BIOLOGICAL SCIENCE

SEVENTH EDITION

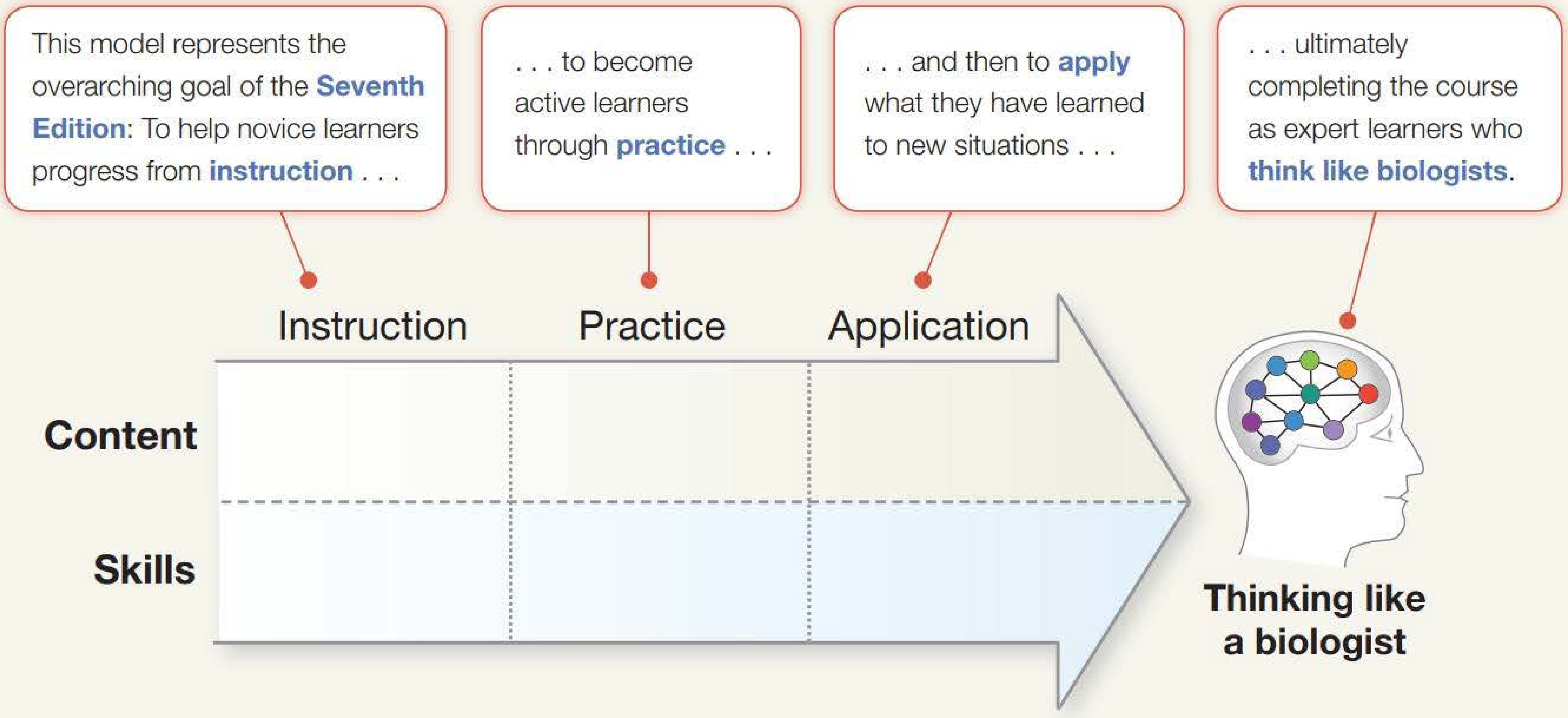
FREEMAN

QUILLIN ALLISON BLACK PODGORSKI TAYLOR CARMICHAEL

Brief Contents

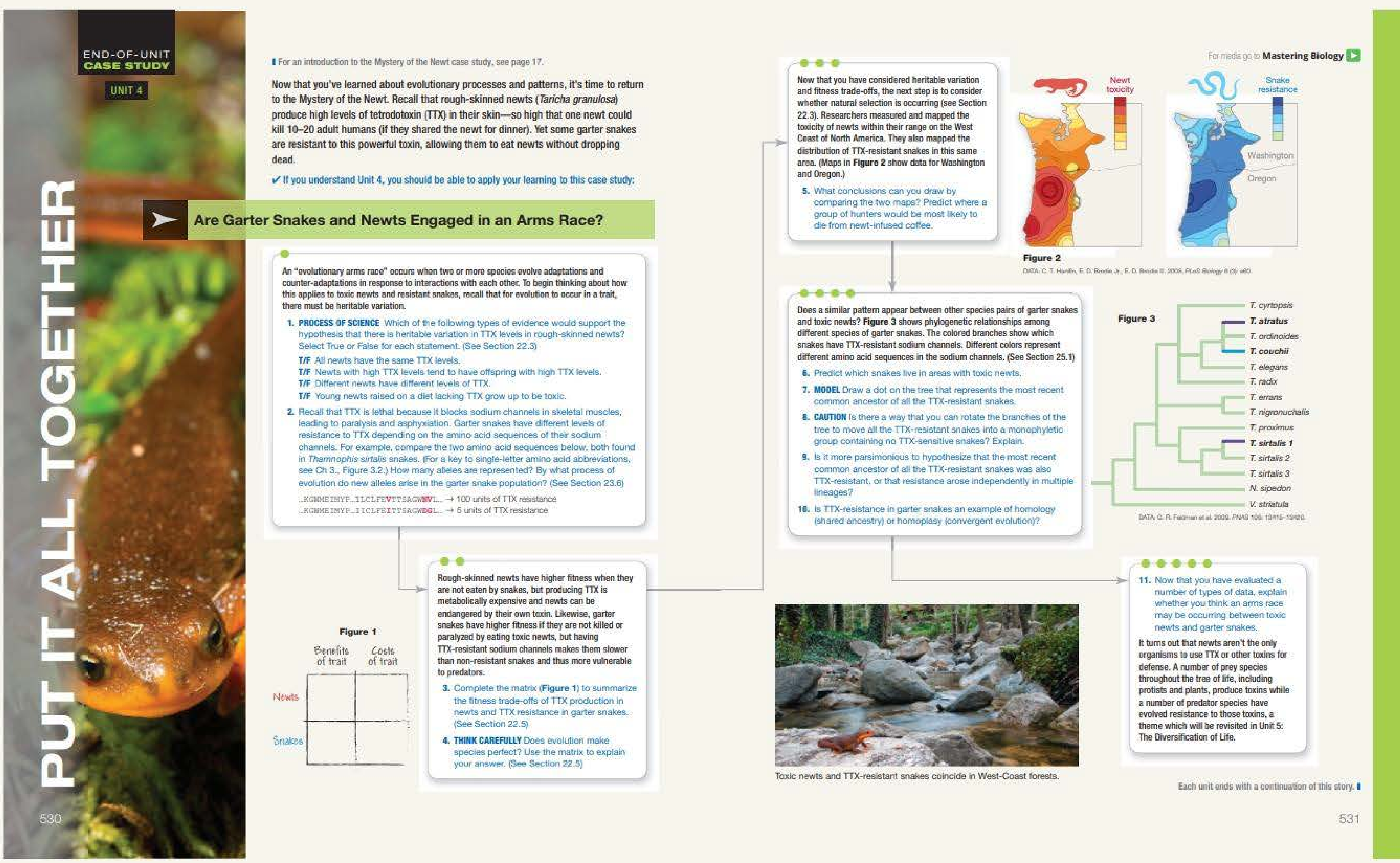
Discover Biology, Develop Skills, and Make Connections

Since its trailblazing First Edition, *Biological Sciences* has delivered numerous biology teaching innovations that emphasize higher-order thinking skills and conceptual understanding rather than an encyclopedic grasp of what is known about biology. Central to this shift is a student-centered approach that provides support for mastering core content and developing skills that help students learn and practice biology.

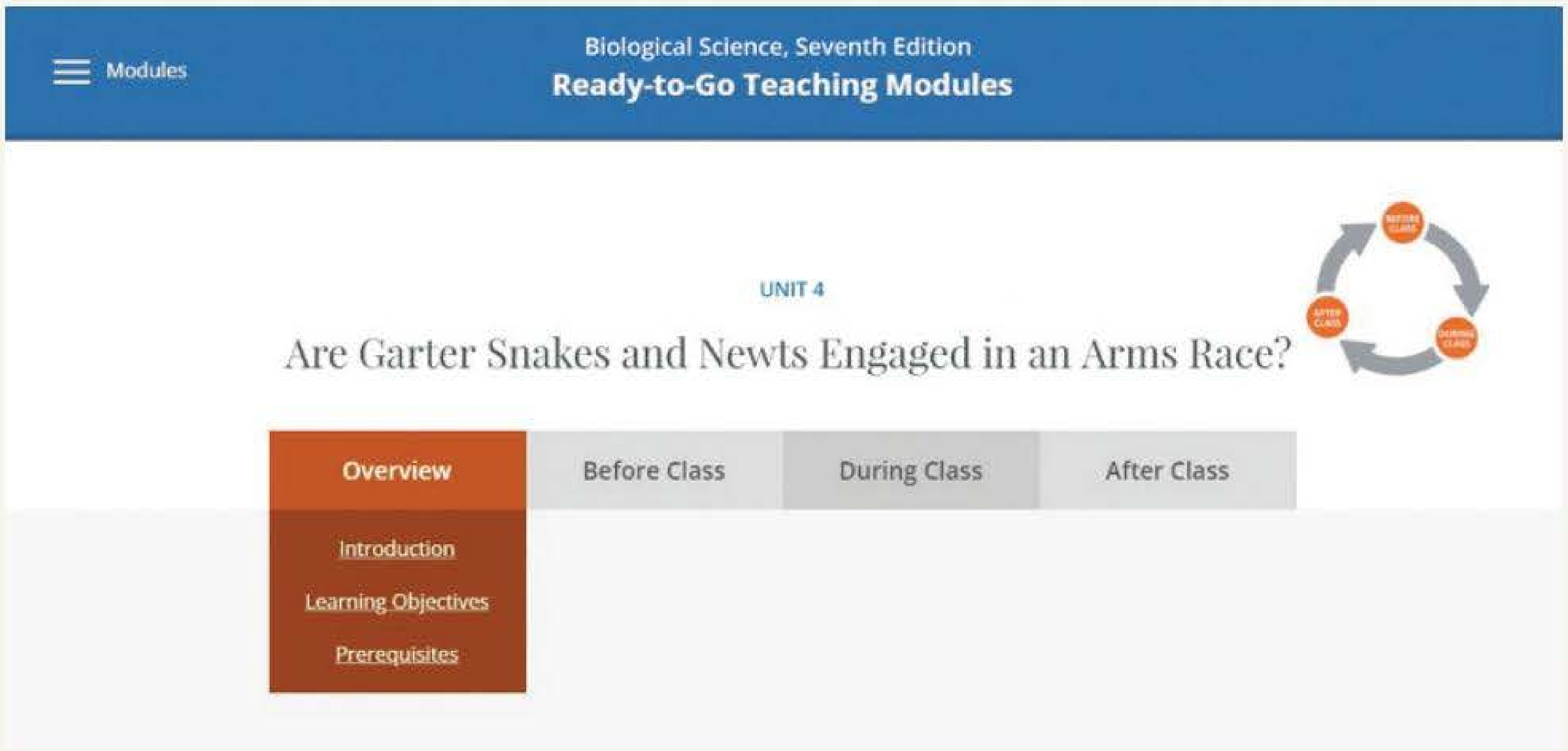


Making Connections Through

NEW Integrative End of Unit Case Study is introduced following Chapter 1. Each unit concludes with a 2-page spread that continues the story, guiding students through an exploration of key biological elements and scientific data. A unifying story about the evolutionary arms race between newts and garter snakes unfolds to illustrate how biology concepts and the various sub-disciplines of biology are connected across multiple levels from molecules, cells, and genetics to evolution and diversity, physiology, and ecology. Materials in Mastering Biology support in-class and out-of-class activities.



