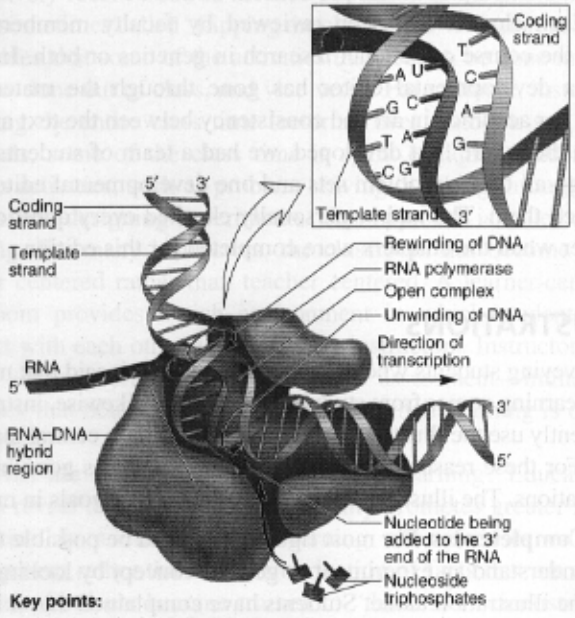
Each chapter has been reviewed by faculty members who teach the course or conduct research in genetics or both. In addition, a developmental editor has gone through the material to check for accuracy in art and consistency between the text and art. When they were first developed, we had a team of students work through all of the problem sets 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. I hope that no one looks at an element in any figure and wonders, "What is that thing?" 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 are introduced 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 exemplify 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 to 23 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 SECOND EDITION

- Each section of every chapter begins with learning outcomes and ends with multiple choice questions.
- As mentioned, a new feature called ***Genetic TIPS*** has been added within chapters and at the end of chapters to help students solve problems.

Examples of Specific Content Changes to Individual Chapters

- Chapter 1. Divided into a new section on the science of genetics; has an explanation of the new ***Genetic TIPS*** feature.
- Chapter 2. Chromosome Transmission during Cell Division and Sexual Reproduction: Improvement in the figures of mitosis and meiosis (see Figures 2.8 and 2.11).
- Chapter 3. Mendelian Inheritance: Divided into shorter sections that end in questions to help students gauge their understanding of Mendel's laws.
- Chapter 5. Extensions of Mendelian Inheritance: This revised chapter begins with an overview that compares different inheritance patterns, and then the inheritance patterns are placed in their own sections, which end with formative assessment questions. This approach should help students see the similarities and differences among the various patterns.
- Chapter 7. Genetic Linkage and Mapping in Eukaryotes: Contains a more concise presentation that focuses on plants and animals.
- Chapter 8. Variation in Chromosome Structure and Number: The 2nd edition contains a more streamlined presentation of Natural and Experimental Mechanisms That Produce Variation in Chromosome Number.
- Chapter 9. Genetics of Bacteria: Contains a new section on the medical relevance of bacterial gene transfer (Section 9.6).
- Chapter 10. Genetics of Viruses: Has a more concise presentation that focuses on viral structure, genetic composition, and reproductive cycles.
- Chapter 11. Molecular Structure of DNA and RNA: The four levels of DNA structure are introduced in an overview section and then the different levels of DNA structure are presented in their own sections, which are followed by formative assessment questions.
- Chapter 12. Molecular Structure and Organization of Chromosomes: Improvements have been made to several figures that depict chromatin structure (e.g., see Figure 12.15).
- Chapter 13. DNA Replication: The figure illustrating a three-dimensional view of DNA replication has been improved (see Figure 13.12).
- Chapter 14. Gene Transcription and RNA Modification: An improved figure has been added, which shows how sigma factor binds into the major groove (see Figure 14.6). A new section (Section 14.5) and summary table have been added at the end of the chapter that compares transcription and RNA modification between bacteria and eukaryotes.
- Chapter 15. Translation of mRNA: A new table has been added that describes how certain antibiotics inhibit translation (see Table 15.7).
- Chapter 17. Gene Regulation in Eukaryotes: Transcriptional Regulation. This chapter has a new section that focuses on epigenetic regulation (see Section 17.5).
- Chapter 18. Gene Mutation and DNA Repair: The figure concerning trinucleotide repeat expansion has been revised (see Figure 18.11).
- Chapter 19. Recombination, Immunogenetics, and Transposition: This is a new chapter that combines topics involving the breakage and rejoining of DNA segments. The figure concerning the function of transposase has been revised into a two-part figure, which shows how transposase causes the transposon to loop out (see Figure 19.10).
- Chapter 20. DNA Technologies: Based on reviewer feedback, the order of topics in this chapter has been revised. DNA sequencing and site-directed mutagenesis come directly after cloning methods.
- Chapter 21. Biotechnology: Various topics have been updated, such as the use of transgenic crops.
- Chapter 22. Genomics I: Analysis of DNA: A new section has been added on metagenomics (see Section 22.6).
- Chapter 23. Genomics II: Functional Genomics, Proteomics, and Bioinformatics: Includes updates to the topic of bioinformatics.
- Chapter 24. Medical Genetics and Cancer: This chapter ends with a new section on personalized medicine (see Section 24.6).
- Chapter 25. Population Genetics: The chapter now contains an overview of microevolution, and then natural selection, genetic drift, migration, nonrandom mating, and sources of new genetic variation are covered in their own separate sections.
- Chapter 26. Quantitative Genetics: This chapter in the 2nd edition presents a more streamlined view of how quantitative loci are mapped. A section on the general features of heritability precedes a section on selective breeding.

