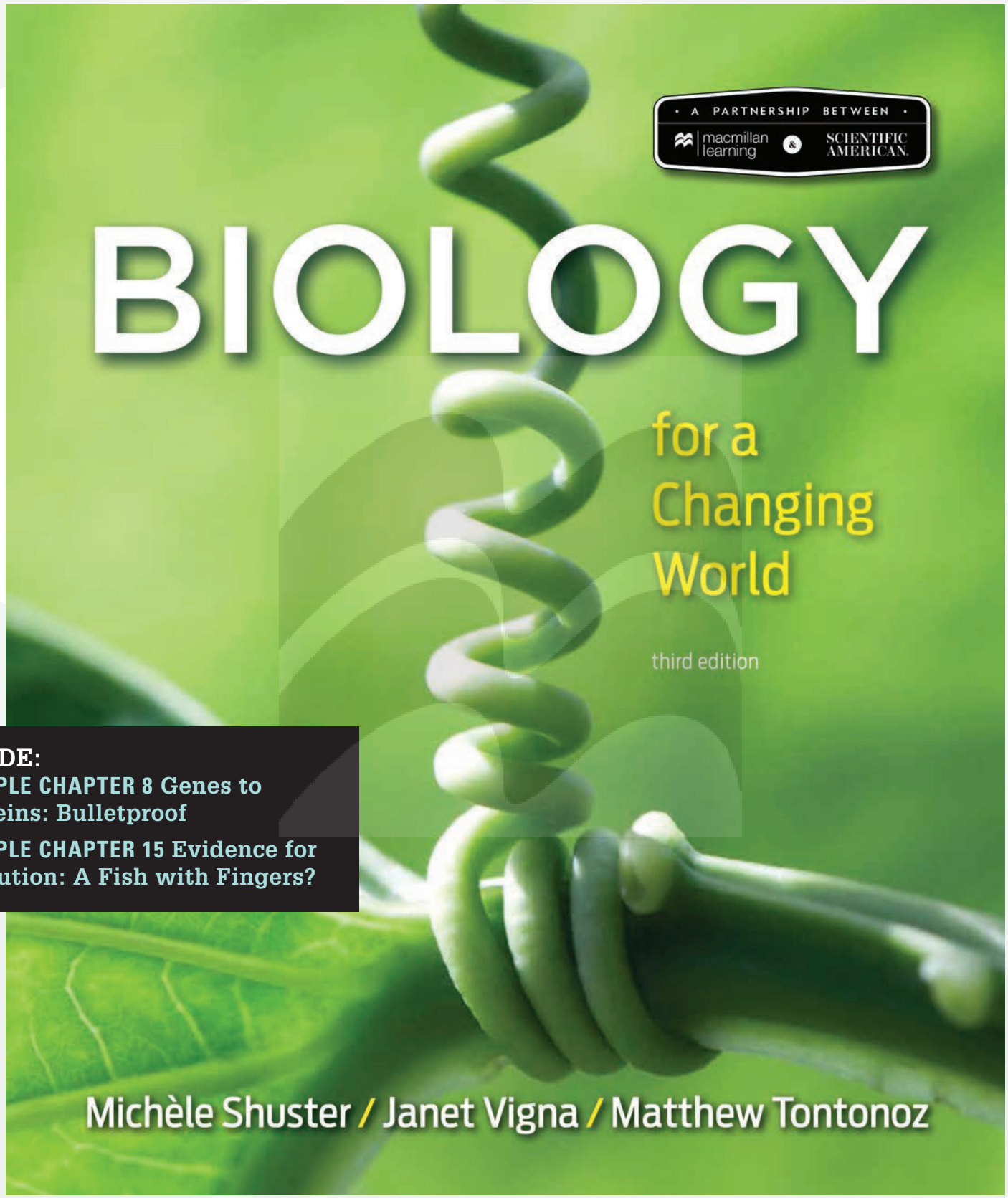


INSIDE:

SAMPLE CHAPTER 8 Genes to Proteins: Bulletproof

SAMPLE CHAPTER 15 Evidence for Evolution: A Fish with Fingers?

w. h. freeman
Macmillan Learning

From the preface...

Dear Student,

Thank you for opening this book! We hope that your journey through it will be as rewarding for you as our journey in writing it has been. When we first came together to collaborate on the development of this text, our biggest overarching goal was to get students interested in biology by showing its relevance to daily life. We wanted to create a textbook that students would actually want to read. Our model and partner in this process has been *Scientific American*, a visually stunning magazine that's been successfully bringing science to the public for more than 150 years. The result is a unique textbook that takes a novel approach to teaching biology, one that we think has the potential to greatly improve learning. We hope that this brief introduction will serve as a road map of the book, so that you can get the most out of your experience with it and be as captivated by the wonders of life as we are.

