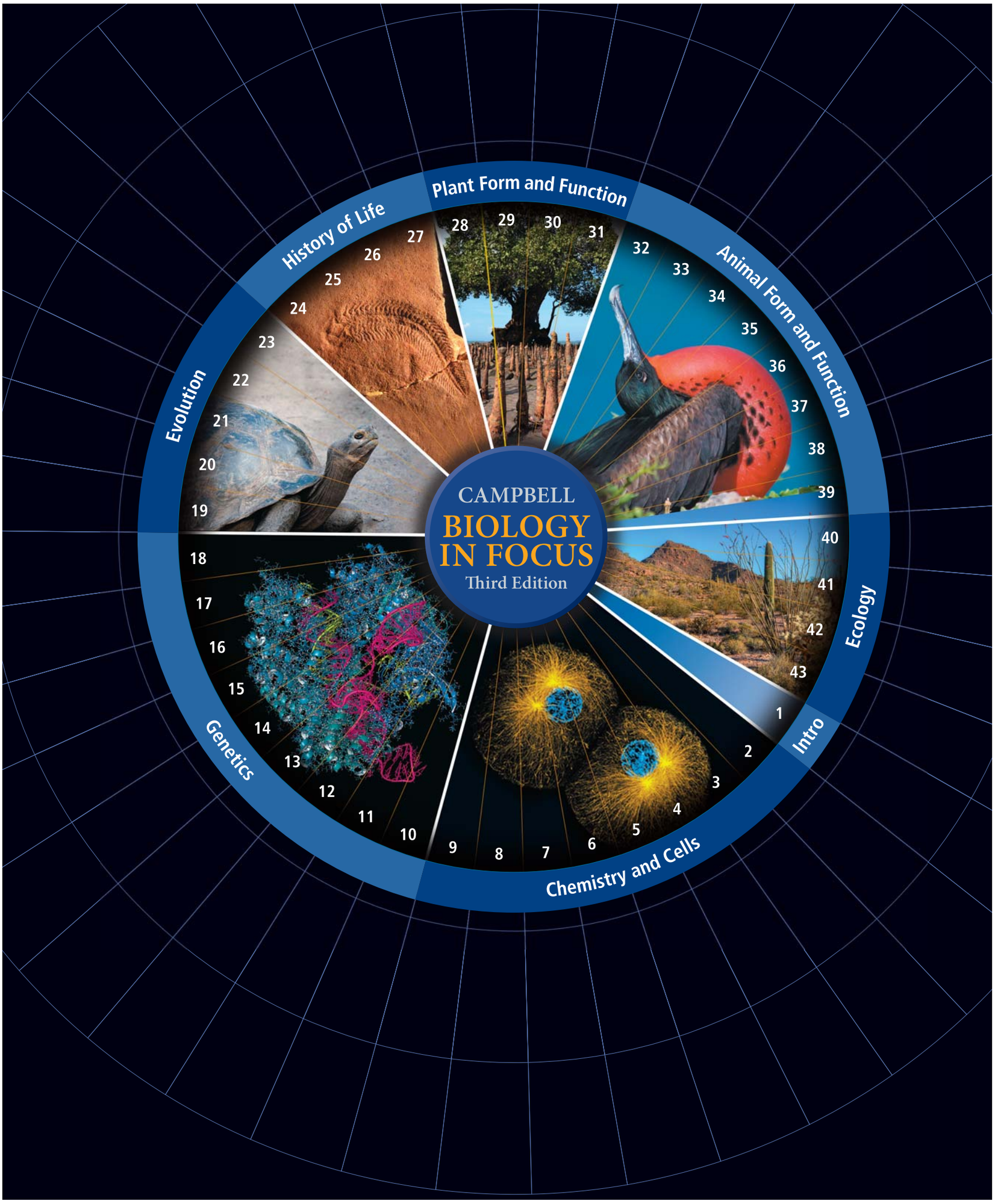
GLOBAL EDITION

3E Campbell

BIOLOGY IN FOCUS

Urry • Cain • Wasserman • Minorsky


Plant Form and Function
28
29
30
31
Animal Form and Function
32
33
34
35
36
37
38
39
Ecology
40
41
42
43
Intro
1
2
3
4
5
Chemistry and Cells
6
7
8
9
Genetics
10
11
12
13
14
15
16
17
18
Evolution
19
20
21
22
23
History of Life
24
25
26
27
CAMPBELL
BIOLOGY
IN FOCUS
Third Edition

CAMPBELL
BIOLOGY IN FOCUS

THIRD EDITION

GLOBAL EDITION

Lisa A. Urry
Mills College, Oakland, California

Michael L. Cain
New Mexico State University

Steven A. Wasserman
University of California, San Diego

Peter V. Minorsky
Mercy College, Dobbs Ferry, New York

Rebecca B. Orr
Collin College, Plano, Texas

Pearson

Courseware Portfolio Management, Director: *Beth Wilbur*
Courseware Portfolio Management Specialist: *Josh Frost*
Portfolio Management Assistant: *Summer Giles*
Courseware Director, Content Development: *Ginnie Simione Jutson*
Supervising Editors: *Beth N. Winickoff and Pat Burner*
Courseware Senior Analysts: *John Burner, Hilair Chism, Evelyn Dahlgren, Mary Ann Murray*
Managing Producer, Science: *Michael Early*
Content Producer, Science: *Margaret Young*
Associate Acquisitions Editor, Global Edition: *Sharon Thekkekara*
Associate Project Editor, Global Edition: *Sulagna Dasgupta*
Senior Project Editor, Global Edition: *K. K. Neelakantan*
Senior Media Producer: *Tod Regan*
Rich Media Content Producer: *Ziki Dekel*
Media Production Manager, Global Edition: *Vikram Kumar*
Senior Content Developer, Mastering Biology: *Sarah Jensen*
Mastering Media Producers: *Kaitlin Smith, Ashley Gordon*
Production Management: *Margaret McConnell, Integra Software Services*
Composition: *Integra Software Services*
Design Manager: *Mark Ong*
Interior Design: *Jeff Puda*
Cover Design, Global Edition: *Lumina Datamatics*
Illustrators: *Lachina*
Rights & Permissions Manager: *Ben Ferrini*
Rights & Permissions Project Manager: *Matt Perry, SPi Global*
Manufacturing Buyer: *Stacey Weinberger, LSC Communications*
Senior Manufacturing Controller, Global Edition: *Kay Holman*
Photo Researcher: *Maureen Spuhler*
Director of Product Marketing: *Allison Rona*
Product Marketing Manager: *Alysun Burns*
Field Marketing Manager: *Kelly Galli*
Cover Photo Credit: *Digital Images Studio/Shutterstock*

Acknowledgments of third-party content appear on the appropriate page within the textbook, or on pages CR-1–CR-6, which constitute an extension of this copyright page.

Pearson Education Limited
KAO Two
KAO Park
Harlow
CM17 9NA
United Kingdom

and Associated Companies throughout the world

Visit us on the World Wide Web at: www.pearsonglobaleditions.com

Authorized adaptation from the United States edition, entitled Campbell Biology in Focus, Third Edition, ISBN 978-0-13-471067-9 by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, and Peter V. Minorsky, published by Pearson Education © 2020.

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

ISBN 10: 1-292-32497-X
ISBN 13: 978-1-292-32497-5
eBook ISBN 13: 978-1-292-32499-9

Typeset by Integra Software Services.

About the Authors

The author team's contributions reflect their biological expertise as researchers and their teaching sensibilities gained from years of experience as instructors at diverse institutions. They are also experienced textbook authors, having written *Campbell Biology* in addition to *Campbell Biology in Focus*.

Lisa A. Urry (Units 1 and 2) is Gibbons Young Professor of Biology at Mills College. After earning a B.A. at Tufts University, she completed her Ph.D. at the Massachusetts Institute of Technology (MIT). Lisa has conducted research on gene expression during embryonic and larval development in sea urchins. Deeply committed to promoting opportunities in science for women and underrepresented minorities, she has taught courses ranging from introductory and developmental biology to a nonmajors course called Evolution for Future Presidents.

Michael L. Cain (Chapter 1 and Units 3, 4, and 7) is an ecologist and evolutionary biologist who is now writing full-time. Michael earned an A.B. from Bowdoin College, an M.Sc. from Brown University, and a Ph.D. from Cornell University. As a faculty member at New Mexico State University, he taught introductory biology, ecology, evolution, botany, and conservation biology. Michael is the author of dozens of scientific papers on topics that include foraging behavior in insects and plants, long-distance seed dispersal, and speciation in crickets. He is also a coauthor of an ecology textbook.

Steven A. Wasserman (Unit 6) is Professor of Biology at the University of California, San Diego (UCSD). He earned an A.B. from Harvard University and a Ph.D. from MIT. Working on the fruit fly *Drosophila*, Steve has done research on developmental biology, reproduction, and immunity. Having taught genetics, development, and physiology to undergraduate, graduate, and medical students, he now focuses on introductory biology, for which he has been honored with UCSD's Distinguished Teaching Award.

Peter V. Minorsky (Unit 5) is Professor of Biology at Mercy College in New York, where he teaches introductory biology, ecology, and botany. He received his A.B. from Vassar College and his Ph.D. from Cornell University. Peter taught at Kenyon College, Union College, Western Connecticut State University, and Vassar College; he is also the science writer for the journal *Plant Physiology*. His research interests concern how plants sense environmental change. Peter received the 2008 Award for Teaching Excellence at Mercy College.

Rebecca B. Orr (Ready-to-Go Teaching Modules, eText Media Integration) is Professor of Biology at Collin College in Plano, Texas, where she teaches introductory biology. She earned her B.S. from Texas A&M University and her Ph.D. from University of Texas Southwestern Medical Center at Dallas. Rebecca has a passion for investigating strategies that result in more effective learning and retention, and she is a certified Team-Based Learning Collaborative Trainer Consultant. She enjoys focusing on the creation of learning opportunities that both engage and challenge students.