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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TEACHING AND LEARNING RESOURCES

Help Your Students Prepare for Class

Digital resources can help you achieve your instructional goals—making your students more responsible for learning outside of class by meeting your students where they live: on the go and online. Use the text and digital tools to empower students to come to class more prepared and ready to engage!

McGraw-Hill Connect® Genetics provides online presentation, assignment, and assessment solutions. It connects your students with the tools and resources they'll need to achieve success. With **Connect Genetics** you can deliver assignments, quizzes, and tests online. A robust set of questions and activities is presented in the Question Bank and a separate set of questions to use for exams is presented in the Test Bank. Every question is tagged to a Learning Outcome and genetics topic so you can customize your assignments to the course material. As an instructor, you can edit existing questions and author entirely new problems. Track individual student performance—by question, by assignment, or in relation to the class overall—with detailed grade reports. Integrate grade reports easily with Learning Management Systems such as Blackboard and Canvas—and much more. **Connect Genetics** provides students with 24/7 online access to *Concepts of Genetics,* Second Edition *eBook*. This media-rich version of the book is available through the McGraw-Hill Connect and allows seamless integration of text, media, and assessments.

Connect® Insight is a powerful data analytics tool that allows instructors to leverage aggregated information about their courses and students to provide a more personalized teaching and learning experience.

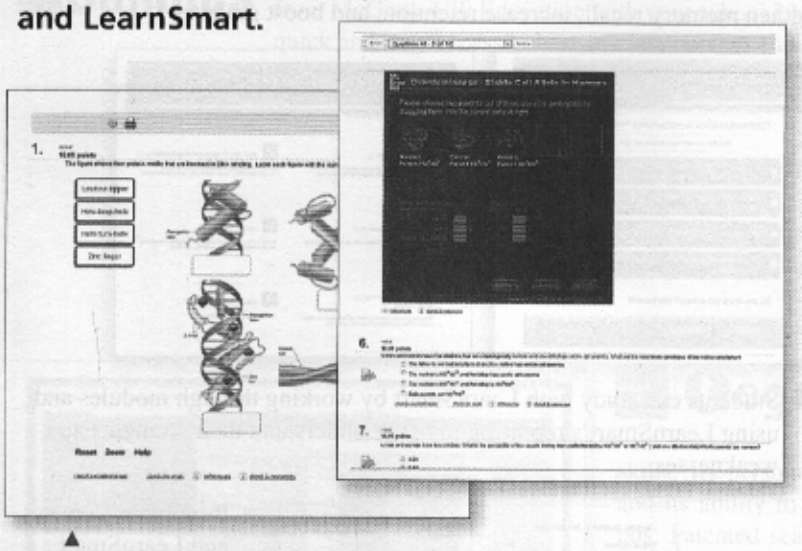
To learn more, visit **www.mcgrawhillconnect.com**.