The main approach of each chapter is the presentation of key science concepts within the context of a relevant and engaging story—a story of discovery, of determination, of human interest, of adventure. From the search for life on Mars to the problem of antibiotic-resistant bacteria, we use stories to bring science to life and to show scientists in action. After all, science is not just a collection of facts, so why would we present it that way? We ask you, our students, to study biology so you can use knowledge to make choices in the real world. We value those stories that will lead you to ask questions about life and how it works and to see the relevance of biology to daily activity. We have seen how stories engage students in our classrooms, and we hope you will be similarly intrigued.

While gripped by a story, you may not even realize how much you are learning. To reinforce the basic learning process, we rely on several strategies:

- Each story is prefaced by a set of **Driving Questions**. By keeping these in mind as you navigate the story, you will have a good framework for learning the key science concepts.
- Eye-catching **Infographics** highlight and drill down into the science of each story. The set of Infographics in a chapter provides a science storyboard for that chapter, illustrating the key scientific concepts and linking them to the story.
- Each Infographic has a **question** to help you ensure that you have grasped the concept illustrated.
- **Key terms** are defined in the margins, making it easy to check a definition without having to leave the story.
- **Chapter summaries** provide a concise set of bullet points that distill the key scientific concepts.
- **Test Your Knowledge** questions at the end of each chapter reinforce basic facts and allow you to apply these facts through data interpretation and mini cases.

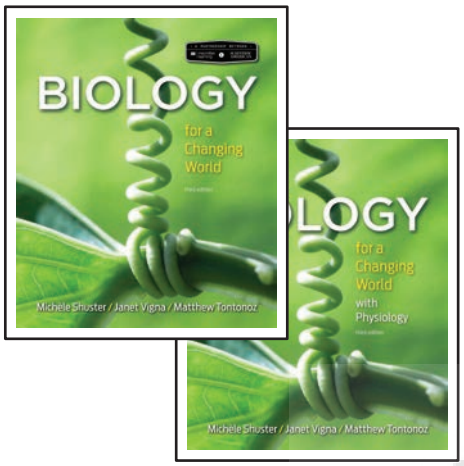
By taking full advantage of these resources, you will be better able to appreciate how biology affects each and every one of us as well as our close and distant relatives on this planet. We hope that you will talk about biology with your friends and family, and that what you learn here will be applicable to your life. We hope that you will think as critically about choices you make outside the classroom as we will ask you to do here in these pages.

Welcome to ***Biology for a Changing World***. We hope that you enjoy your journey, and complete it more prepared for your life in a changing world.

Michèle Shuster

Janet Vigna

Matthew Tontonoz



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Michèle Shuster, New Mexico State University
Janet Vigna, Grand Valley State University
Matthew Tontonoz

Real stories. Real biology.

Scientific American + Biology for a Changing World, Third Edition

From the groundbreaking partnership of Macmillan Learning and *Scientific American* comes this one-of-a-kind introduction to the science of biology and its impact on the way we live.

In *Biology for a Changing World*, two experienced educators and a science writer explore the core ideas of biology through chapters written and illustrated in the style of a *Scientific American* article. Chapters don't just feature compelling stories of real people—each chapter *is* a newsworthy story that serves as a context for covering the standard curriculum for the non-majors biology course. Updated throughout, the new edition offers new stories, enhanced plant and diversity coverage, and an expanded media program.

Biology for a Changing World is supported by its own dedicated (and fully updated) version of LaunchPad, which fully integrates an interactive e-Book, all student media, a wide range of assessments, and course management features.

To request your review copy, contact your local Macmillan Learning representative or visit
macmillanlearning.com/learnmoreShuster3e

Science through Stories

Each chapter of ***Biology for a Changing World*** is written in the style of a ***Scientific American*** article. This story-based approach captures student interest immediately and teaches not only the fundamental concepts of the discipline but why understanding those concepts matters to students' lives and the world in general.

5

Energy and Photosynthesis

DRIVING QUESTIONS

1. What are the photosynthetic organisms on the planet, and why are they so important?
2. What are the different types of energy, and what transformations of energy do organisms carry out?
3. How do plants and algae convert the energy in sunlight into energy-rich organic molecules? (And why can't other organisms, including humans, do this?)
4. How do algal biofuels compare to other fuels in terms of costs, benefits, and sustainability?

Grady Summers/Science Source

the FUTURE of FUEL?

Scientists seek to make algae the next alternative energy source

AS AN ENGINEER WORKING FOR the Navy Seals in 1978, Jim Sears took a nighttime scuba dive off the coast of Panama City, Florida, one of many he took to do underwater research. The dive started out routinely, but then, suddenly, glowing phosphorescent algae appeared as if out of nowhere. When Sears put his hands out in front of him, sparkling streamers of microbes trickled off his fingertips. "It was magical," he recalls.