Neil A. Campbell (1946–2004) earned his M.A. from the University of California, Los Angeles, and his Ph.D. from the University of California, Riverside. His research focused on desert and coastal plants. Neil's 30 years of teaching included introductory biology courses at Cornell University, Pomona College, and San Bernardino Valley College, where he received the college's first Outstanding Professor Award. He was also a visiting scholar at the University of California, Riverside. Neil was the founding author of *Campbell Biology*, upon which this book is based.

To Jane, our coauthor, mentor, and friend. Enjoy your retirement!
LAU, MLC, SAW, and PVM

Preface

The eye of the iguana (*Iguana iguana*) has a suite of evolutionary adaptations that give it excellent color vision and long-distance vision, helping the iguana find food and avoid predators. The iguana's remarkable eye is an apt metaphor for our goal in writing this text: to focus with high intensity on the core concepts that introductory biology students need to master to build a solid foundation in biology.

The current explosion of biological information, while exhilarating in its scope, poses a significant challenge—how best to teach a subject that is constantly expanding. In particular, instructors have become increasingly concerned that their students are overwhelmed by an excessive volume of detail and are losing sight of the big ideas in biology. In response to this challenge, various groups of biologists have initiated efforts to refine and, in some cases, redesign the introductory biology course. In particular, the report *Vision and Change in Undergraduate Biology Education: A Call to Action** advocates focusing course material and instruction on key ideas while transforming the classroom through active learning and scientific inquiry. Many instructors have embraced such approaches and have changed how they teach. Cutting back on the amount of detail they present, they focus on core biological concepts, explore select examples, and engage in a rich variety of active learning exercises.

We were inspired by these ongoing changes in biology education to write *Campbell Biology in Focus,* a shorter textbook that has been received with widespread excitement by instructors. Guided by their feedback, we have honed the Third Edition so that it does an even better job of helping students explore the key questions, approaches, and ideas of modern biology.

* Copyright 2011 American Association for the Advancement of Science. See also *Vision and Change in Undergraduate Biology Education: Chronicling Change, Inspiring the Future* (copyright 2015 American Association for the Advancement of Science) and *Vision and Change in Undergraduate Biology Education: Unpacking a Movement and Sharing Lessons Learned* (copyright 2018 American Association for the Advancement of Science).
For more information, see www.visionandchange.org.

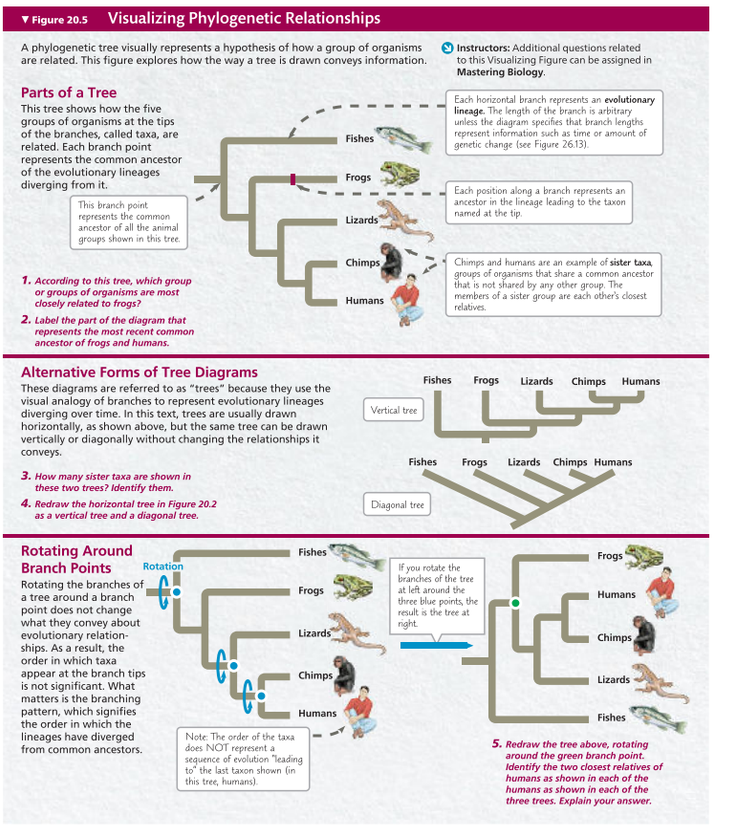
New to This Edition

Our goals for the Third Edition include:

- **increasing visual literacy** through new figures, questions, and exercises that build students' skills in understanding and creating visual representations of biological structures and processes
- giving students the opportunity to **practice scientific skills** by applying scientific skills to **real-world problems**
- **integrating text and media** to engage, guide, and inform students in an active process of inquiry and learning
- **supporting instructors** by providing teaching modules with tools and materials for introducing, teaching, and assessing important and often challenging topics

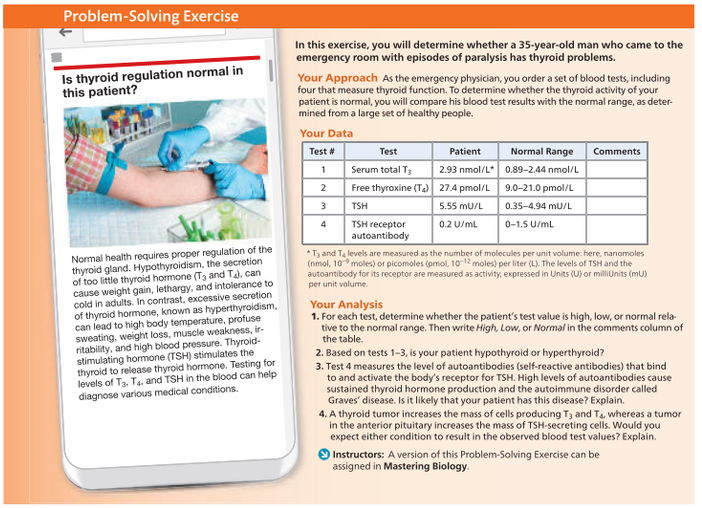
Our starting point, as always, was our commitment to crafting text and visuals that are accurate, are current, and reflect our passion for teaching biology. Here we provide an overview of the new features that we have developed for the Third Edition. We invite you to explore pages 11–12 for more information and examples.

- **NEW! Visualizing Figures** and **Visual Skills Questions** help students practice interpreting and creating visual representations in biology. The Visualizing Figures have embedded questions that guide students in exploring how



diagrams, photographs, and models represent and reflect biological systems and processes. Assignable questions are also available in **Mastering Biology** that allow students to practice the visual skills addressed in these figures.

- **NEW! Problem-Solving Exercises** challenge students to apply scientific skills and interpret data in solving engaging real-world problems:

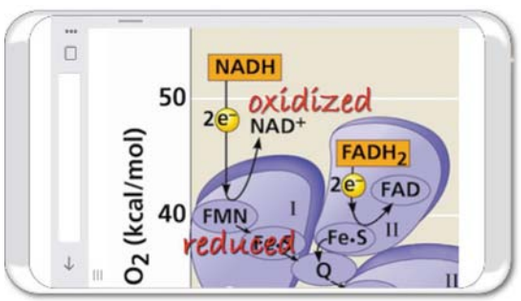


Problem-Solving Exercises can also be assigned and automatically graded in **Mastering Biology**.

- **NEW! Integrated text and media**: Media references in the printed book direct students to a wealth of online self-study resources available to them in the **Mastering Biology eText** or **Study Area**. For example:

> **Mastering Biology**
> **BioFlix® Animation: Protein Synthesis**

- **NEW! Get Ready for This Chapter** online questions provide a quick check of student understanding of the background information needed to learn a new chapter's content, with feedback to bolster their preparation.
- **NEW! Figure Walkthroughs** guide students through key figures with narrated explanations and figure markups that reinforce important points:



Check students' understanding of Figure Walkthroughs with assignable questions in **Mastering Biology**.

- **EXPANDED!** Bring biology to life with **400 animations** and **videos** in the Mastering Biology eText, Study Area, Instructor Resources, and Item Library. These include **BioFlix® 3-D Animations** and resources from **HHMI BioInteractive**:

- **NEW! Mastering Biology** includes automatically graded assignments with links to annotated research papers from *Science* on the **AAAS Science in the Classroom** website:

- **FIVE NEW! Ready-to-Go Teaching Modules** provide instructors with active learning exercises and assessment questions to use in class, plus **Mastering Biology** assignments that can be assigned before and after class. The Third Edition includes five new modules for a total of 15 modules.
- **EXPANDED!** The impact of **climate change** at all levels of the biological hierarchy has been expanded throughout the text, starting with a new chapter opener and Figure 2.21 in Chapter 2 and continuing with new figures and increased coverage of climate change in Chapters 22, 40, and 42.
- As in each new edition of *Campbell Biology in Focus*, the Third Edition incorporates **new content**, which is summarized on pages 7–10. Content updates reflect rapid, current changes in technology and knowledge in the fields of genomics, gene-editing technology (CRISPR), evolutionary biology, microbiology, and more.

Our Guiding Principles

Our key objective in creating *Campbell Biology in Focus* was to produce a shorter text by streamlining selected material, while emphasizing conceptual understanding and maintaining clarity, proper pacing, and rigor.

Here are the five guiding principles of our approach:

1. Focus on Core Concepts

We developed this text to help students master the fundamental content and scientific skills they need as college biology majors. In deciding what to include in this text, we were guided by discussions with biology professors across the country, analysis of over 1,000 syllabi, study of the debates in the literature of scientific pedagogy, and our experience as instructors at a range of institutions. The result is a **briefer book for biology majors** that informs, engages, and inspires. Page 7 provides more information on the book's organization.