Every Chapter and Unit



NEW The **End-of-Unit Case Studies** are supported by **Ready-to-Go Teaching Modules** in Mastering Biology that provide pre- and post-class assignments as well as a wealth of ideas for in-class activities. These resources will help enliven your class time and provide students with opportunities to apply what they are learning.

Updated **"Put It All Together" Case Studies** appear at the end of every chapter and provide a sample of contemporary biology research in action. Each case study poses questions that help students connect what they learn in class with current, real-world biology research. At least one question requires students to analyze real data or apply quantitative skills.

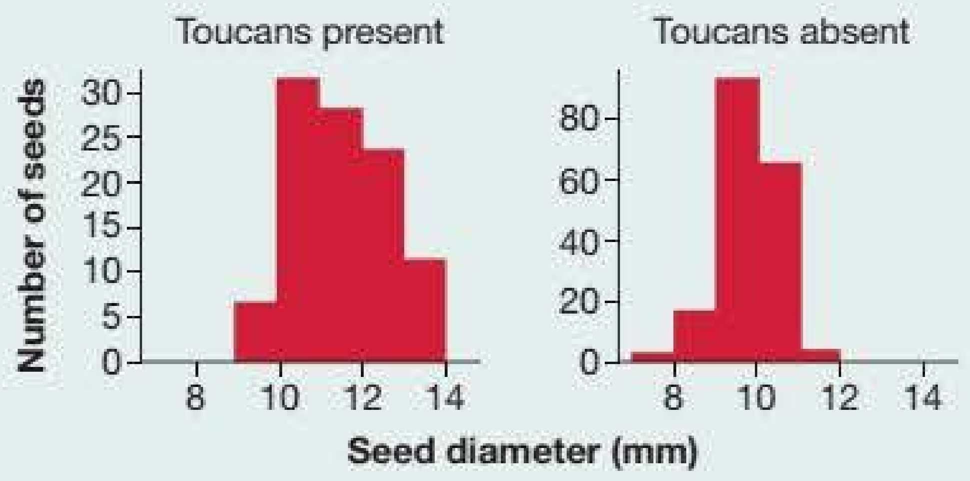
✓PUT IT ALL TOGETHER: Case Study

Are toucans important to tropical forests?

Human activities are causing the fragmentation of the Brazilian Atlantic rain forest. One result is that toucans have become extinct or nearly extinct in some of the forest fragments. Does the absence of toucans affect the forest?

11. Toucans disperse seeds of key forest species such as juçara palms by eating the fruit and defecating the seeds in new locations, sometimes more than a kilometer away. If there are no toucans, is the genetic diversity of palms likely to increase or decrease within forest fragments? Why?
a. increase (due to increased genetic drift)
b. decrease (due to decreased gene flow)
c. decrease (due to decreased mutation rate)
d. decrease (due to decreased natural selection)

12. QUANTITATIVE Toucans can eat fruits with large seeds because their large bills can open wide. Most other birds in the same forest can only eat small seeds. Ecologist Mauro Galetti and his colleagues measured the seed sizes of palms in forest fragments with and without toucans. The graphs show two of the forest populations they studied. What is the take-home message of the data?



Source: M. Galetti, R. Guevara, and M. C. Côrtes, et al. 2013. *Science* 340: 1086–1090.

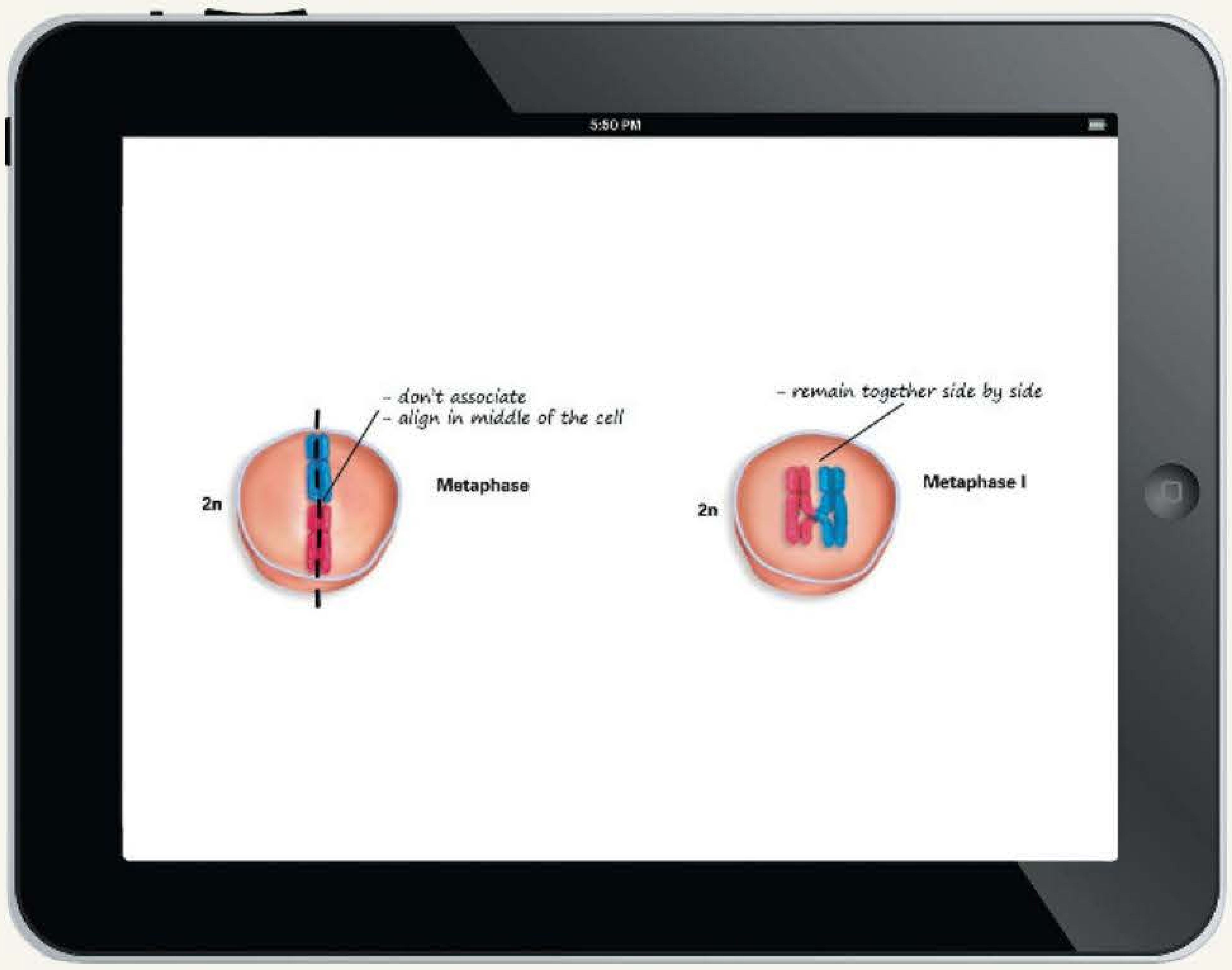
13. Do these data illustrate directional, stabilizing, disruptive, or balancing selection? Justify your answer in terms of fitness.

14. Large seeds carry more resources than small seeds and tend to have a higher rate of survival, especially after being dispersed by a bird. Predict how the local extinction of toucans will affect the palm population over time.

15. PROCESS OF SCIENCE The data in the graphs are from two of the 22 forest fragments studied by the researchers: 7 with toucans present, 15 with toucans absent. Why do you think the researchers bothered to study so many forest fragments?