Sears is an inventor with many and varied devices to his credit. In the 1970s and 1980s, he built an underwater speech descrambler and a portable mine detector, among other gadgets. Later, he moved on to more creative technologies, including a "hump-o-meter" that could tell farmers when their animals were in heat or mating.

But the seeds of his real claim to fame weren't sown until 2004, when Sears was working in agricultural electronics. That's when he turned his attention toward what he felt was the world's biggest problem: dwindling fossil fuel reserves. After he did some thinking and a little research, the tiny, glowing organisms that had wowed him during his nighttime dive more than two decades earlier came to mind. He realized suddenly that they might be able to help.

Algae are perhaps best known as the layer of green scum coating the surfaces of ponds and swimming pools, but they have other claims to fame as well. Like plants, algae have the impressive ability to capture the **energy** of sunlight and convert it into a form that other organisms can use. Even more remarkable, algae trap much of this energy in the form of oils ideally suited to making fuel. The oil that

97

NEW CHAPTER STORIES

The Sitting Disease: Understanding the causes and consequences of obS#Wq1 and Cellular RespirationQ1)

Bulletproof: Scientists hope to spin spider silk into the next indestructible superfiber

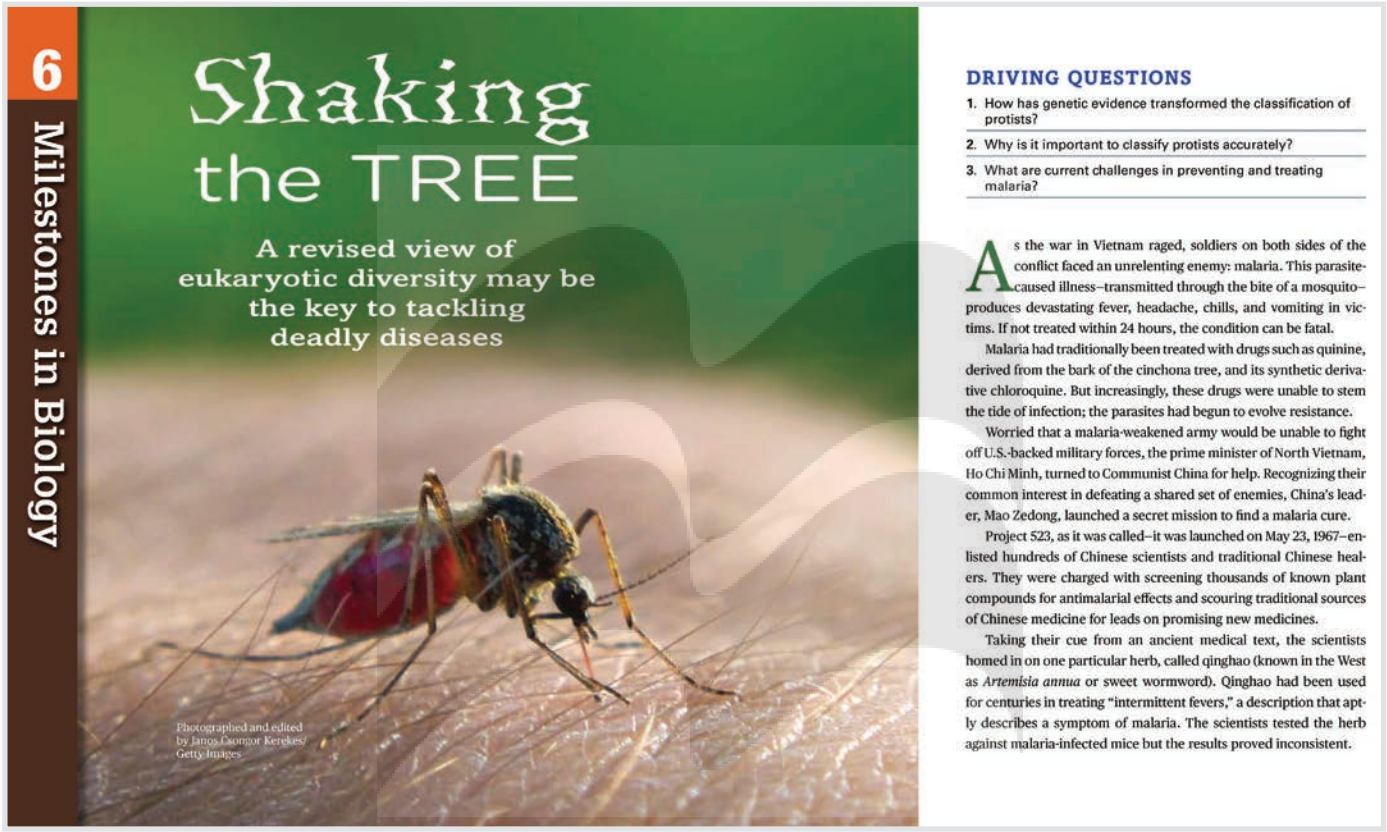
(Ch. 8, Genes to Proteins)

Can Rubber Save the Rainforest? A small state in Brazil aims to find out

(Ch. 18, Eukaryotic Diversity)

Plants 2.0: Is genetic engineering the solution to world hunger?