Assignments can include reading assignments from the eBook or SmartBook, homework or quizzes, LearnSmart and SmartBook, your own web or short answer activities, and more.

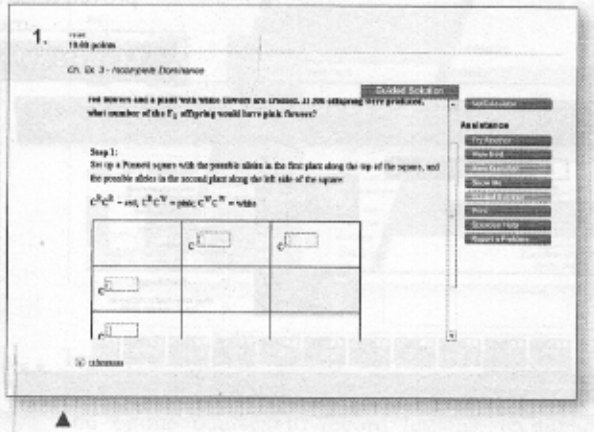
Help Your Students by Making Assignments—Reading, Homework, and LearnSmart

Connect content can be assigned as homework before class to help students with basic concepts so they can better understand classroom presentations and projects. Quizzes taken after class can also evaluate their comprehension. These assignments support the rich assessment presented in the text so that students and professors can gauge the level of understanding of concepts and the mastery of skills.

Help your students prepare for class and revisit content by assigning homework in Connect and LearnSmart.



▲ Interactive and traditional questions help assess your students' knowledge of the material. Having achieved a base level of knowledge, students will get more out of their time in class.

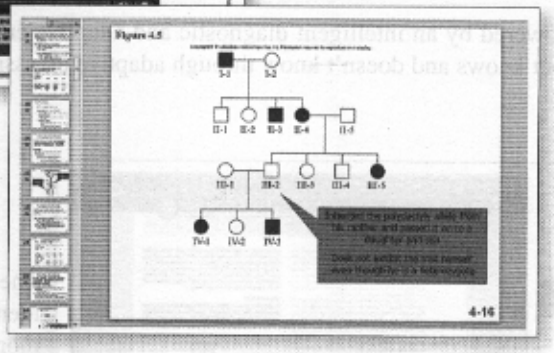


▲ Quantitative questions help you challenge your students to apply material they learn in class and in the book.

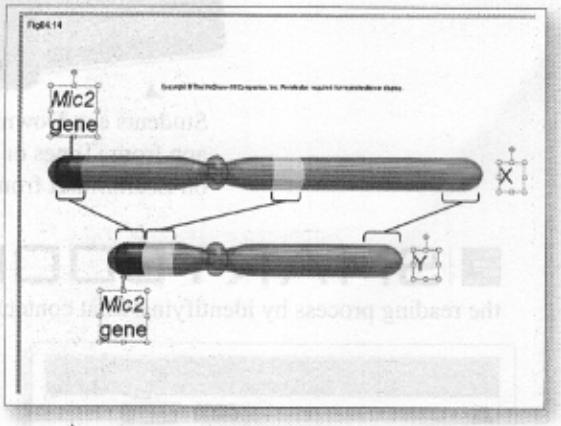
Presentation Tools

Within Connect, you will find presentation materials to enhance your class all in one place.