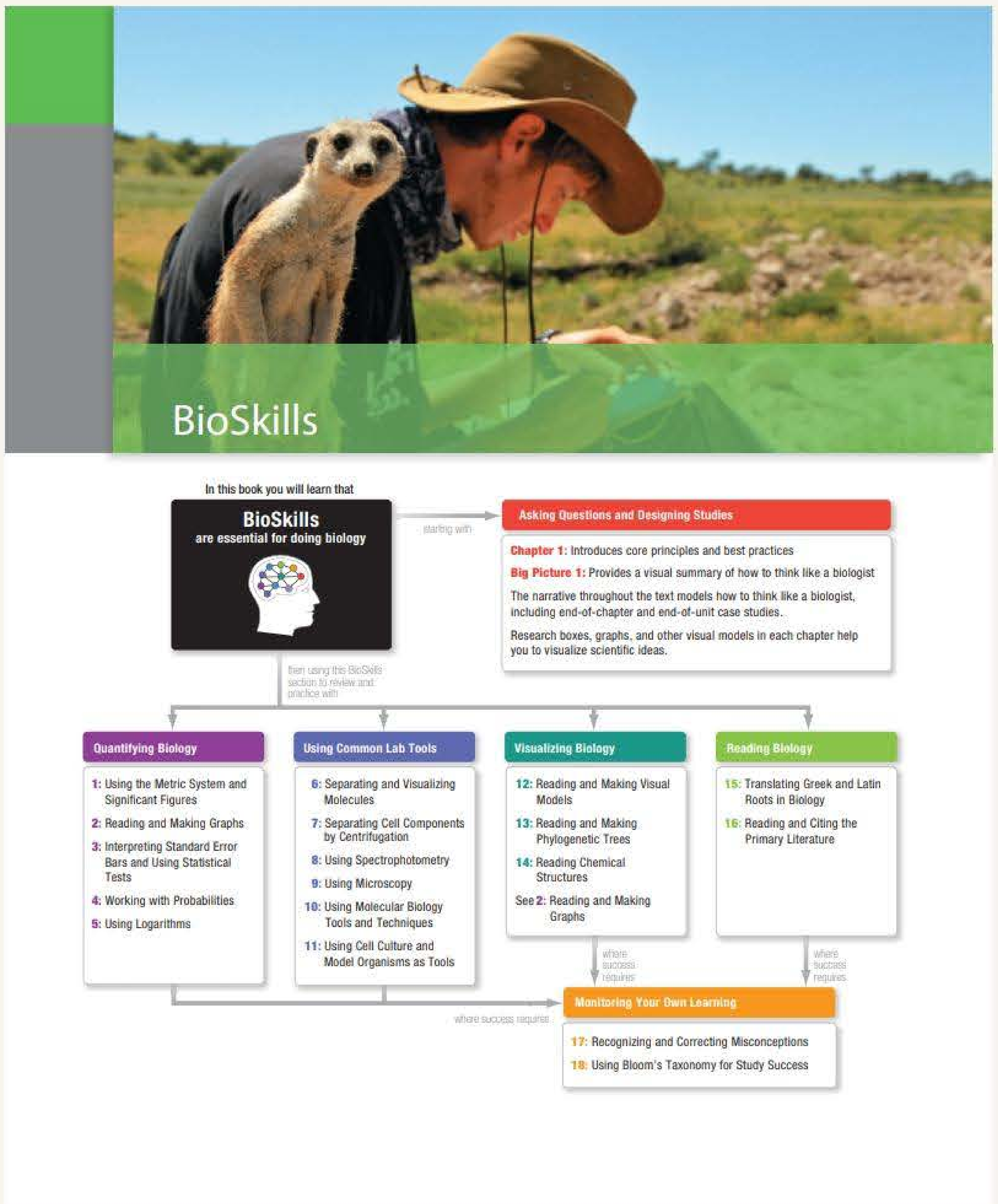
16. SOCIETY If you were a journalist covering this story, how could you use data from this study to respond to the following social media post? "Evolution is a slow process. Humans do not cause evolution in other organisms."

Developing Skills with



NEW 24 Interactive Figures with Walkthrough Videos help students develop skills to interpret figures, as well as develop a better understanding of key concepts. Figure Walkthrough Videos are embedded in Pearson eText for viewing at the initial point of learning and also assignable in Mastering with questions that help students practice working with visuals.

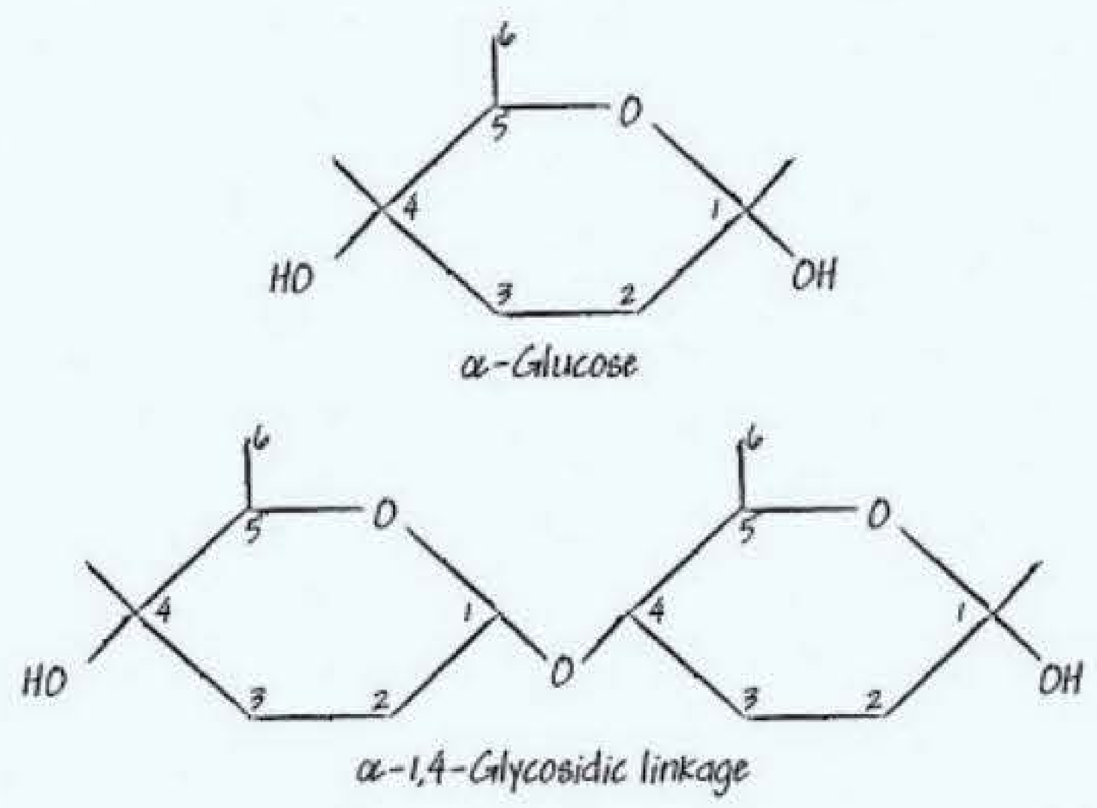
The **BioSkills** reference section appears between Chapters 1 and 2, drawing attention to key skills students need to succeed in biology. This compendium of easy-to-find reference material supports skill development throughout the course. Each BioSkill includes practice exercises in the book, questions in the Study Area of Mastering, and assignable, skill-reinforcing activities in Mastering.



Interactive and Engaging Content

Making Models 5.1 Tips on Drawing Carbohydrates

Drawing simple models is the best way to understand the structures of monosaccharides and glycosidic linkages. In these models, focus on the overall shape of each monomer and how the monomers' carbons are numbered. You can keep the drawings simple by showing only the hydroxyl groups on the carbons being linked together, as in these examples based on α-glucose:



MODEL Use the examples above and Figure 5.4b to draw simplified models of a β-glucose monosaccharide and a β-glucose disaccharide with a β-1,4-glycosidic linkage.

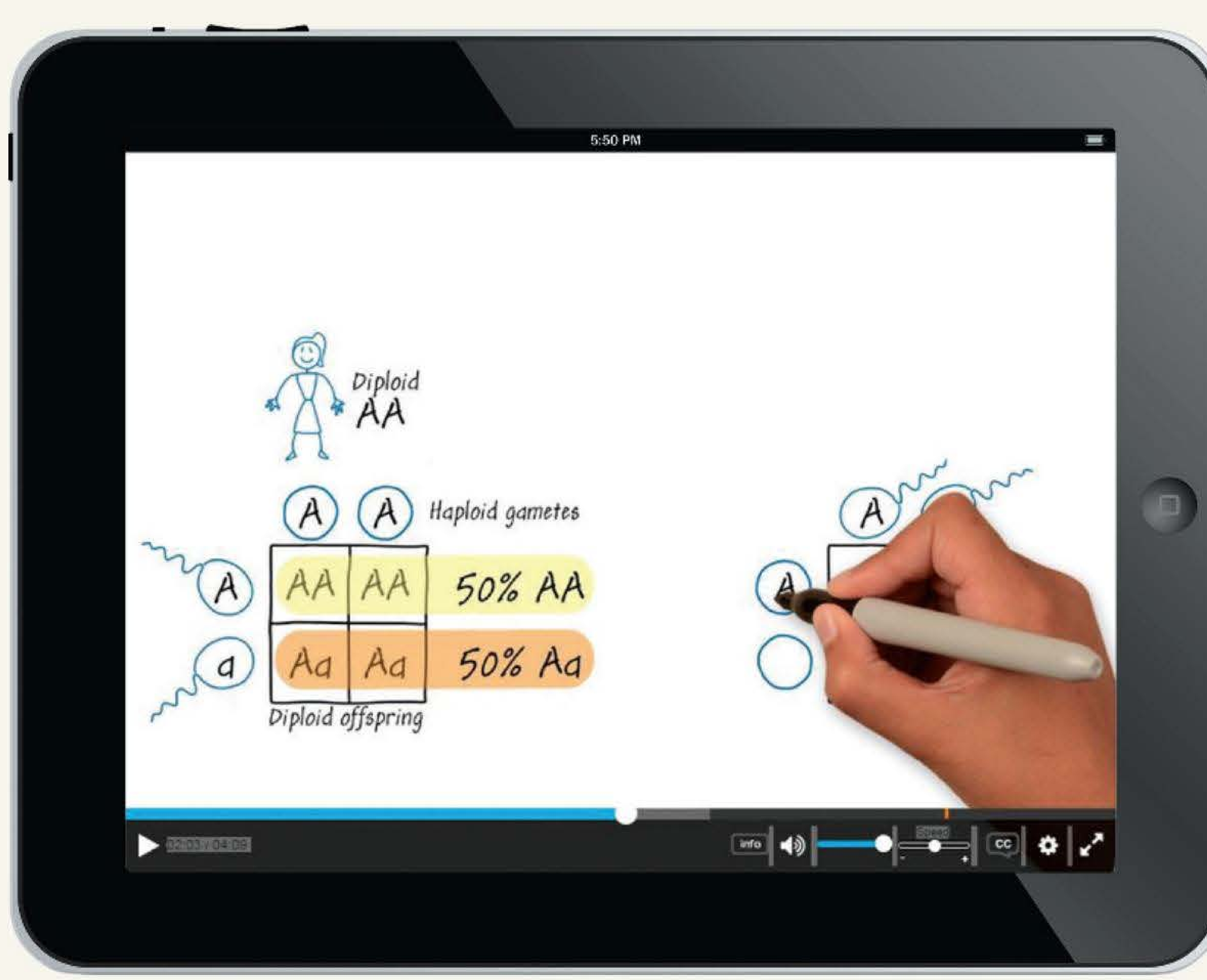
To see this model in action, go to the Study Area of **Mastering Biology**

Making Models boxes explicitly teach students how to use visual models to learn and do biology. 45 boxes throughout the book guide students in deepening their understanding of modeling and of biology concepts. Making Models are also available for self-study in the Study Area and assignable with questions in Mastering.