(Ch. 24, Plant Growth & Reproduction)



6 Milestones in Biology

Shaking the TREE

A revised view of eukaryotic diversity may be the key to tackling deadly diseases

Photographed and edited by Janos Csongor Kerekes/ Getty Images

DRIVING QUESTIONS

1. How has genetic evidence transformed the classification of protists?
2. Why is it important to classify protists accurately?
3. What are current challenges in preventing and treating malaria?

As the war in Vietnam raged, soldiers on both sides of the conflict faced an unrelenting enemy: malaria. This parasite-caused illness–transmitted through the bite of a mosquito–produces devastating fever, headache, chills, and vomiting in victims. If not treated within 24 hours, the condition can be fatal.

Malaria had traditionally been treated with drugs such as quinine, derived from the bark of the cinchona tree, and its synthetic derivative chloroquine. But increasingly, these drugs were unable to stem the tide of infection; the parasites had begun to evolve resistance.

Worried that a malaria-weakened army would be unable to fight off U.S.-backed military forces, the prime minister of North Vietnam, Ho Chi Minh, turned to Communist China for help. Recognizing their common interest in defeating a shared set of enemies, China's leader, Mao Zedong, launched a secret mission to find a malaria cure.

Project 523, as it was called–it was launched on May 23, 1967–enlisted hundreds of Chinese scientists and traditional Chinese healers. They were charged with screening thousands of known plant compounds for antimalarial effects and scouring traditional sources of Chinese medicine for leads on promising new medicines.

Taking their cue from an ancient medical text, the scientists homed in on one particular herb, called qinghao (known in the West as *Artemisia annua* or sweet wormword). Qinghao had been used for centuries in treating "intermittent fevers," a description that aptly describes a symptom of malaria. The scientists tested the herb against malaria-infected mice but the results proved inconsistent.

ALSO IN THIS EDITION

Enhanced Plant and Diversity Coverage

New two-chapter plant unit:

- Plant Growth & Reproduction (new chapter)
- Plant Physiology (new to the "without Physiology" version)