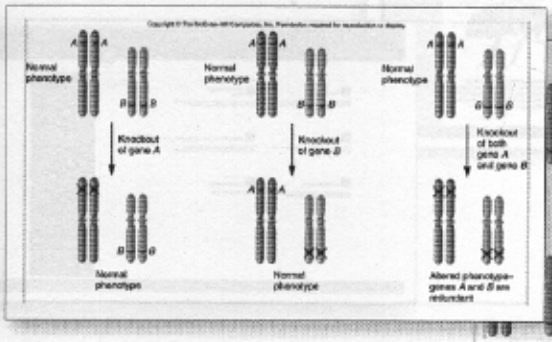
◄ Animation PowerPoints contain full-color animations illustrating important processes, which are fully embedded in PowerPoint slides for easy use in your presentations.

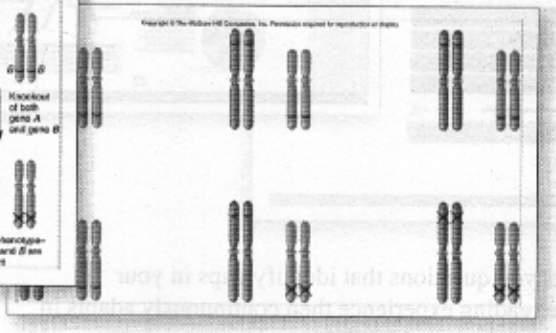


Lecture PowerPoints with animations fully embedded. ►



▲ FlexArt PowerPoints contain editable art from the text. For all figures, labels and leader lines are editable, and some figures also have editable or stepped-out art, allowing you to customize your PowerPoint presentations.

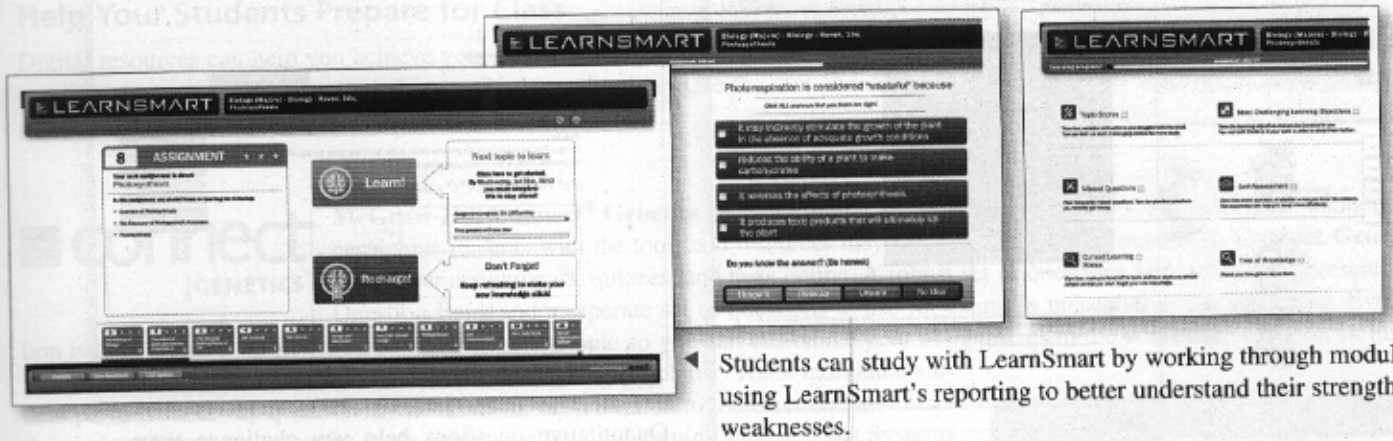




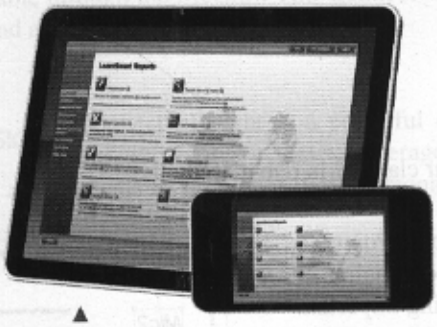
◄ Labeled and unlabeled JPEG files of all art and photos in the text to be readily incorporated into presentations, exams, or custom-made classroom materials.