2. Establish Evolution as the Foundation of Biology

Evolution is the central theme of biology and the core theme of this text, as exemplified by the various ways that evolution is integrated into the text:

- Every chapter includes an **Evolution section** and a question called **Focus on a Theme: Evolution**.
- Evolution is the unifying idea of **Chapter 1**.
- Evolution provides the storyline for **Unit 4, The Evolutionary History of Life**.

3. Engage Students in Scientific Thinking

Helping students learn to "think like a scientist" is a nearly universal goal of introductory biology courses. Scientific thinking and data interpretation skills top lists of learning outcomes and foundational skills desired for students entering higher-level courses. Students need to understand how to formulate and test hypotheses, design experiments, and interpret data. *Campbell Biology in Focus* meets this need in several ways:

- **NEW!** Problem-Solving Exercises
- **NEW!** Links to annotated research papers in the AAAS Science in the Classroom website
- Scientific Skills Exercises
- Interpret the Data Questions
- Scientific Inquiry Questions
- Inquiry Figures
- Research Method Figures

4. Use Outstanding Pedagogy to Help Students Learn

Campbell Biology in Focus, Third Edition, builds on our hallmarks of clear and engaging text and superior pedagogy:

- **NEW! Get Ready for This Chapter** online questions help prepare students for the chapter ahead.
- Each chapter is organized around a framework of carefully selected **Key Concepts** so students don't lose sight of the "forest" for the "trees."
- **Questions throughout the text** catalyze learning by encouraging students to actively engage with the material.
- **Test Your Understanding Questions** at the end of each chapter help students assess their understanding of the chapter. They are organized by **Bloom's Taxonomy**:
  Levels 1-2: Remembering/Understanding
  Levels 3-4: Applying/Analyzing
  Levels 5-6: Evaluating/Creating

5. Create Art and Animations That Teach

Biology is a visual science, and students learn from the art as much as the text. Therefore, we have developed our art and animations to teach with clarity and focus. Our visual teaching tools include:

- **NEW!** Visualizing Figures
- **NEW!** Visual Skills Questions
- **NEW!** Figure Walkthroughs
- Make Connections Figures
- BioFlix® 3-D Animations
- Exploring Figures

Mastering Biology

Mastering Biology is the most widely used online assessment and tutorial program for biology, providing an extensive library of homework assignments that are graded automatically. Self-paced **tutorials** provide individualized coaching with specific **hints and feedback** on the most difficult topics in the course. Optional **Adaptive Follow-up Assignments** provide additional questions tailored to each student's needs.

Mastering Biology also includes the **Instructor Resources, Ready-to-Go Teaching Modules, eText,** and **Study Area**. For more information about Mastering Biology, see pages 18–23.

* * *

Our overall goal in developing and revising this text was to assist instructors and students in their exploration of biology. Although this Third Edition is now completed, we recognize that *Campbell Biology in Focus*, like its subject, will evolve. As its authors, we are eager to hear your thoughts, questions, comments, and suggestions for improvement. We encourage you to contact us directly by e-mail:

- Lisa Urry (Units 1 and 2): lurry@mills.edu
- Michael Cain (Ch. 1, Units 3, 4, and 7): mlcain@nmsu.edu
- Peter Minorsky (Unit 5): pminorsky@mercy.edu
- Steven Wasserman (Unit 6): stevenw@ucsd.edu
- Rebecca Orr (Ready-to-Go Teaching Modules, eText Media Integration): rorr@collin.edu

Organization and New Content

Organization

Campbell Biology in Focus, Third Edition, is organized into an introductory chapter and seven units that cover core concepts of biology at a thoughtful pace. When we adapted *Campbell Biology* to write the first edition of this text, we made informed choices about how to design each chapter of *Campbell Biology in Focus* to meet the needs of instructors and students. We analyzed over 1,000 syllabi, read hundreds of reviews, and talked to biology instructors across the country. In some chapters, we retained most of the content; in other chapters, we pruned some material; and in still others, we completely reconfigured the coverage. In creating the Third Edition, we solicited feedback from reviewers and used their thoughtful critiques to further fine-tune the content and pedagogy.

CHAPTER 1 Introduction: Evolution and the Foundations of Biology

Chapter 1 introduces the **five biological themes** woven throughout the text: the core theme of **Evolution**, together with **Organization, Information, Energy and Matter**, and **Interactions**. Chapter 1 also explores the process of scientific inquiry through a case study describing experiments on the evolution of coat color in the beach mouse. The chapter concludes with a discussion of the importance of diversity within the scientific community.

UNIT 1 Chemistry and Cells

A succinct, two-chapter treatment of basic chemistry (Chapters 2 and 3) provides the foundation for this unit focused on cell structure and function. The related topics of cell membranes and cell signaling are consolidated into one chapter (Chapter 5). Due to the importance of the fundamental concepts in Units 1 and 2, much of the material in the rest of these two units has been retained from *Campbell Biology*.

UNIT 2 Genetics

Topics in this unit include meiosis, classical genetics, the chromosomal and molecular basis for genetics and gene expression (Chapters 10–14), regulation of gene expression (Chapter 15), and the role of gene regulation in development, stem cells, and cancer (Chapter 16). Methods in biotechnology are integrated into appropriate chapters. The standalone chapter on viruses (Chapter 17) can be taught at any point in the course. The final chapter in the unit, on genome evolution (Chapter 18), provides both a capstone for the study of genetics and a bridge to the evolution unit.

UNIT 3 Evolution

This unit provides in-depth coverage of essential evolutionary topics, such as mechanisms of natural selection, population genetics, speciation, and long-term patterns of evolutionary change. Early in the unit, Chapter 20 introduces "tree thinking" to support students in interpreting phylogenetic trees and thinking about the big picture of evolution.

UNIT 4 The Evolutionary History of Life

This unit employs a novel approach to studying the evolutionary history of biodiversity. Each chapter focuses on one or more major steps in the history of life, such as the origin of cells or the colonization of land. The coverage of natural history and biological diversity also emphasizes the evolutionary process—how factors such as the origin of key adaptations have influenced the rise and fall of different groups of organisms over time.

UNIT 5 Plant Form and Function

The form and function of vascular plants are often treated as separate topics, making it difficult for students to make connections between the two. In Unit 5, plant anatomy (Chapter 28) and the acquisition and transport of resources (Chapter 29) are bridged by a discussion of how plant architecture influences resource acquisition. Chapter 30 provides an introduction to plant reproduction and examines controversies surrounding the genetic engineering of crop plants. The final chapter (Chapter 31) explores how plants sense and respond to environmental challenges and opportunities by effecting changes in their growth and reproduction.

UNIT 6 Animal Form and Function

This unit's focused exploration of animal physiology and anatomy uses a comparative approach to bring out fundamental principles and conserved mechanisms. An integrative introductory chapter (Chapter 32) introduces students to the closely related topics of endocrine signaling and homeostasis. Other interconnections are explored in chapters that meld presentations of circulation and gas exchange, reproduction and development, neurons and nervous systems, and motor mechanisms and behavior.

UNIT 7 Ecology

This unit applies the key themes of the text, including evolution, interactions, and energy and matter, to help students learn ecological principles. Chapter 40 integrates material on population growth and Earth's environment, highlighting the importance of both biological and physical processes in determining where species are found. Chapter 43 ends the book with a focus on conservation biology and global change.

Highlights of New Content

Here, we highlight the major content updates and revisions made to the Third Edition of *Campbell Biology in Focus*.

CHAPTER 1 Introduction: Evolution and the Foundations of Biology

Chapter 1 includes several new and significantly revised figures: Figure 1.13, depicting researchers studying hominin fossils in South Africa, providing a new example of how life on Earth has changed over time; Figure 1.15, providing a new example of unity and diversity in birds; and Figure 1.18, a new image depicting Jane Goodall observing a chimpanzee mother and baby in the field.

UNIT 1 Chemistry and Cells

In Unit 1, new content engages students in learning foundational chemistry and making the cell-related material more accessible and inviting. The opening of Chapter 2 and a new figure show organisms affected by **loss of Arctic sea ice (Figure 2.21)**. Chapter 3 has a new chapter opener featuring Qinling golden snub-nosed monkeys, as well as updates on lactose intolerance, *trans* fats, dietary fiber (with a nutritional label), protein sequences and structures, and intrinsically disordered proteins. New Visualizing Figure 3.20 helps students understand various ways proteins are depicted. A new Problem-Solving Exercise in Concept 3.7 engages students by having them compare DNA sequences in a case of possible fish fraud.

▼ Figure 2.21 Effects of climate change on the Arctic.