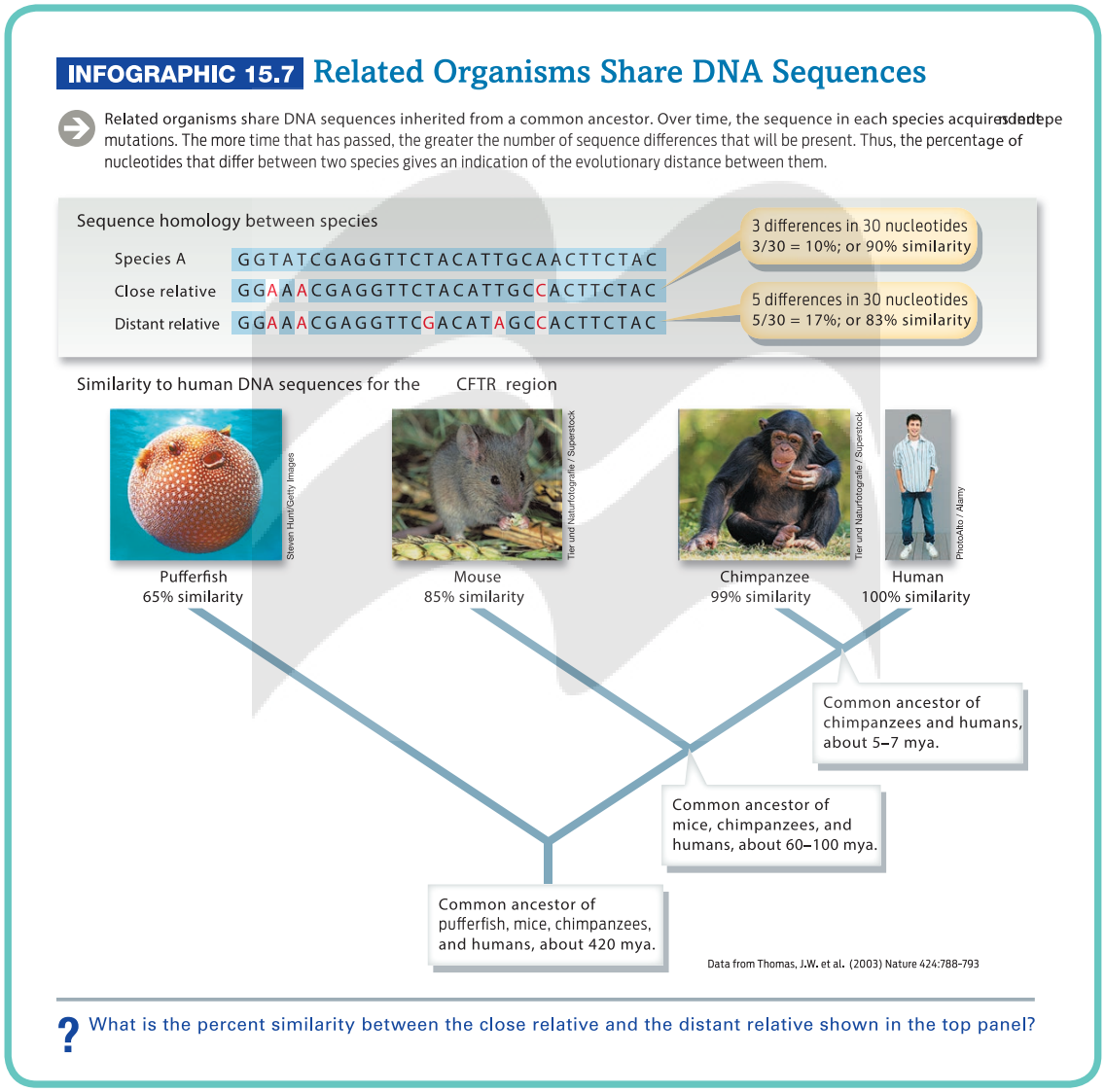
MILESTONES

These **mini-chapters on historically important discoveries** in biology teach students how we know what we know, prompting them to consider how future research will expand our understanding of biology.

NEW MILESTONE! Shaking the Tree: A revised view of eukaryotic diversity may be the key to tackling deadly diseases

Infographics

Engaging and informative **Infographics** are used throughout the book. These powerful pieces of art teach students how to learn from charts, graphs, and images, and add visual appeal to the science. Animated Infographics in LaunchPad are accompanied by assignable quiz questions.

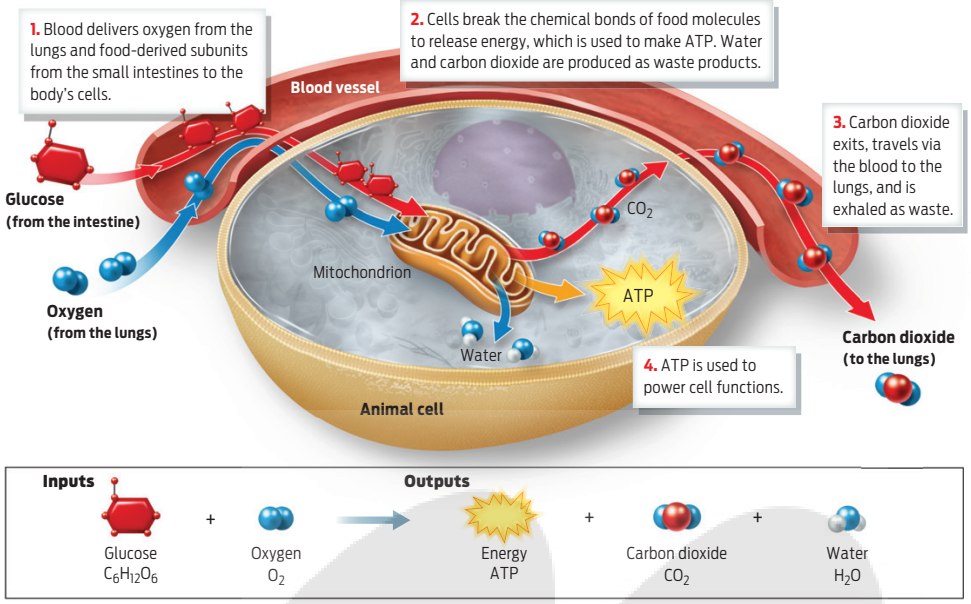


NEW INFOGRAPHIC QUESTIONS

Each Infographic now includes a thought-provoking question at the end to encourage students to think critically about the information presented in the figure.

INFOGRAPHIC 6.6 Aerobic Respiration Transfers Food Energy to ATP

During aerobic respiration, our cells use the oxygen we inhale to help extract energy from food. Cells convert the energy stored in food molecules into the bonds of ATP, the cell's energy currency.