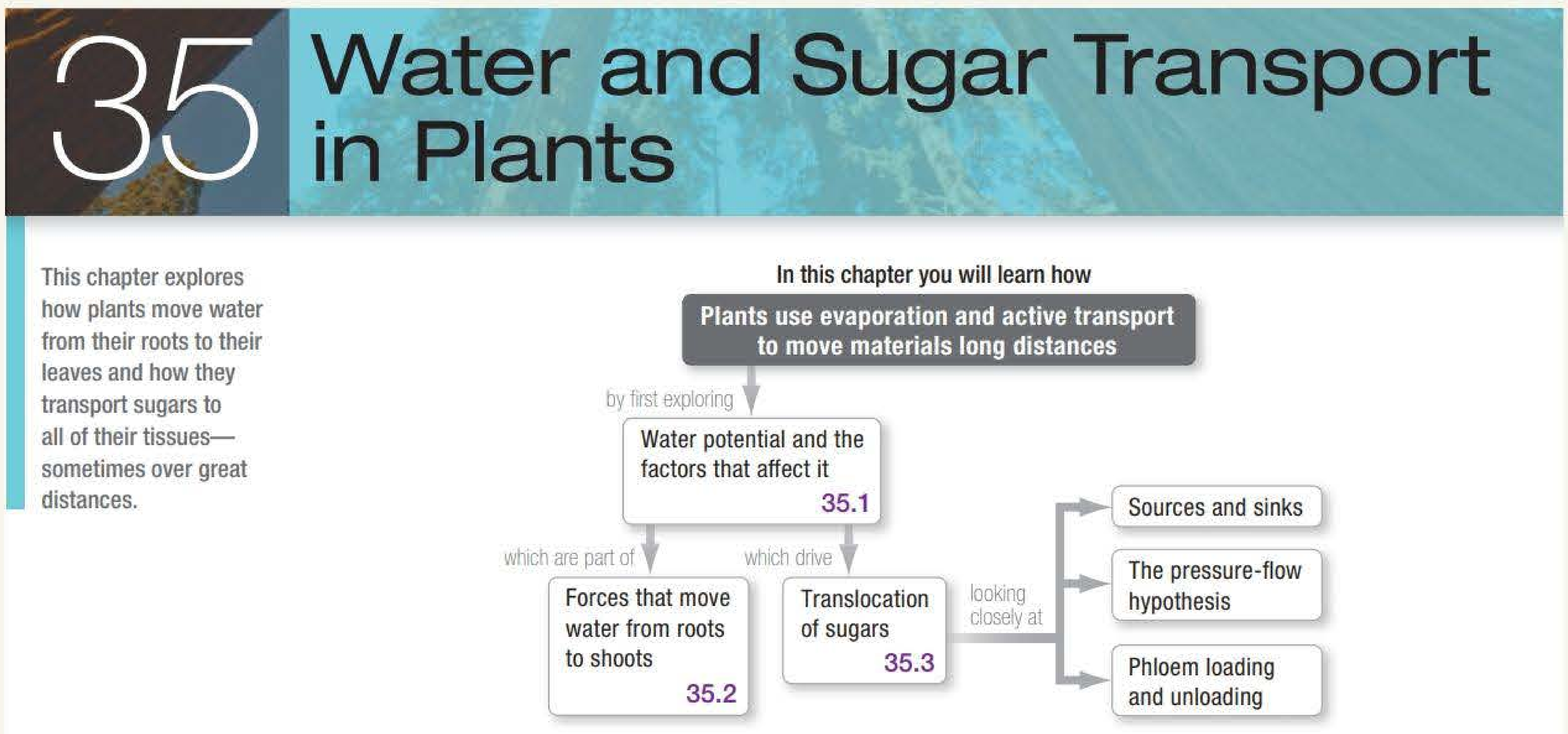
3 NEW Making Models boxes are:

- Ch. 5: Tips on Drawing Carbohydrates
- Ch. 40: Tips on Drawing Arrows
- Ch. 48: Tips on Drawing Immune System Processes

Dynamic whiteboard videos support each **Making Models** box, bringing the modeling activity to life and helping students better understand how to interpret and build models. The videos are embedded in the eText, available in the Study Area, and assignable as homework in Mastering Biology.

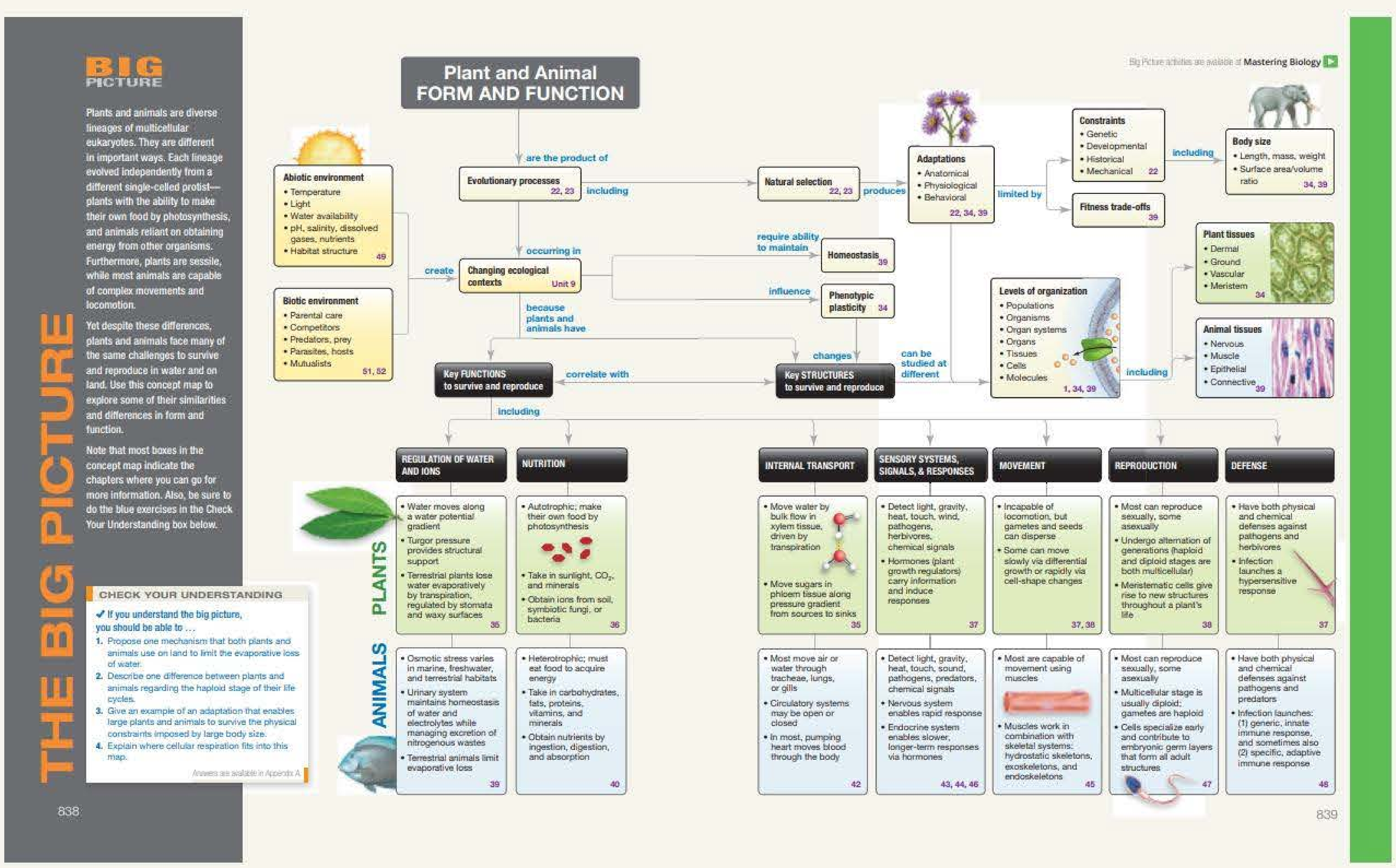


Guiding Students to Learning



Unique **Chapter-Opening Road-maps** set the table for learning by visually group-ing and organizing information to help students anticipate key ideas as well as recognize meaning-ful relationships and connections that are explored in the chapter that follows.

Big Picture Concept Maps help students review key ideas. Words and visuals are integrated in these 2-page spreads to help students synthesize information about challenging topics that span multiple chapters or units. Accompanying question sets encourage students to analyze important patterns within each Big Picture. Mastering Biology provides related mapping activities and questions to help students work on higher order problems.



and Increasing Engagement

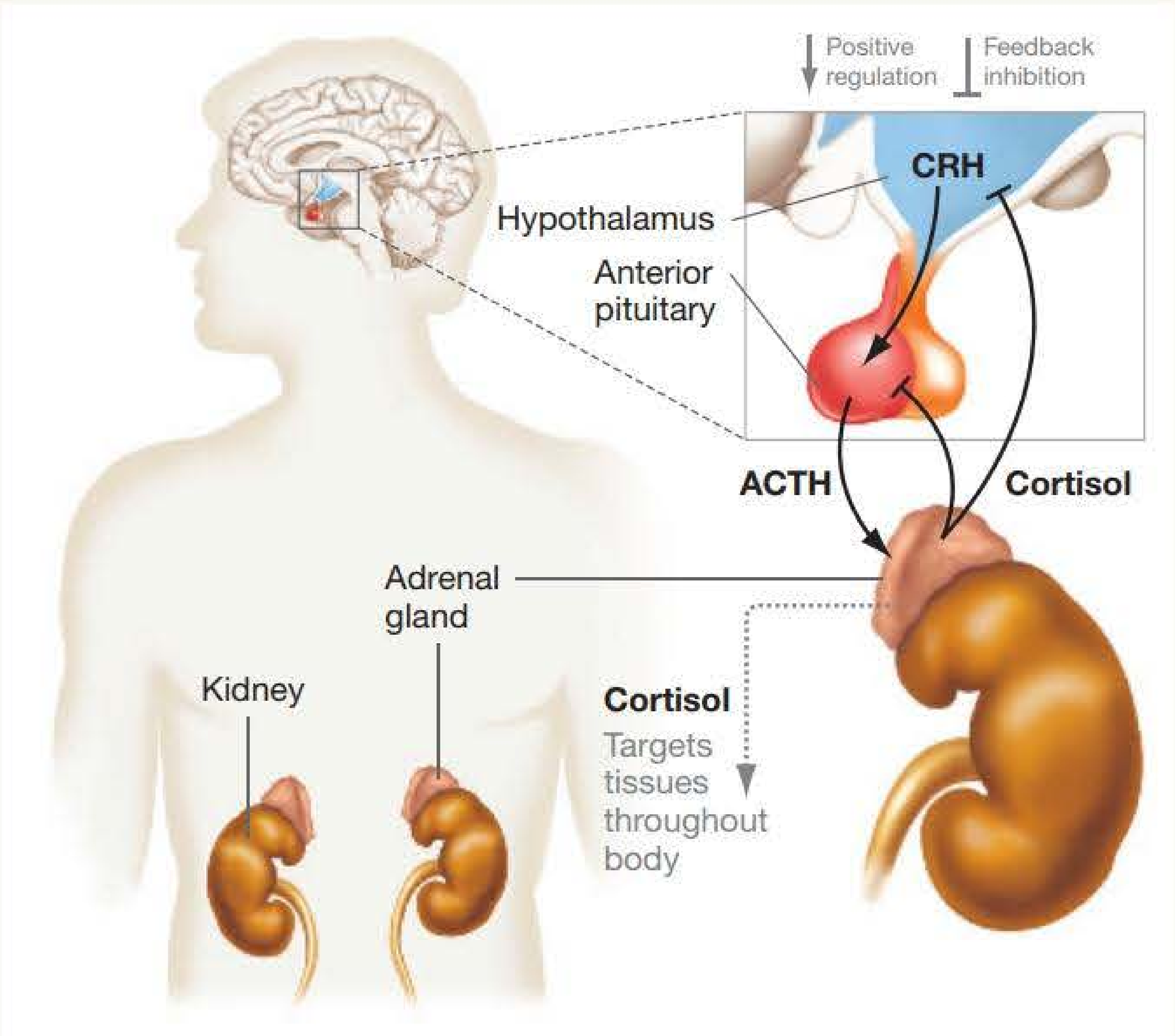


Figure 46.14 **The Interaction between Cortisol, ACTH, and CRH Is an Example of Negative Feedback.**

✔ **PROCESS OF SCIENCE** Use the figure to devise a test for adrenal failure in humans.