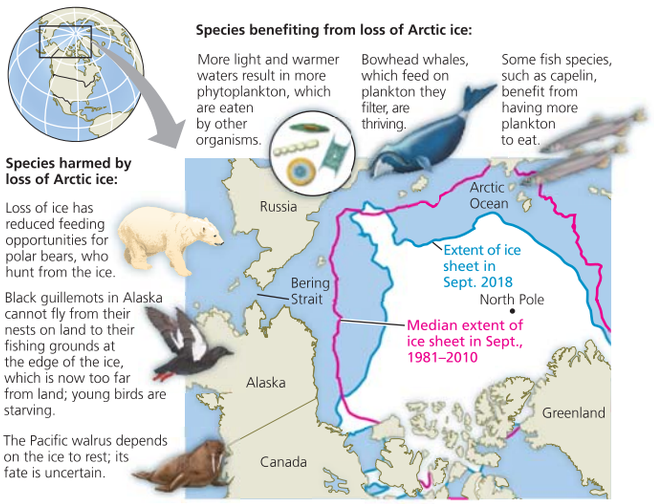
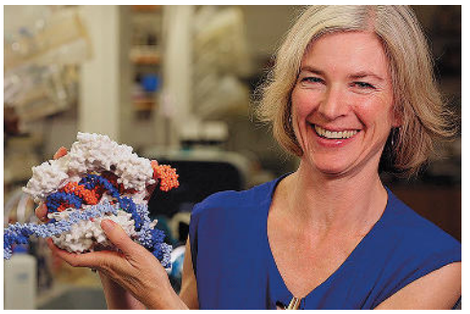


Figure 4.1 is a new chapter-opening photo—a striking colorized micrograph of the rods and cones in the eye. New Visualizing Figure 4.30 shows the profusion of molecules and structures in a cell, all drawn to scale. Chapter 5 begins with a new chapter opener, a computer-based, artistic image depicting a cross section through two brain cells, showing neurotransmitter release during exocytosis. Chapter 6 includes a new photo of a firefly to show terrestrial bioluminescence. To illustrate order as a characteristic of life, Figure 6.4 includes photos of a Venus flower basket glass sponge and La Sagrada Família church in Barcelona, Spain. The structure of the glass sponge inspired the architect Antoni Gaudí in his design of the church's towers. Chapter 7 begins with striking photos of puffins, both capturing food and in flight, and includes an addition on the role of fermentation and anaerobic respiration in the production of chocolate from cacao beans. Chapter 8 includes a new concept head (Concept 8.4, Life depends on photosynthesis) to facilitate instructor use of this final summary and the two important review figures at the end of the chapter. In Chapter 9, more cell cycle control checkpoints have been added.

UNIT 2 Genetics

Chapters 10–14 incorporate changes that help students grasp the more abstract concepts of genetics and their chromosomal and molecular underpinnings. For example, a new Visual Skills Question with Figure 10.6 asks students to identify where haploid cells undergo mitosis in the three life cycles shown in the figure and what type of cells are formed. Chapter 11 includes information on a 2014 genomic study on the number of genes and genetic variants contributing to height. In Chapter 12, the section on sex determination is more inclusive, explaining that sex is no longer thought to be simply binary and clarifying the emerging distinction between the terms *sex* and *gender*. Also, new research on sex determination has been added. New Visualizing Figure 13.8 shows various ways that DNA is illustrated. In Concept 13.4, updates to the CRISPR-Cas9 coverage include progress on attempting to cure sickle-cell disease, use of gene drives to address insect-borne diseases, a photo of **Jennifer Doudna with a CRISPR-Cas9 model (Figure 13.33)**, text about her role in discovering CRISPR technology, and text about ethical considerations. Chapter 14 has a new opening photo and story about albino donkeys to pique student interest in gene expression, and the one-letter codes for amino acids have been added to increase student familiarity with these widely used symbols. A new Problem-Solving Exercise asks students to identify mutations in the insulin gene and predict their effect on the protein.

▶ Figure 13.33 Jennifer Doudna holding a model of CRISPR-Cas9.



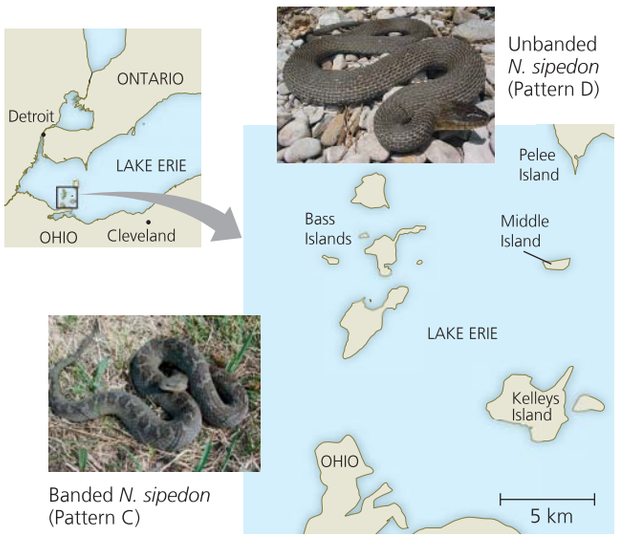
Chapters 15–18 are extensively updated, driven by exciting new discoveries based on DNA sequencing and gene-editing technology. Chapter 15 has updates on histone modifications, the percent of protein-coding genes expressed by a typical human cell, alternative splicing, functional RNAs, miRNAs, and siRNAs. A mention of CRISPR in bacteria has been added to the section on evolution. Concept 15.4 includes brief descriptions of both quantitative RT-PCR and RNA sequencing because these techniques are becoming more widely used. Chapter 16 includes updates on the role of master regulatory genes in modifying chromatin structure and the possible role of *p53* in the low incidence of cancer in elephants. Make Connections Figure 16.21 ("Genomics, Cell Signaling, and Cancer") has been revised to reflect recent research on breast cancer subtypes. Chapter 17 updates include the Ebola, Chikungunya, and Zika viruses (Figure 17.10), new research on the structure of the influenza virus, and discovery of the largest virus known to date. A discussion has been added on mosquito transmission of viral diseases and the possibility of global climate change affecting mosquito ranges and therefore disease transmission. Chapter 18 begins with new photos of an elephant shark (*Callorhinchus milii*), which has the slowest-evolving vertebrate genome identified to date, and a tiger tail sea horse (*Hippocampus comes*), which has the fastest-evolving known fish genome. Also, in addition to the usual updates of sequence-related data (speed of sequencing, number of species' genomes sequenced, etc.), there are several research updates, including results from a 2015 study showing the similarity of certain yeast and human genes, underscoring the common origin of yeasts and humans.

UNIT 3 Evolution

A major goal for this revision was to strengthen how we help students understand and interpret visual representations of evolutionary data and concepts. Toward this end, new Figure 20.5 ("Visualizing Phylogenetic Relationships") introduces how phylogenetic trees represent evolutionary relationships and what such trees do and do not convey, and new Figure 23.5 ("Visualizing the Scale of Geologic Time") explores some visual conventions used to represent the enormity of geologic time. The unit also features new material that connects evolutionary concepts and societal problems. Examples include text in Chapter 19 on the 2015 discovery of teixobactin, an antibiotic that is effective

against some hard-to-treat pathogens, a new discussion in Chapter 22 on the impact of climate change on hybrid zones, and a new Problem-Solving Exercise in Chapter 22 on how hybridization may have led to the spread of insecticide resistance genes in mosquitoes that transmit malaria. Additional changes include new text in Concept 19.3 emphasizing how populations can evolve over short periods of time, new content in Concept 20.1 emphasizing how sister groups provide a clear way to describe evolutionary relationships and how trees do not show a "direction" in evolution, a new example in Concept 20.5 of horizontal gene transfer from prokaryote species to a eukaryote lineage, a new table (Table 21.1) highlighting the five conditions required for a population to be in Hardy-Weinberg equilibrium, and new text and a new figure on **gene flow (Figure 21.12)**.

▼ Figure 21.12 Gene flow and local adaptation in the Lake Erie water snake (*Nerodia sipedon*).



UNIT 4 The Evolutionary History of Life

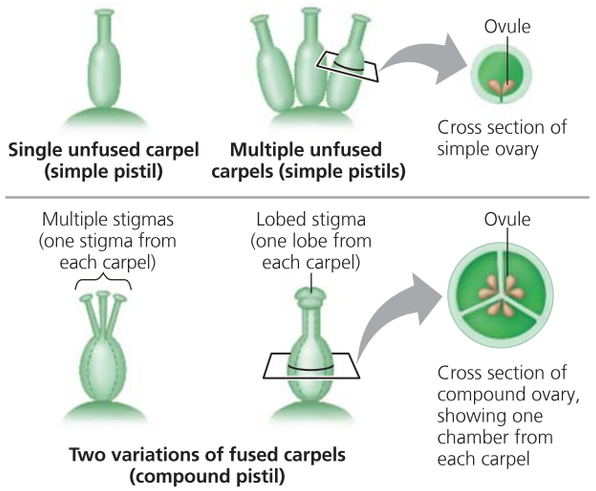
In keeping with our goal of improving how students interpret and create visual representations in biology, we have added a new figure (Figure 27.8, "Visualizing Animal Body Symmetry and Axes") that introduces some visual conventions and terminology used in describing animal bodies. Students are also provided many opportunities to practice their visual skills, with more than ten new Visual Skills Questions on topics ranging from interpreting phylogenetic trees to inferring which regions of a bacterial flagellum are hydrophobic. Other major content changes include new text in Concepts 24.4 and 25.1 on the 2015 discovery of the Lokiarchaeota, a group of archaea that may represent the sister group of the eukaryotes, a new Scientific Skills Exercise in Chapter 24 on calculating and interpreting means and standard errors using data on the effectiveness of a promising new antibiotic, teixobactin, and new text and a new figure (Figure 26.24) on the earliest known seed plants. A new Problem-Solving Exercise in Chapter 27 engages students in interpreting data from a study investigating whether frogs can acquire resistance to a fungal pathogen through controlled exposure to it. Other updates include the revision of many phylogenies to reflect recent phylogenomic data, new material in Concept 24.1 describing how researchers recently succeeded for the first time in constructing a "protocell" in which replication of a template strand of RNA could occur (a key step in our understanding of the origin of life), and new text and a new figure in Concept 27.6 describing the 2017 discovery of 315,000-year-old hominin fossils of ***Homo naledi* (Figure 27.37)**, a close relative of *Homo sapiens*.

▼ Figure 27.37 Fossils of hand bones and foot bones (top and side views) of *Homo naledi*.