Inputs			Outputs			
Glucose $C_6H_{12}O_6$	+	Oxygen O_2	→ Energy ATP	+	Carbon dioxide CO_2	+ Water H_2O

? What is the source of the glucose and the oxygen used in aerobic respiration?

ADDITIONAL PEDAGOGICAL FEATURES

Driving Questions provide the pedagogical framework for the chapter content by prompting students to consider the questions they need to be able to answer to have a full understanding of the material.

End-of-chapter questions, written by Michèle Shuster, are framed around the chapter's **Driving Questions**. Each question set includes **Interpreting Data**, **Mini-Case**, and **Bring It Home** questions to help students develop higher-order thinking skills. Selected questions are also assignable online through LaunchPad.

apply YOUR KNOWLEDGE

INTERPRETING DATA

20 The gene responsible for hairlessness in Mexican hairless dogs is called corneodesmosin (*CDSN*). This gene is present in other organisms. Look at the sequence of a portion of the *CDSN* gene from pairs of different species, given below. For each pair, determine the number of differences. From the variations in this sequence, which organism appears to be most closely related to humans? Which organism appears to be least closely related to humans?

Species	Sequence
Homo sapiens (human)	ACTCCGGCCCCTACATCCCCAGCTCCCA
Canis lupus familiaris (dog)	ATTCTGGCTCCTACATTTCCAGCTCCCA
Homo sapiens (human)	ACTCCGGCCCCTACATCCCCAGCTCCCA
Pan troglodytes (chimpanzee)	ACTCCGGCCCCTACATCCCCAGCTCCCA
Homo sapiens (human)	ACTCCGGCCCCTACATCCCCAGCTCCCA
Sus scrofa (pig)	AGTCTGGCTCCTACATCTCCAGCTCCCA
Homo sapiens (human)	ACTCCGGCCCCTACATCCCCAGCTCCCA
Macaca mulatta (rhesus monkey)	ACTCTGGCCCCTACATCCCCAGCTCCCA

apply YOUR KNOWLEDGE

MINI CASE

21 Fossils allow us to understand the evolution of many lineages of plants and animals. They therefore represent a valuable scientific resource. What if *Tiktaalik* (or an equally important transitional fossil) had been found by amateur fossil hunters and sold to a private collector? Do you think there should be any regulation of fossil hunting to prevent the loss of valuable scientific information from the public domain?

apply YOUR KNOWLEDGE

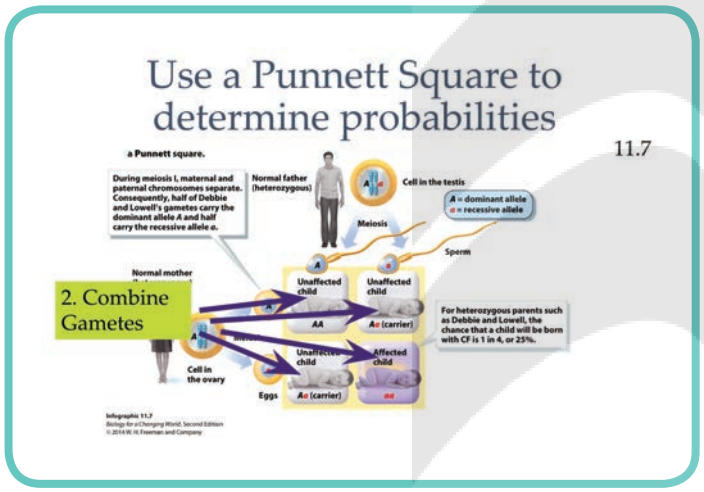
BRING IT HOME

7 Do an Internet search to find out about fossils discovered in your home state. Determine what kinds of organisms they represent, how old they are, and where in your state you would need to go in order to have a chance of finding fossils in the field.

DRIVING QUESTION 2 What features make *Tiktaalik* a transitional fossil, and what role do these types of fossils play in the fossil record?

Expanded Media Program in LaunchPad

Built to address the biggest classroom issues instructors face, **LaunchPad** gives students everything they need to prepare for class and exams, while giving instructors everything they need to quickly set up a course, shape the content to their syllabus, craft presentations and lectures, assign and assess homework, and guide the progress of individual students and the class as a whole.



Simple Inheritance Worksheet

Activity Guide

Chapter 11: Simple Inheritance and Meiosis

Introduction

This activity gives students the opportunity to practice genetics problems in class, either individually or with a partner/group.