LEARNSMART ADVANTAGE

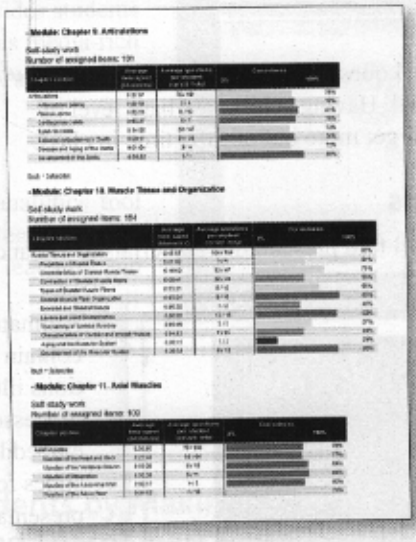
LearnSmart Advantage® is a new series of adaptive learning products including SmartBook fueled by LearnSmart—the most widely used adaptive learning resource proven to strengthen memory recall, increase retention, and boost grades.



Students can study with LearnSmart by working through modules and using LearnSmart's reporting to better understand their strengths and weaknesses.



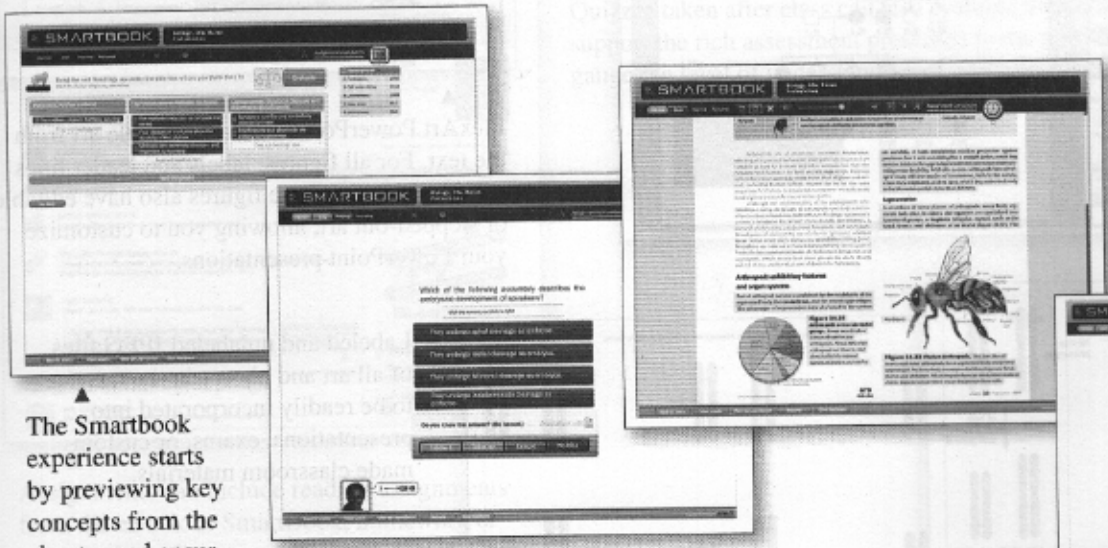
Students can Download the LearnSmart app from iTunes or Google Play and work on LearnSmart from anywhere!



Reports in Connect and LearnSmart help you monitor student assignments and performance, allowing for "just-in-time" teaching to clarify concepts that are more difficult for your students to understand.