UNIT 5 Plant Form and Function

A major aim in revising Chapter 28 was to help students better understand how primary and secondary growth are related. New Visualizing Figure 28.10 enables students to picture these two types of growth more effectively. New coverage of the primary meristems (protoderm, procambium, and ground meristem) helps students visualize the transition of meristematic to mature tissues. A new flowchart (Figure 28.21) summarizes growth in a woody shoot. In Chapter 29, new Figure 29.7 illustrates the fine branching of leaf veins to emphasize the relationship between transport and structure. In Chapter 30, a new chapter opener highlights the biomimetic inspiration for the invention of Velcro as an example of how basic research can impact people's lives in unexpected ways. A new figure clarifies how **the terms *carpel* and *pistil* are related (Figure 30.3)**. The text on flower structure and

▼ Figure 30.3 The relationship between the terms *carpel* and *pistil*.



the angiosperm life cycle figure identify carpels as megasporophylls and stamens as microsporophylls, correlating with the plant evolution discussion in Unit 5. New Figure 30.17 compares insect damage in non-*Bt* maize and *Bt* maize. In Chapter 31, the coverage of control of apical dominance is enhanced by new Figure 31.5 on effects of removing the apical bud and new text on the role of sugars. In Concept 31.3, a new Problem-Solving Exercise highlights how global climate change affects crop productivity. Figure 31.24 on defense responses against pathogens has been simplified and improved.

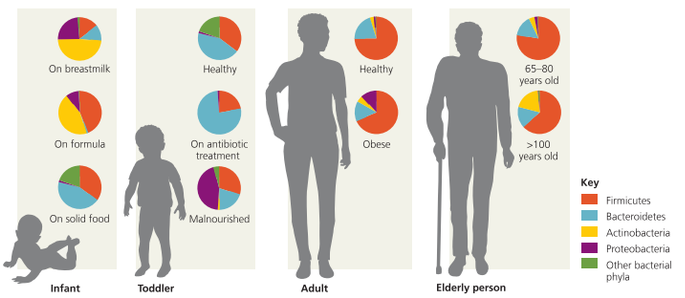
UNIT 6 Animal Form and Function

A major goal of the Unit 6 revision was to transform how students interact with and learn from representations of anatomy and physiology. For example, the art for homeostatic control systems in Chapter 32 (Figures 32.11, 32.15, and 32.24) and throughout the book has been revised to provide a clear and consistent presentation of the role of perturbation in triggering a response. In Chapter 34, Figure 34.10 on blood velocity and pressure has been revised to help students appreciate both time-dependent variation in systolic and diastolic pressure and location-dependent variation in mean pressure. In Chapter 36, Figure 36.12 on female reproductive cycles has been redesigned to make key events stand out and to highlight coordination of the ovarian and uterine cycles, and new Visualizing Figure 36.18 provides students with a clear and carefully paced introduction to the three-dimensional rearrangements that occur during gastrulation. In Chapter 37, new Visual Skills and Draw It Questions lead students to visualize ion movement through voltage-gated ion channels (Figure 37.10), engage with representations of action potential formation and propagation (Figure 37.12), and explore the commonalities and distinctions between spatial and temporal summation at synapses (Figure 37.18). In Chapter 38, the art illustrating the cellular responses of photoreceptors (Figure 38.27) has been transformed into two parallel drawings that highlight more effectively how enzyme-induced changes in second messenger concentration trigger changes in ion flow, membrane potential, and ultimately neurotransmitter production.

The Unit 6 revision also introduces new material and updates that are designed to promote student engagement and appreciation of biology as an active, vibrant science. For example, a new Problem-Solving Exercise in Chapter 32 taps into student interest in medical mysteries through a case study that explores the science behind laboratory testing and diagnosis.

New text and figures introduce students to recent discoveries regarding topics such as the **microbiome** **(Figure 33.14)** and to cutting-edge technology, including a method for the rapid, comprehensive characterization of viral exposure (Figure 35.19). The revision also addresses students misconceptions with, for instance, new art (Figure 35.18) that highlights the success of immunization in fighting a number of communicable diseases. A new opening figure and text for Chapter 36 highlight the diversity of reproductive systems and strategies across the animal kingdom, helping students overcome the misconception that reproduction inherently involves a male and a female. In Chapter 37, the discussion of the complementary roles of inactivation and voltage gating of ion channels during action potential formation has been revised for clarity (Concept 37.3). Finally, additional content updates help students appreciate the continued evolution of our understanding of biological phenomena, such as how animals detect magnetic fields (Concept 38.4) and how jellies move (Concept 39.2).

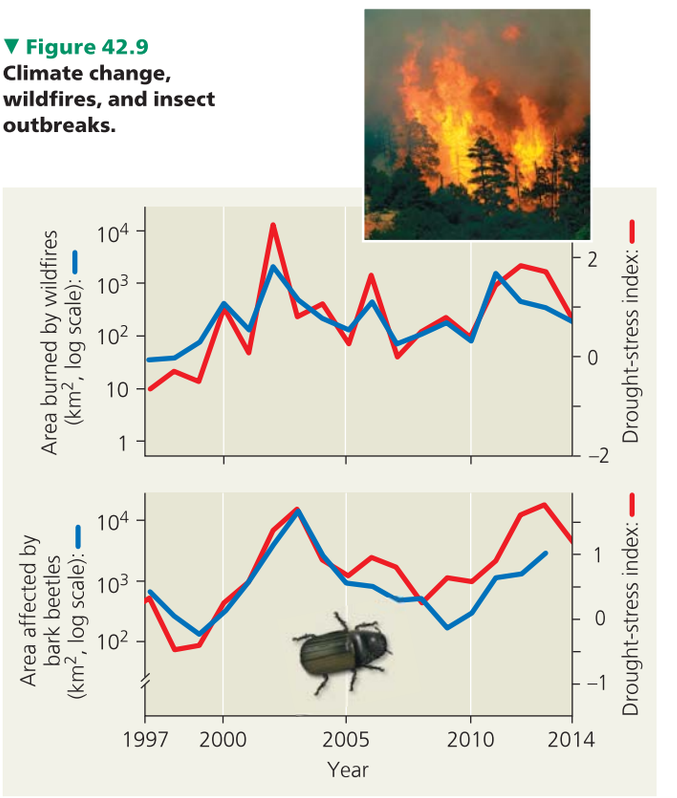
▼ Figure 33.14 Variation in human gut microbiome at different life stages.



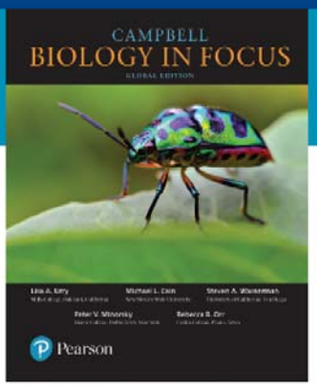
UNIT 7 Ecology

Complementary goals of the Unit 7 revision were to strengthen our coverage of core concepts while also increasing our coverage of how human actions affect ecological communities. Revisions include new text in Concept 43.1 on the mechanisms by which acid precipitation harms aquatic and terrestrial organisms, new text and a new figure (Figure 41.24) in Concept 41.4 on the island equilibrium model (and how it relates to human-caused habitat fragmentation), and new material in Concepts 42.2 and 43.4 on eutrophication and how it can cause the formation of large "dead zones" in aquatic ecosystems. A new figure (Figure 43.21) shows the extent of the record-breaking 2017 dead zone in the Gulf of Mexico and the watershed that contributes to its nutrient load. In addition, Chapter 41 has a new chapter-opening story on a seemingly unlikely mutualism between a tiny wrasse and a much larger predatory fish, and Concept 42.4 includes new Figure 42.14, "Visualizing Biogeochemical Cycles," which explores how biological and geological processes are represented visually in nutrient cycle diagrams. In keeping with our book-wide goal of expanding our coverage of climate change, we have added new text and a new figure (Figure 40.14) on how climate change has affected the distribution of a species of sea urchin that decimates kelp communities, new text in Concept 42.2 on how climate change affects primary production in ecosystems, a new figure on how **climate change** relates to an increase in wildfires and insect outbreaks **(Figure 42.9)**, and a new Problem-Solving Exercise in Chapter 42 that explores how insect outbreaks induced by climate change can cause an ecosystem to switch from a carbon sink (that stores CO_2) to a carbon source (that releases CO_2).

▼ Figure 42.9 Climate change, wildfires, and insect outbreaks.



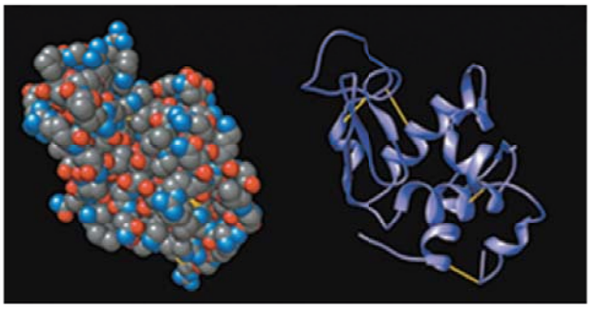
Focus on Core Concepts and Skills



Campbell Biology in Focus, Third Edition, is designed to help students master the fundamental **content** and scientific **skills** they need as college biology majors. Here is an overview of the features of the Third Edition:

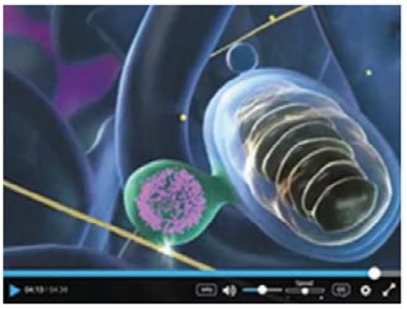
▼Visualizing Figures and Visual Skills Questions

Build the skills needed to interpret diagrams and models in biology (pp. 12–13).