Hallmark **Blue-Thread** questions throughout the text encourage students to engage with content, think like biologists, and monitor their learning. There are a variety of question types throughout the text to help students retrieve and apply information and practice skills at all cognitive levels of Bloom's taxonomy.

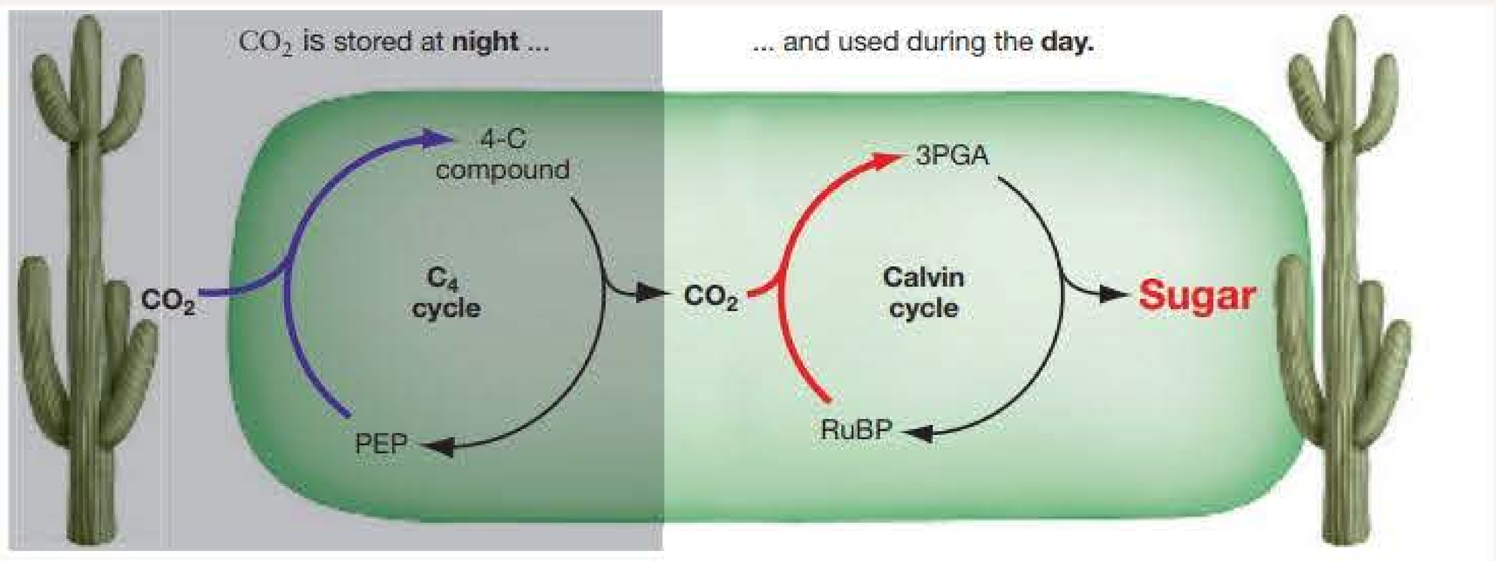
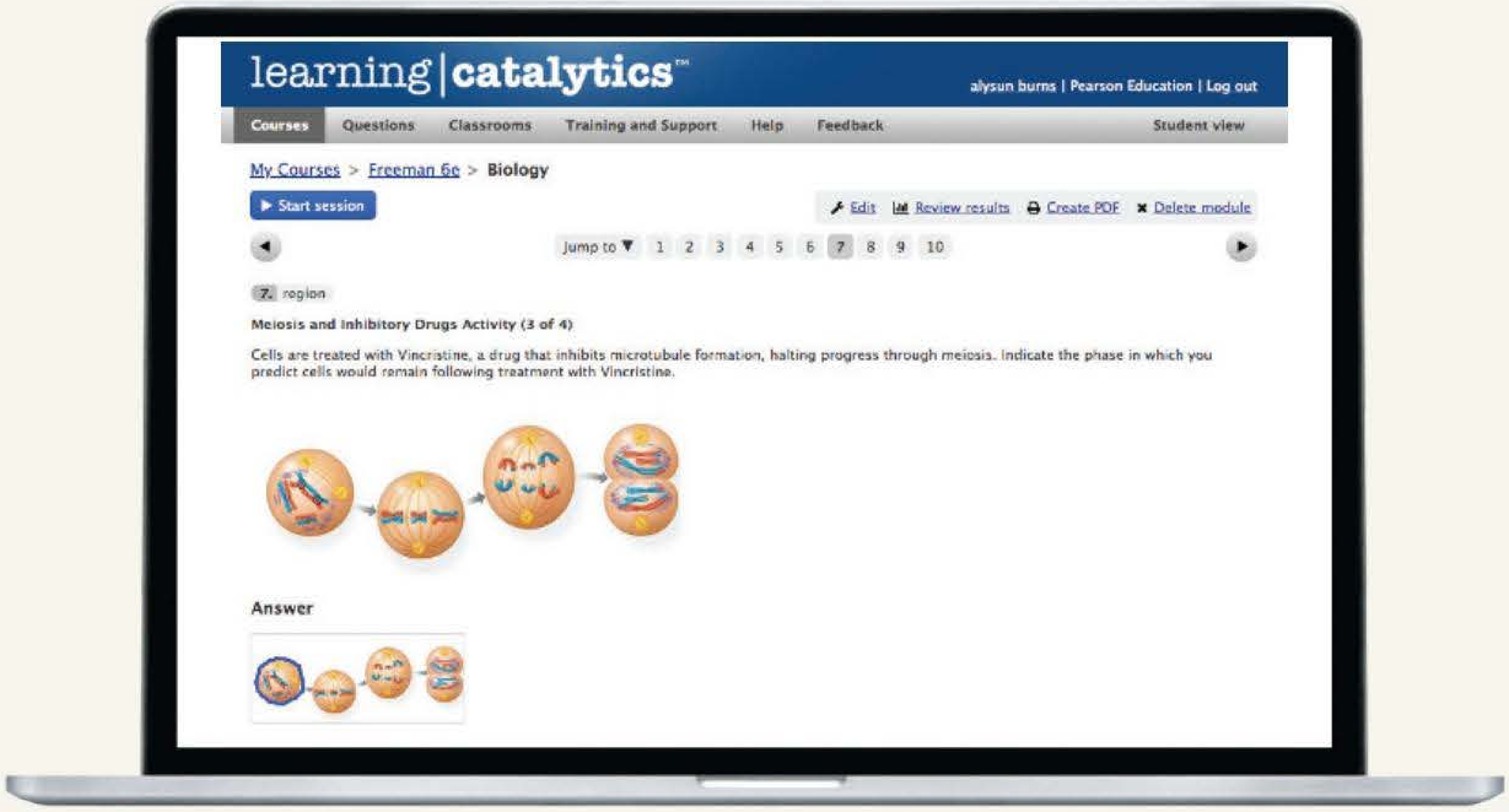


Figure 10.25 **In CAM Plants, Carbon Fixation Occurs at Night and the Calvin Cycle Occurs during the Day.**

✔ At what part of the day would there be the highest concentration of four-carbon organic acids in the vacuoles of CAM plants?

Hear from every student with **Learning Catalytics**. Utilizing a variety of question types, students recall ideas, apply concepts, and develop critical-thinking skills. Students respond using smartphones, tablets, or laptops. Responses are monitored in real-time and allow you to see what your students do—and don't—understand. Instructors can create their own questions, draw from community content, or access Pearson's library of question clusters. Focused on key topics, the clusters consist of 2-5 questions about a single data set or scenario.



Multiple Levels of Assessment

24.1 How Are Species Defined and Identified?

If your friend tells you she's planning to study polar bears and grizzly bears for her summer research project, you'd likely know that these animals are distinct species. But what if your friend is going to compare forest elephants and savanna elephants of Africa? Are they the same species or two different species?

Evolutionary biologists have been wrangling with the definition of species for decades—how can you reliably distinguish two or more species of bears, elephants, or bacteria in the field or fossil record? Although there is no single, universal answer, scientists do agree there is a distinction between the *general definition* of a species and the criteria used in the *practical identification* of species in particular cases.

After you complete this section, you should be able to . . .

- Compare mechanisms of reproductive isolation.
- Compare the advantages and disadvantages of different species concepts.

NEW Learning Objectives at the beginning of every section make it clear what fundamental content students should expect to learn and how they should be able to apply that knowledge.

Check Your Understanding Questions at the end of every section are tightly aligned to the learning objectives for the section.

CHECK YOUR UNDERSTANDING

✔ **If you understood this section, you should be able to . . .**

1. Predict which mechanism of reproductive isolation played a role in trumpeter speciation in the Amazon basin. Note: Trumpeters cannot fly across large rivers.
2. Determine which species concept(s) could be used to identify the number of trumpeter species in the Amazon.

Answers are available in Appendix A.

Steps to Building Understanding

Each chapter ends with three groups of questions that build in difficulty

✔ **TEST YOUR KNOWLEDGE**

Begin by testing your basic knowledge of new information.

✔ **TEST YOUR UNDERSTANDING**

Once you're confident with the basics, demonstrate your deeper understanding of the material.