Learning Objectives

After completing this activity, students should be able to:

- Determine the genotypes and phenotypes of individuals from information given
- Determine possible gametes
- Predict genotypes and phenotypes of individuals

Materials

- Activity guide and Answer Key
- Student Handout
- Activity PowerPoint presentation with introductory slides and clicker questions

Simple Inheritance Activity

Because we know that one copy of each allele is inherited from each parent, we can figure out the possible genotypes and phenotypes of offspring. Working individually or with a partner, answer the following questions.

1. In humans, normal skin pigmentation (B) is a dominant trait and albinism (b) is recessive.
   a. Two people with normal pigmentation have an albino child. Use a Punnett square to demonstrate how the child could have a different phenotype than the parents.
   b. If the mom had normal pigmentation and the dad was albino, how many of each phenotype would you expect out of 4 children? What are the phenotypic and genotypic ratios of the offspring? (hint: there may be more than one answer).

Simple Inheritance Worksheet

Answer Key

1. In humans, normal skin pigmentation (B) is a dominant trait and albinism (b) is recessive.
   a. Two people with normal pigmentation have an albino child. Use a Punnett square to demonstrate how the child could have a different phenotype than the parents.

Both parents have to be heterozygous for any offspring to be white.

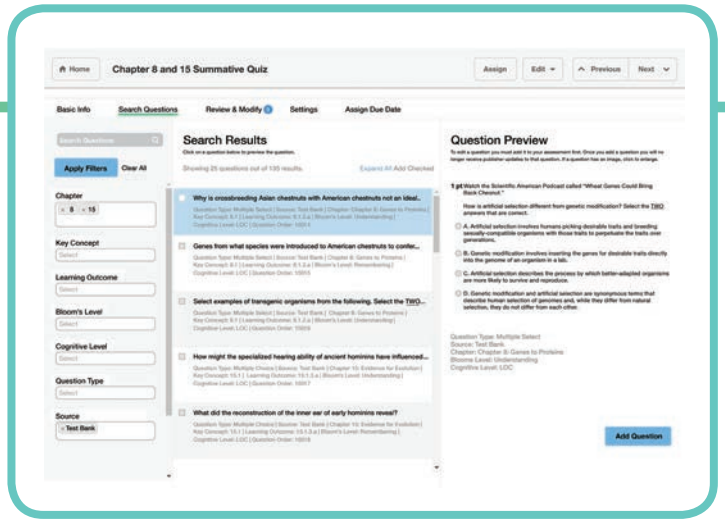
	B	b
B	BB	Bb
b	Bb	bb

   a. If the mom had normal pigmentation and the dad was albino, how many of each phenotype would you expect out of 4 children? What are the phenotypic and genotypic ratios of the offspring? (hint: there may be more than one answer).

Either 2 normal and 2 albino (the mother is heterozygous); 1:1

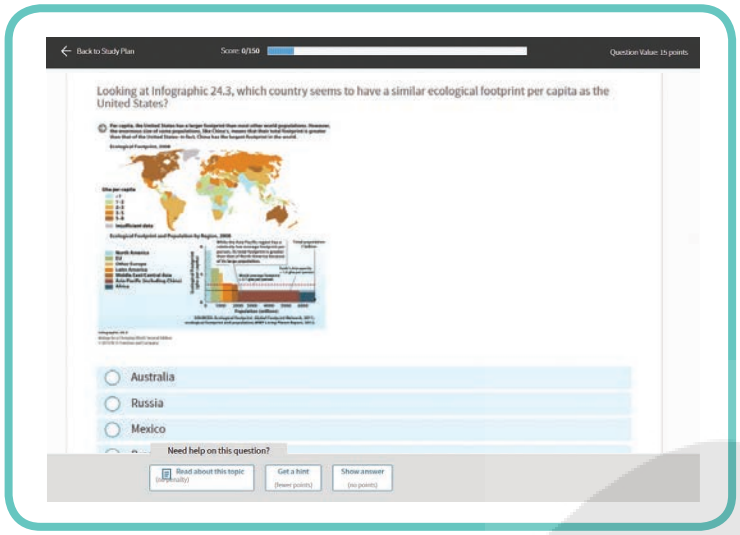
	B	b
b	Bb	bb
b	Bb	bb

Active Learning Lesson Plans Curated and customizable, these sets of lecture slides, instructor guides, and student activities provide instructors with an easy-to-use framework for including active learning in their lectures, deepening student engagement with the text. They are available for all chapters and organized by each chapter's Driving Questions.