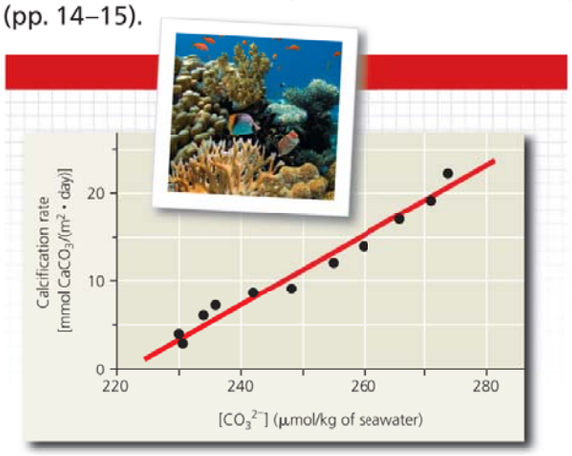
▼Student Success with Mastering™ Biology

Succeed in biology by using the eText, and Study Area (pp. 18–19).



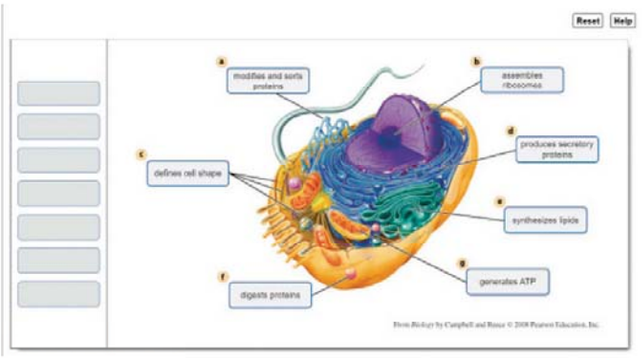
▼Scientific Skills and Problem-Solving Exercises

Use real data to build key skills needed for biology (pp. 14–15).



▼Personalized Coaching in Mastering Biology

Master concepts with assignable tutorials that provide hints and feedback (pp. 20–21).



▼Make Connections Figures and Questions

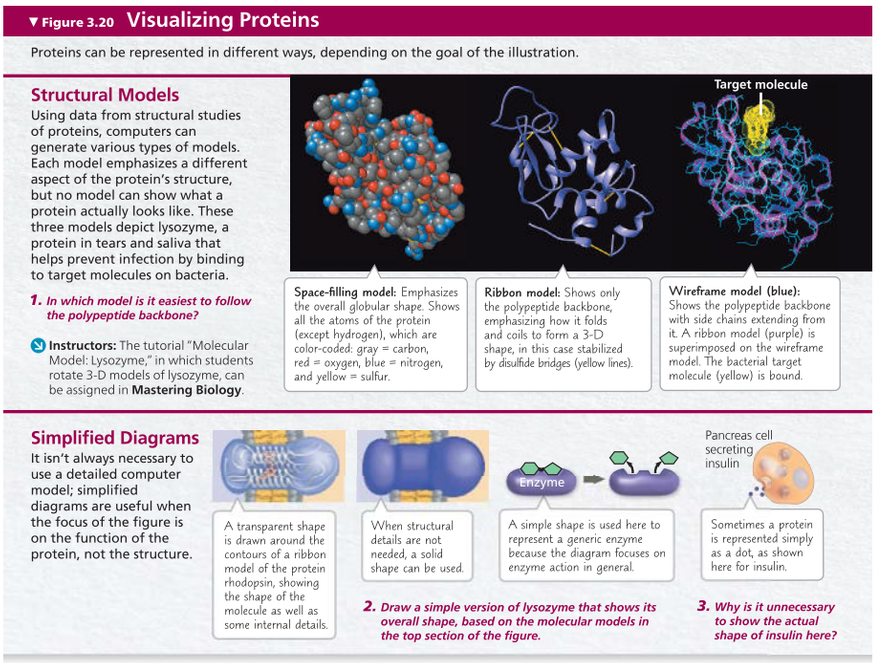
See the big picture of biology by integrating content from different chapters (pp. 16–17).

▼Active Learning

Enliven class time and increase student learning with the Ready-to-Go Teaching Modules (p. 22).

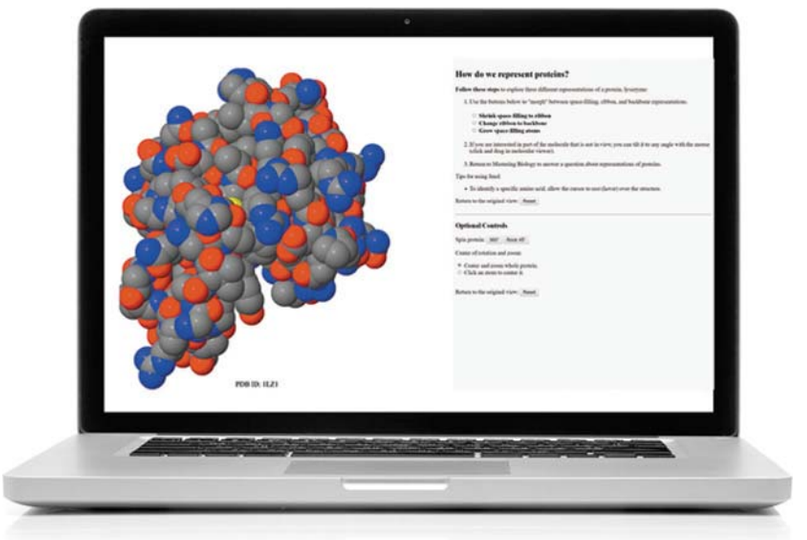
Focus on Visual Skills

NEW! Visualizing Figures teach students how to interpret diagrams and models in biology.

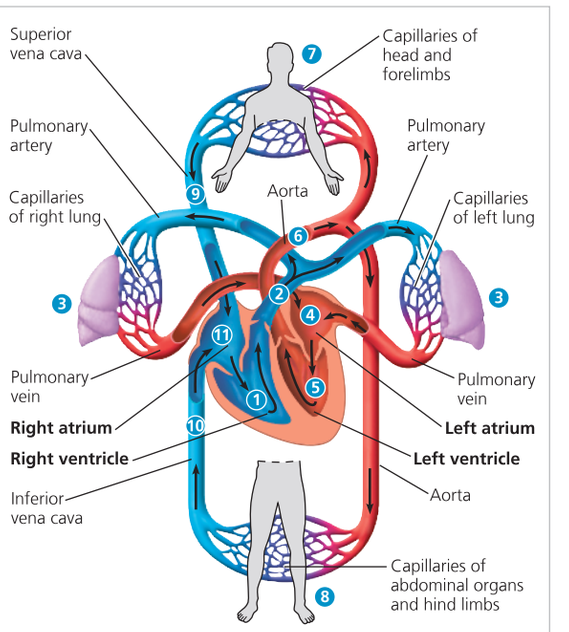


◀ Embedded **questions** give students practice applying **visual skills** as they read the figure.

▼ **NEW! Assignable activities** in **Mastering Biology** support each Visualizing Figure.

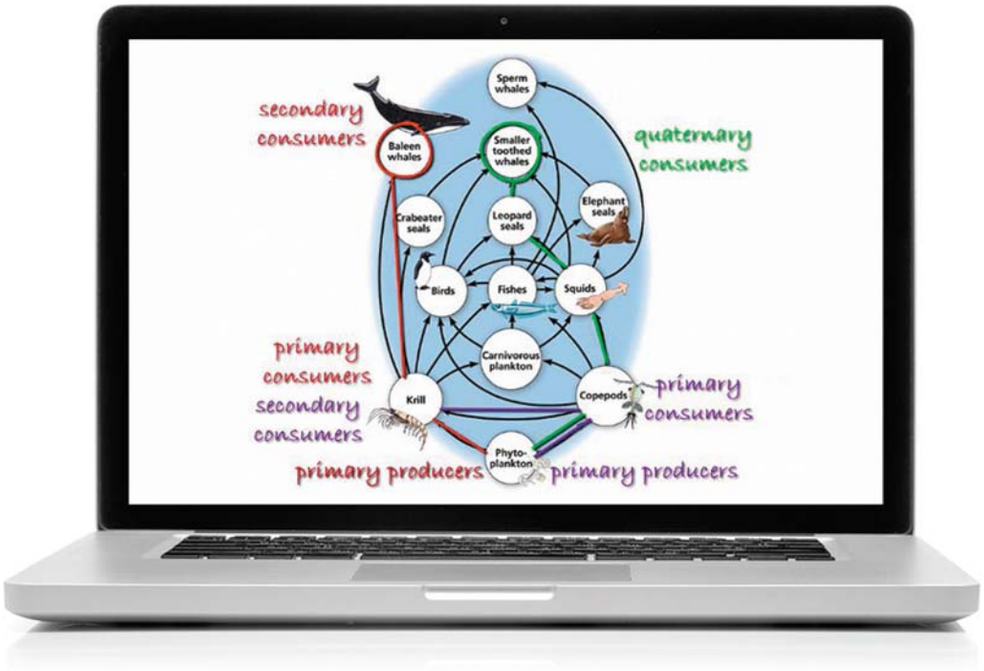


▶ **NEW! Visual Skills Questions** give students practice interpreting illustrations and photos in the text.