✔ **TEST YOUR PROBLEM-SOLVING SKILLS**

Work towards mastery of the content by answering questions that challenge you at the highest level of competency.

End-of-Chapter Questions are organized in three levels–Test Your Knowledge, Test Your Understanding, and Test Your Problem-Solving Skills–so students can build from lower- to higher-order cognitive levels of assessment.

Help Students Learn and Practice

Blue Thread questions, throughout the text and figures, help students gauge their learning.

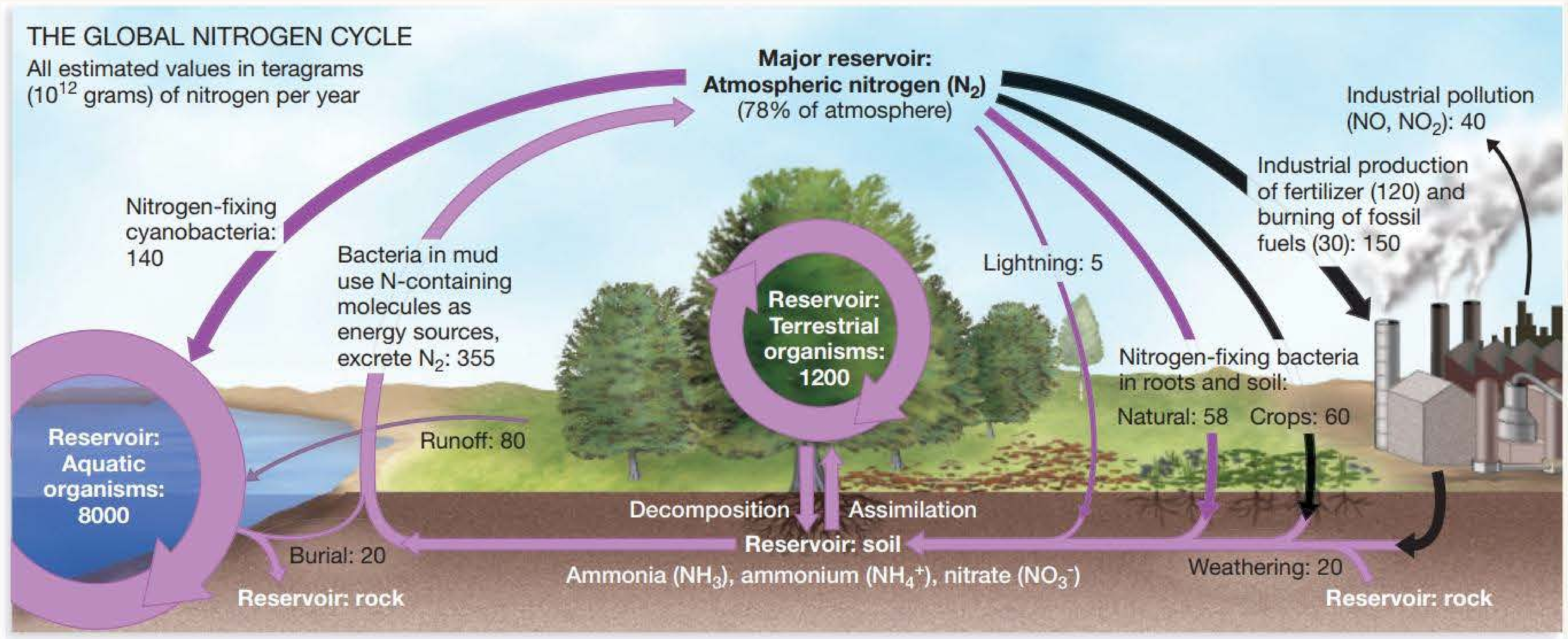


Figure 53.15 The Global Nitrogen Cycle. Nitrogen enters ecosystems as ammonia or nitrate via fixation from atmospheric nitrogen. It is exported in runoff and as nitrogen gas given off by bacteria.

DATA: D. Fowler et al. 2013. *Philosophical Transactions of the Royal Society B* 368 (1621): 20130165.

✔ **QUANTITATIVE** Calculate the percentage of total nitrogen fixation (all downward-pointing arrows) that is caused by human activities (black arrows).

Chapter Assessment Grids help instructors quickly identify suitable assessment questions in the text according to learning outcomes, Bloom's taxonomy level, core concepts and core competencies discussed in the *Vision and Change in Undergraduate Biology Education* report, and when, applicable, common misconceptions.

BLOOMS TAXONOMY RANKING

"Blue Thread" questions, including end-of-chapter problems, are ranked according to **Bloom's taxonomy** and are assignable in Mastering Biology.

LEARNING OUTCOMES

Each question is tagged to a publisher-provided **Learning Outcome**. Instructors may also track their own Learning Outcomes using Mastering Biology.

MISCONCEPTIONS

When applicable, **common student misconceptions** are addressed and identified with targeted questions.

VISION & CHANGE CORE CONCEPTS

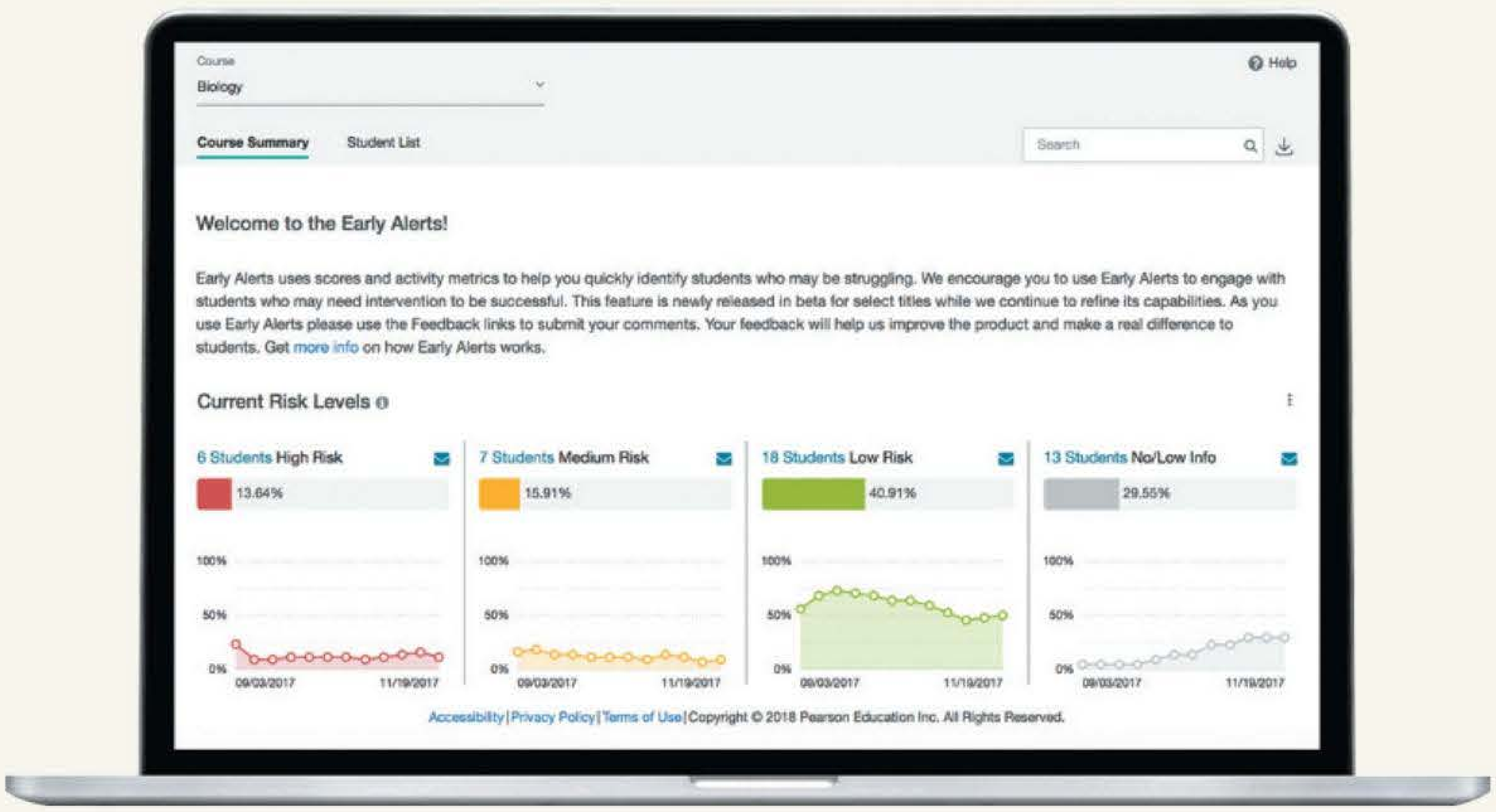
Each question that covers a **Core Concept** from the *Vision and Change in Undergraduate Biology Education* report is noted in the chapter assessment grid and in Mastering Biology.

VISION & CHANGE CORE COMPETENCIES

Core Competencies from the *Vision and Change in Undergraduate Biology Education* report are indicated in the chapter assessment grid and in Mastering Biology.