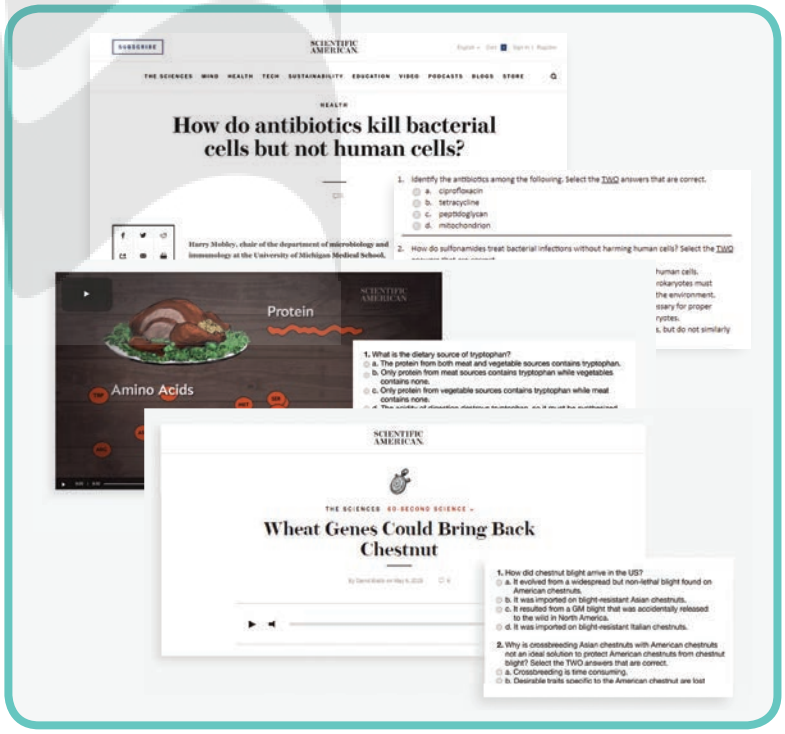
Assignable End-of-Chapter Questions

Selected from Michèle Shuster's question sets, these include Interpreting Data activities that ask students to analyze data in tables, charts, or graphs and draw their own conclusions about their meaning.



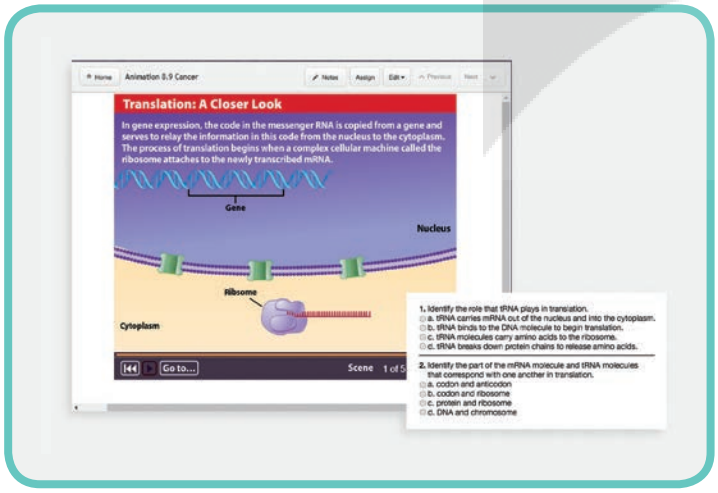
LearningCurve

Putting "testing to learn" into action, LearningCurve is the perfect tool to get students to engage before class, and review after. With game-like quizzing, it creates individualized activities for each student, selecting questions—by difficulty and topic—according to their performance.



Content from *Scientific American*

Assignable activities that integrate *Scientific American* content—including articles, podcasts, and videos—are available for each chapter in LaunchPad.



Infographic Animations with Questions

Animated Infographics include assignable questions that encourage students to think critically about the information presented in the figure.

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About the Authors

Michèle Shuster, Matthew Tontonoz, and Janet Vigna

MICHÈLE SHUSTER, PH.D., is an associate professor in the biology department at New Mexico State University in Las Cruces, New Mexico. She focuses on the scholarship of teaching and learning and teaches introductory biology, microbiology, and cancer biology classes at the undergraduate level, as well as working on several K–12 science education programs. Michèle is involved in mentoring graduate students and postdoctoral fellows in effective teaching, preparing the next generation of undergraduate educators. She is the recipient of numerous teaching awards, including the Westhafer Award for Teaching Excellence at NMSU. Michèle received her Ph.D. from the Sackler School of Graduate Biomedical Sciences at Tufts University School of Medicine, where she studied meiotic chromosome segregation in yeast.

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MATTHEW TONTONOZ is a science writer and independent scholar living in Brooklyn, New York. For ten years, he was a development editor for textbooks in biology before shifting his focus to writing. He is currently senior science writer at Memorial Sloan Kettering Cancer Center, where he covers advances in basic science and clinical cancer research. Matt received his B.A. in biology from Wesleyan University and his M.A. in the history and sociology of science from the University of Pennsylvania.