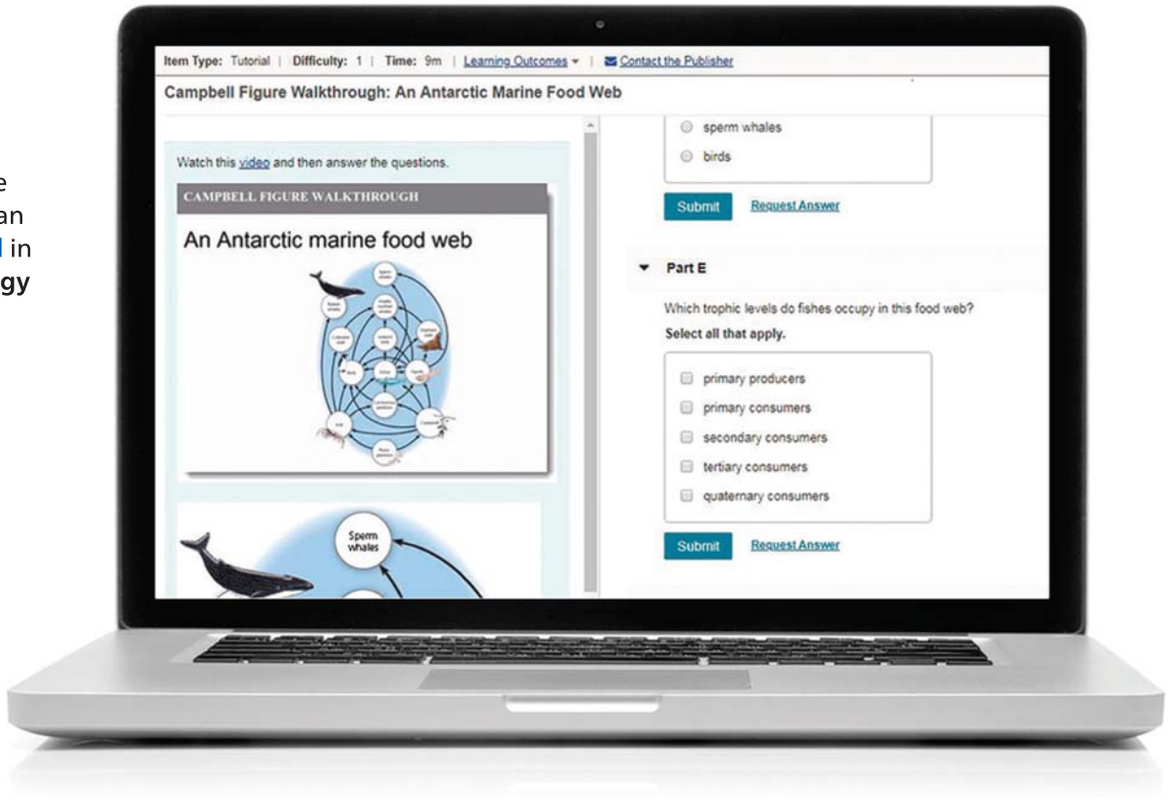


VISUAL SKILLS *If you trace the path of a molecule of carbon dioxide that starts in an arteriole in the right thumb and leaves the body in exhaled air, what is the minimum number of capillary beds the molecule encountered? Explain.*

NEW! Figure Walkthroughs guide students through key figures with narrated explanations and figure markups that reinforce important points.



- **NEW!** The Figure Walkthroughs can also be **assigned** in **Mastering Biology** with questions.



Focus on Scientific Skills and Problem Solving

Scientific Skills Exercises use real data to build key skills needed for biology, including data analysis, graphing, experimental design, and math skills.

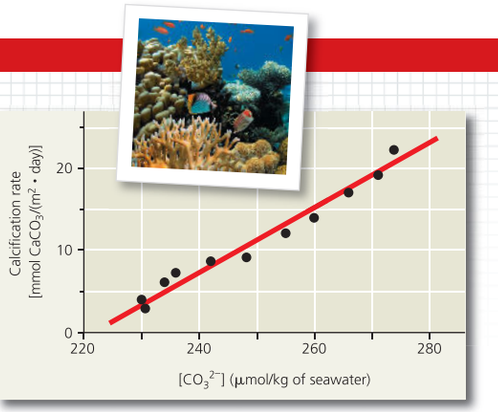
Scientific Skills Exercise

Interpreting a Scatter Plot with a Regression Line

How Does the Carbonate Ion Concentration of Seawater Affect the Calcification Rate of a Coral Reef? Scientists predict that acidification of the ocean due to higher levels of atmospheric CO_2 will lower the concentration of dissolved carbonate ions, which living corals use to build calcium carbonate reef structures. In this exercise, you will analyze data from a controlled experiment that examined the effect of carbonate ion concentration ($[CO_3^{2-}]$) on calcium carbonate deposition, a process called calcification.

How the Experiment Was Done For several years, scientists conducted research on ocean acidification using a large coral reef aquarium at Biosphere 2 in Arizona. They measured the rate of calcification by the reef organisms and examined how the calcification rate changed with differing amounts of dissolved carbonate ions in the seawater.

Data from the Experiment The black data points in the graph form a scatter plot. The red line, known as a linear regression line, is the best-fitting straight line for these points. These data are from one set of experiments, in which the pH, temperature, and calcium ion concentration of the seawater were held constant.



Data from C. Langdon et al., Effect of calcium carbonate saturation state on the calcification rate of an experimental coral reef, *Global Biogeochemical Cycles* 14:639–654 (2000).

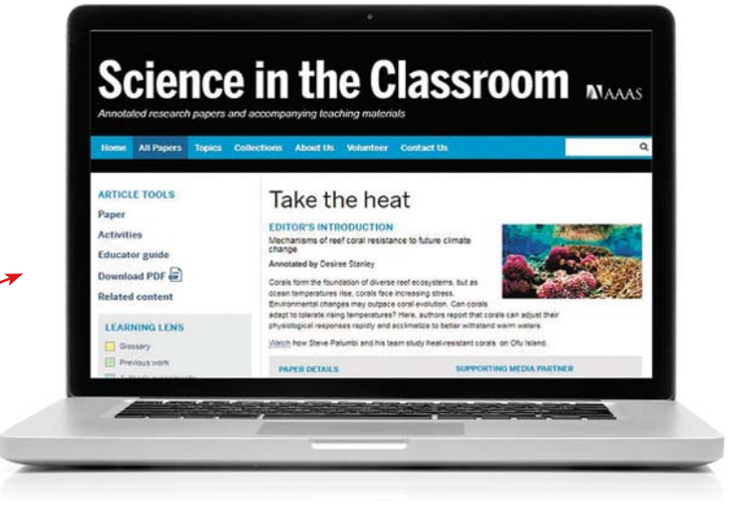
INTERPRET THE DATA

1. When presented with a graph, first determine what each axis represents. **(a)** In words, what is shown on the *x*-axis? (Include the units.) **(b)** What is on the *y*-axis? **(c)** Which variable is the independent variable—the one that was *manipulated* by the researchers? **(d)** Which is the dependent variable—the one that responded to the treatment, which was *measured* by the researchers? (For additional information about graphs, see the Scientific Skills Review in Appendix F.)
2. Based on the data shown in the graph, describe in words the relationship between carbonate ion concentration and calcification rate.
3. If the seawater CO_3^{2-} concentration is 270 μmol/kg, estimate the rate of calcification and how many days it would take 1 square meter of reef to accumulate 30 mmol of $CaCO_3$.
4. **(a)** Which step of the process in Figure 2.25 is measured in this experiment? **(b)** Are the results of this experiment consistent with the hypothesis that increased atmospheric $[CO_2]$ will slow the growth of coral reefs? Why or why not?

Instructors: A version of this Scientific Skills Exercise can be assigned in **Mastering Biology**.

▼ **NEW!** 24 chapters contain links to papers from *Science* on the **AAAS Science in the Classroom** website, where the papers are annotated to aid student comprehension.

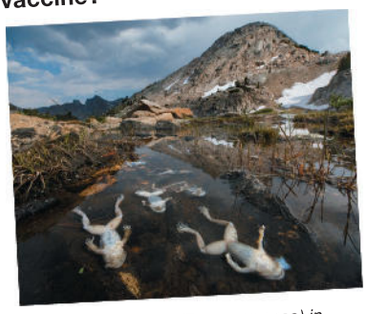
Explore Scientific Papers with Science in the Classroom AAAS
How are some coral reefs responding to climate change?
Go to "Take the Heat" at www.scienceintheclassroom.org.
Instructors: Questions can be assigned in **Mastering Biology.**



NEW! Problem-Solving Exercises guide students in applying scientific skills and intepreting real data in the context of solving a real-world problem.

Problem-Solving Exercise

Can declining amphibian populations be saved by a vaccine?



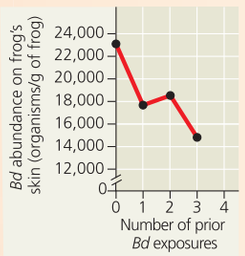
Yellow-legged frogs (Rana muscosa) *in California killed by* Bd *infection*

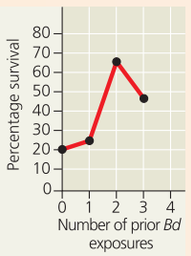
Amphibian populations are declining rapidly worldwide. The fungus *Batrachochytrium dendrobatidis* (*Bd*) has contributed to this decline: This pathogen causes severe skin infections in many amphibian species, leading to massive die-offs. Efforts to save amphibians from *Bd* have had limited success, and there is little evidence that frogs and other amphibians have acquired resistance to *Bd* on their own.

In this exercise, you will investigate whether amphibians can acquire resistance to the fungal pathogen *Bd*.

Your Approach The principle guiding your investigation is that prior exposure to a pathogen can enable amphibians to acquire immunological resistance to that pathogen. To see whether this occurs after exposure to *Bd*, you will analyze data on acquired resistance in Cuban tree frogs (*Osteopilus septentrionalis*).

Your Data To create variation in number of prior exposures to *Bd*, Cuban tree frogs were exposed to *Bd* and cleared of their infection (using heat treatments) from 0 to 3 times; frogs with 0 prior exposures are referred to as "naive." Researchers then exposed frogs to *Bd* and measured mean abundance of *Bd* on the frog's skin, frog survival, and abundance of lymphocytes (a type of white blood cell involved in the vertebrate immune response).