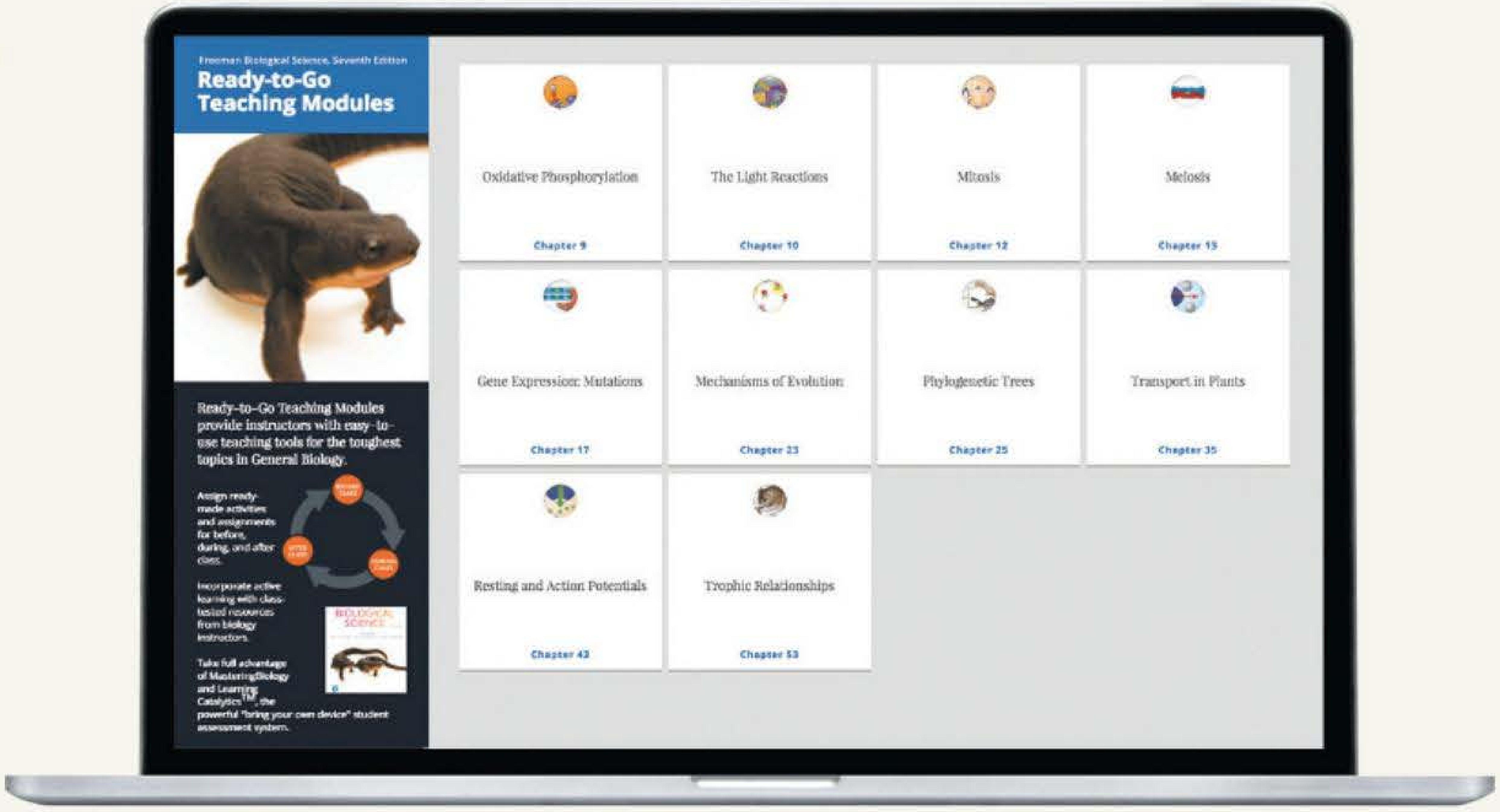
Succeeding with Mastering Biology

Mastering Biology is the teaching and learning platform that empowers you to reach every student. By combining trusted author content with digital tools developed to engage students and emulate the office-hour experience, Mastering personalizes learning and improves results for each student.

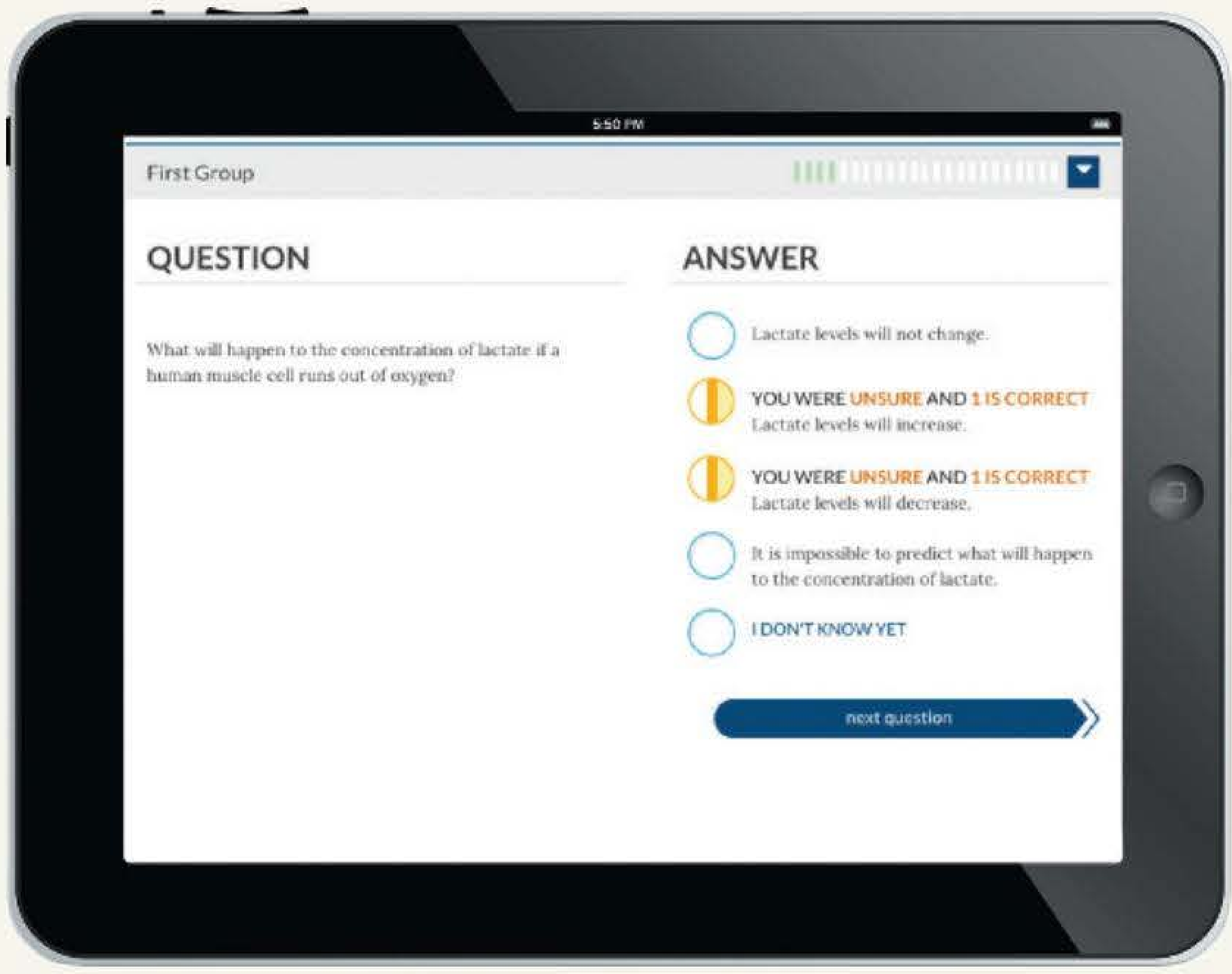


NEW Early Alerts in Mastering Biology uses scores and behavioral data to help instructors identify individual students at risk of not performing well in the course. This insight enables instructors to provide informed feedback and support at the moment struggling students need it so they can stay—and succeed—in the course.

Ready-To-Go Teaching Modules offer prepared teaching tools for use before, during, and after class, including ideas for in-class active learning. The modules incorporate the best that the text, Mastering Biology, and Learning Catalytics have to offer and can be accessed through the Instructor Resources area of Mastering Biology.

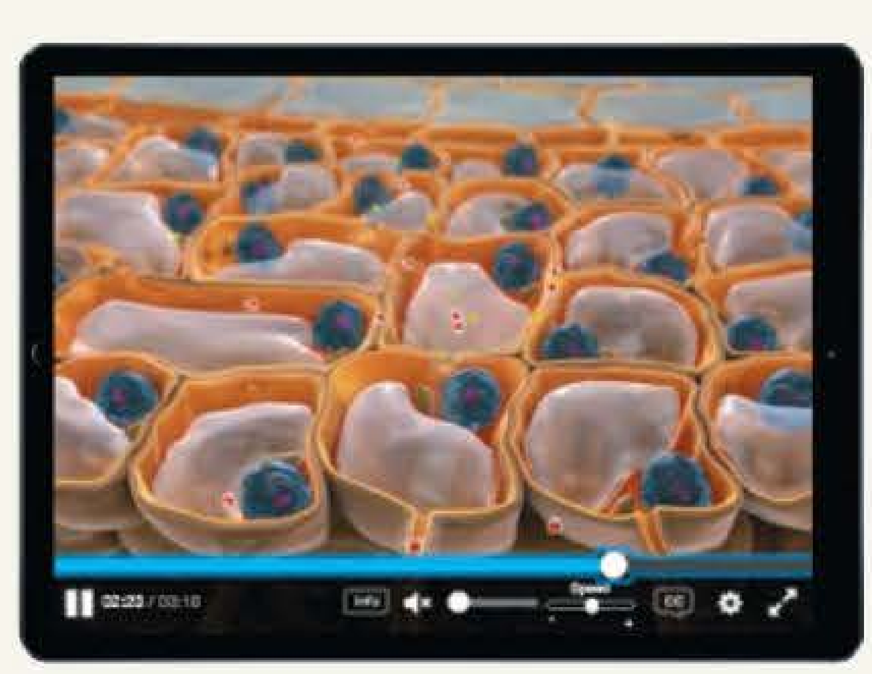


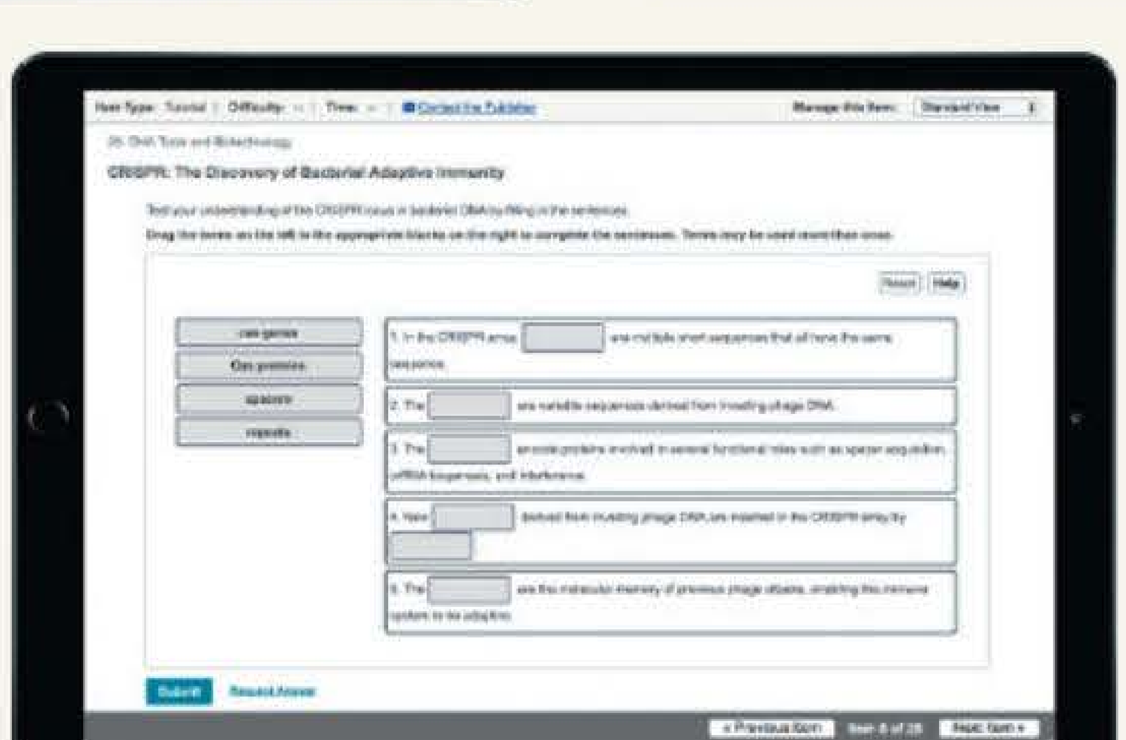
Personalizing Learning and the Classroom



Dynamic Study Modules, based on the latest developments in cognitive science, adapt to student performance in real time to help students study course topics. As a result, students build the confidence they need to deepen their understanding, participate meaningfully, and perform better—in and out of class. Available on smartphones, tablets, and computers.