SMARTBOOK

Powered by an intelligent diagnostic and adaptive engine, **SmartBook®** facilitates the reading process by identifying what content a student knows and doesn't know through adaptive assessments.

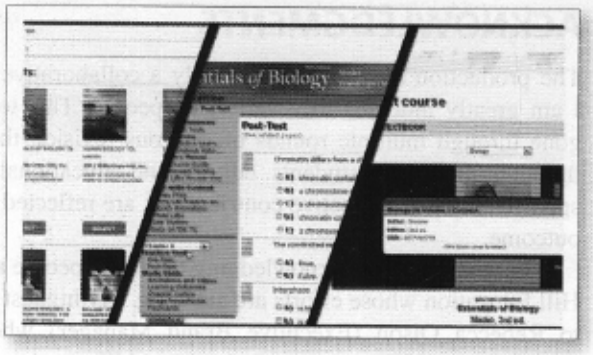


The Smartbook experience starts by previewing key concepts from the chapter and ensuring that you understand the big ideas.

SmartBook asks you questions that identify gaps in your knowledge. The reading experience then continuously adapts in response to the assessments, highlighting the material you need to review based on what you don't know.

The reports in SmartBook help identify topics where you need more work.

Campus MH Campus® integrates all of your digital products from McGraw-Hill Education with your school LMS for quick and easy access to best-in-class content and learning tools.



Tegrity Tegrity Campus is a fully automated lecture capture solution used in traditional, hybrid, "flipped classes" and online courses to record lessons, lectures, and skills. Its personalized learning features make study time incredibly efficient, and its ability to affordably scale brings this benefit to every student on campus. Patented search technology and real-time LMS integrations make Tegrity the market-leading solution and service. More than just a recorded lecture, Tegrity lets you search and bookmark content, take notes, and work with fellow classmates in order to make learning incredibly efficient.

ACKNOWLEDGMENTS

The production of a textbook is truly a collaborative effort, and I am greatly indebted to a variety of people. This textbook has gone through multiple rounds of rigorous revision that involved the input of faculty, students, editors, and educational and media specialists. Their collective contributions are reflected in the final outcome.

Let me begin by acknowledging the many people at McGraw-Hill Education whose efforts are amazing. My highest praise goes to Rebecca Olson (Executive Brand Manager) who managed many aspects of this project. I also would like to thank Elizabeth Sievers (Director of Development–Biology), for her patience in overseeing this project and her contributions to the digital components. Other people at McGraw-Hill have played key roles in producing an actual book and the supplements that go along with it. In particular, Jayne Klein (Content Project Manager) has done a superb job of managing the components that need to be assembled to produce a book. I would also like to thank John Leland (Content Licensing Specialist), who acted as an interface between me and the photo company. In addition, my gratitude goes to David Hash (Designer), who provided much input into the internal design of the book as well as creating an awesome cover. Finally, I would like to thank Patrick Reidy (Marketing Manager), whose major efforts begin once the book is published!

With regard to the content of the book, Deborah Brooker (Freelance Developmental Editor) has worked closely with me in developing the art for this textbook. She has scrutinized each figure for clarity and logic. I would also like to thank Kevin Campbell (Freelance Copy Editor) for making grammatical improvements throughout the text and art, which has significantly improved the text's clarity.

I would also like to extend my thanks to everyone at SPI Global, including the many artists who have played important roles in developing the art for this textbook. Also, the folks at SPI Global worked with great care in the paging of the book, making sure that the figures and relevant text are as close to each other as possible. Likewise, the people at Photo Affairs, inc. have done a great job of locating many of the photographs that have been used in this textbook.

Finally, I want to thank the many scientists who reviewed the chapters of this textbook. Their broad insights and constructive suggestions were an important factor that shaped its final content and organization. I am truly grateful for their time and effort.

REVIEWERS

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