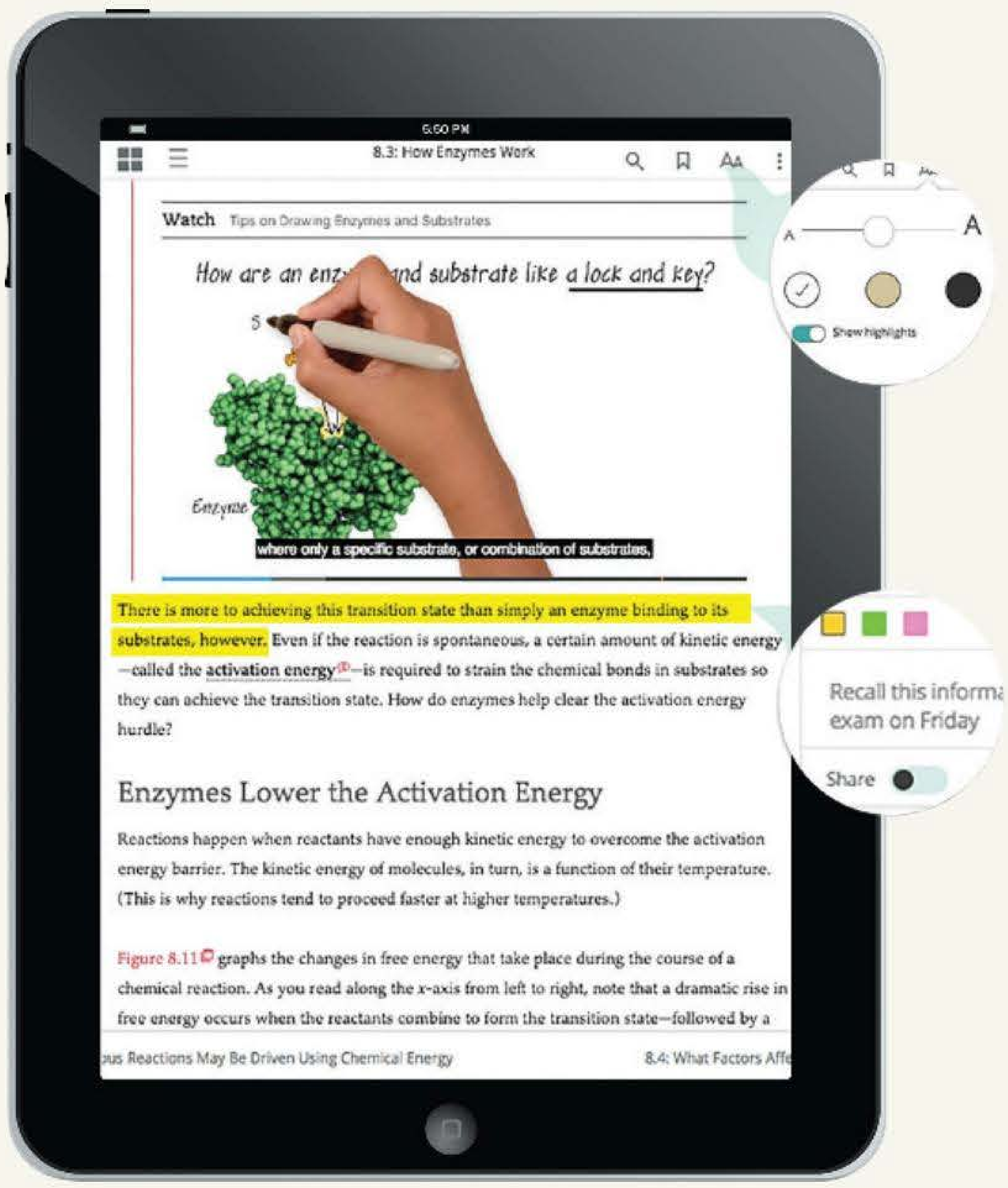
Adaptive Follow-Up Assignments provide each student with targeted question sets that address the specific concepts and skills he or she struggled with in the original homework assignment.





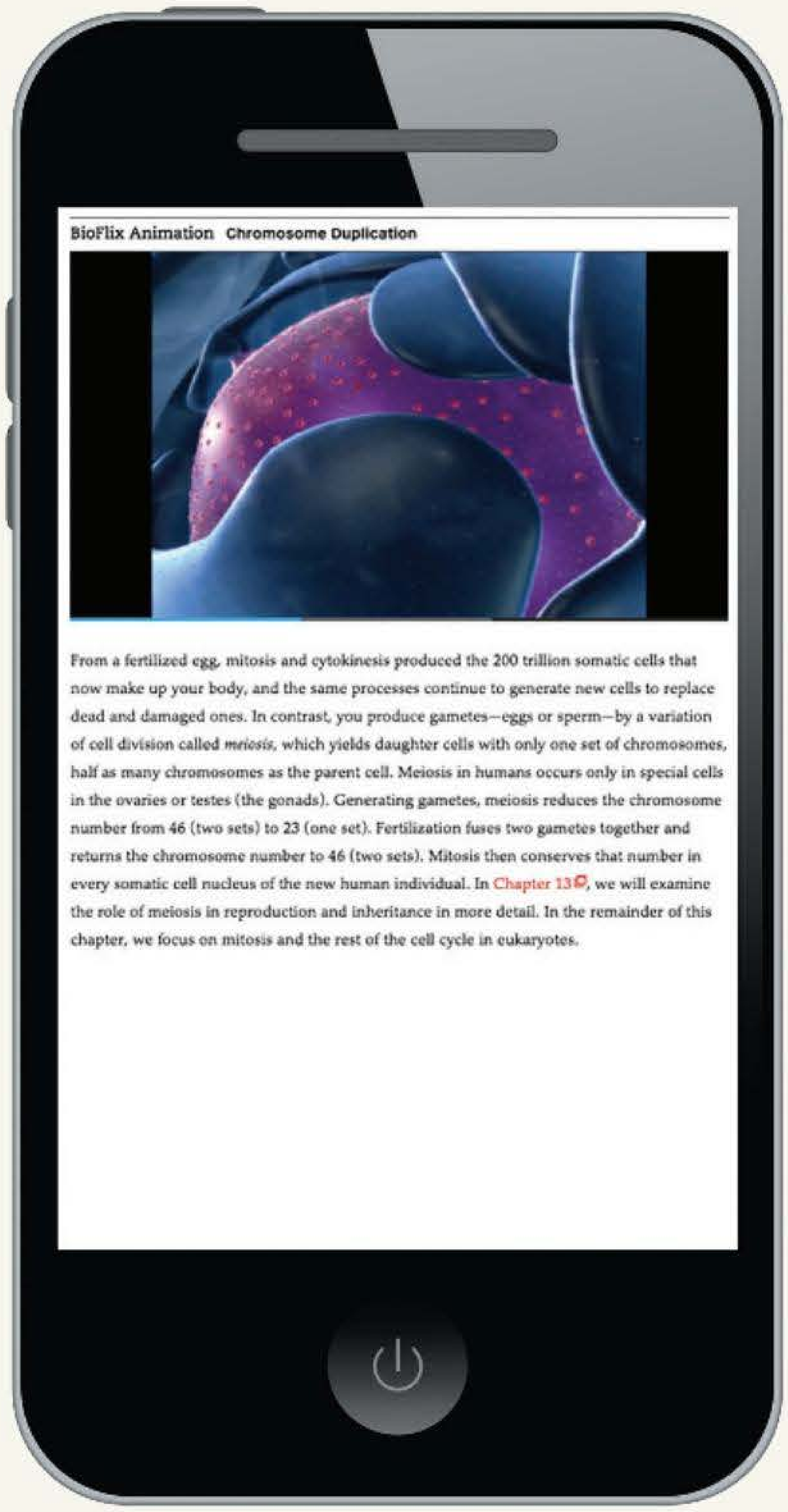
Additional Mastering Resources include: BioFlix, GraphIt! activities, HHMI videos, animations, concept maps, new tutorials, and many other tools to engage students and bring concepts to life. Available for self-study and assignment.

A Whole New Learning Experience with Pearson eText



NEW Pearson eText is a simple-to-use, mobile-optimized, personalized reading experience. It allows students to easily highlight, take notes, and review key vocabulary all in one place. Instructors can share notes from their eText with students to help focus student attention on important ideas.

The **7th edition eText** is accessible on computers, tablets, and smart phones. To engage students, it includes embedded multimedia carefully selected or created to support key ideas in the text, including 45 Making Models videos, 25 Figure Walkthrough videos, 12 interactive graphs, and over 150 additional animations and videos.



BIOLOGICAL SCIENCE

This garter snake, *Thamnophis sirtalis*, is a fearsome predator. It devours whatever it can easily overpower, including snails, slugs, earthworms, frogs, bird nestlings, mice—and newts. Can it counter the deadly defense of the rough-skinned newt (see back cover)? You'll find out the answer in this edition of *Biological Science*, while exploring an ongoing "evolutionary arms race" between snakes and newts (see the case study at the end of Unit 4 on pages 530–531).

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SEVENTH EDITION

SCOTT FREEMAN
University of Washington

KIM QUILLIN
Salisbury University

LIZABETH ALLISON
College of William & Mary

MICHAEL BLACK
California Polytechnic State University in San Luis Obispo

GREG PODGORSKI
Utah State University

EMILY TAYLOR
California Polytechnic State University in San Luis Obispo

JEFF CARMICHAEL
University of North Dakota

Pearson

Director, Courseware Portfolio Management: Beth Wilbur
Courseware Portfolio Management Specialist: Michael Gillespie
Content Producer: Laura Perry
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