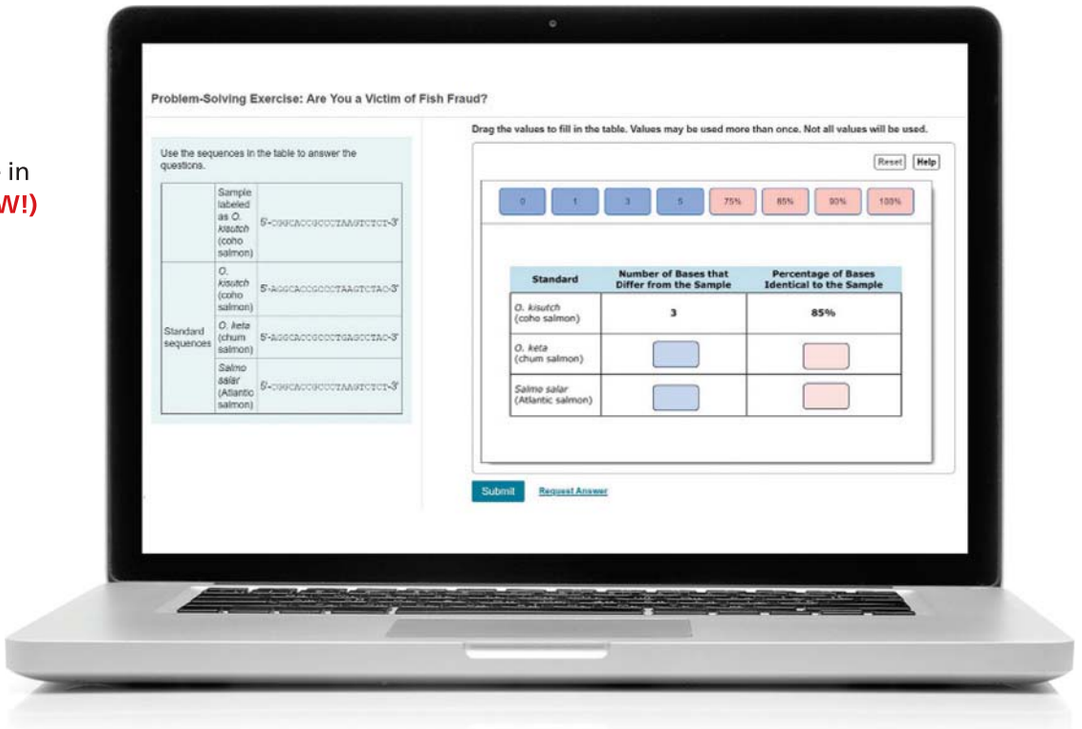
Number of prior *Bd* exposures	Thousands of lymphocytes per g of frog
0	134
1	240
2	244
3	227

Your Analysis

1. Describe and interpret the results shown in the two graphs.
2. **(a)** Graph the data in the table. **(b)** Based on these data, develop a hypothesis that explains the results in the above two graphs.
3. Breeding populations of amphibian species threatened by *Bd* have been established in captivity. In addition, evidence suggests that Cuban tree frogs can acquire resistance after exposure to dead *Bd*. Based on this information and your answers to questions 1 and 2, suggest a strategy for repopulating regions decimated by *Bd*.

Instructors: A version of this Problem-Solving Exercise can be assigned in **Mastering Biology**.

- Scientific Skills Exercises, Problem-Solving Exercises **(NEW!)**, and AAAS Science in the Classroom articles **(NEW!)** are all **assignable** through **Mastering Biology**.



Focus on Making Connections

Ten **Make Connections Figures** pull together content from different chapters, providing a visual representation of "big picture" relationships.

▶ **NEW! Media references in the text** direct students to digital content in the **Mastering Biology** eText and Study Area.

▼ Figure 42.20

MAKE CONNECTIONS

The Working Ecosystem

This arctic tundra ecosystem teems with life during the short two-month growing season each summer. In ecosystems, organisms interact with each other and with the environment around them in diverse ways, including those illustrated here.

Populations Are Dynamic (Chapter 40)

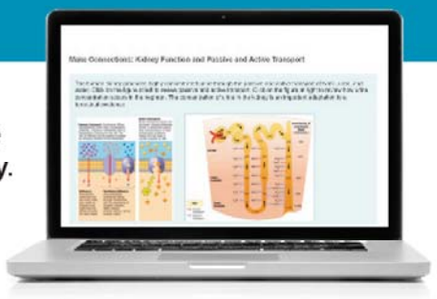
1. Populations change in size through births and deaths and through immigration and emigration. Caribou migrate across the tundra to give birth at their calving grounds each year. (See Figure 40.15.)
2. Snow geese and many other species migrate to the Arctic each spring for the abundant food found there in summer. (See Concept 39.3.)
3. Birth and death rates influence the density of all populations. Death in the tundra comes from many causes, including predation, competition for resources, and lack of food in winter. (See Figure 40.25.)

Mastering Biology
BioFlix® Animation: Population Ecology

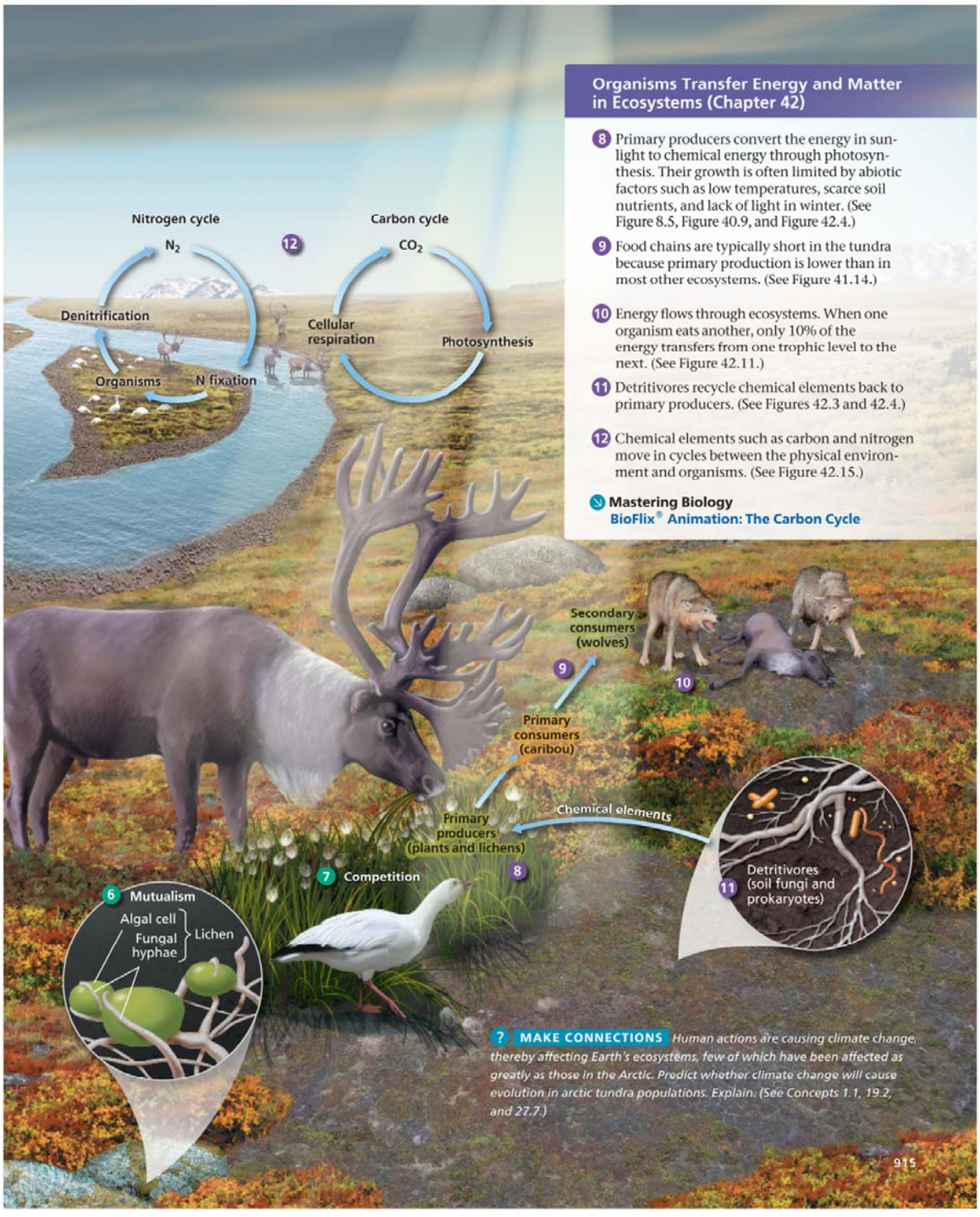
Species Interact in Diverse Ways (Chapter 41)

4. In predation, an individual of one species kills and eats another. (See Concept 41.1.)
5. In herbivory, an individual of one species eats part of a plant or other primary producer, such as a caribou eating a lichen. (See Concept 41.1.)
6. In mutualism, individuals of two species interact in ways that benefit each other. In some mutualisms, the partners live in direct contact, forming a symbiosis; for example, a lichen is a symbiotic mutualism between a fungus and an alga or cyanobacterium. (See Concept 41.1 and Figure 26.30.)
7. In competition, individuals seek to acquire the same limiting resources. For example, snow geese and caribou both eat cottongrass. (See Concept 41.1.)

914



▶ **Make Connections Tutorials** are **assignable** in **Mastering Biology**.



Organisms Transfer Energy and Matter in Ecosystems (Chapter 42)

8 Primary producers convert the energy in sunlight to chemical energy through photosynthesis. Their growth is often limited by abiotic factors such as low temperatures, scarce soil nutrients, and lack of light in winter. (See Figure 8.5, Figure 40.9, and Figure 42.4.)

9 Food chains are typically short in the tundra because primary production is lower than in most other ecosystems. (See Figure 41.14.)

10 Energy flows through ecosystems. When one organism eats another, only 10% of the energy transfers from one trophic level to the next. (See Figure 42.11.)

11 Detritivores recycle chemical elements back to primary producers. (See Figures 42.3 and 42.4.)

12 Chemical elements such as carbon and nitrogen move in cycles between the physical environment and organisms. (See Figure 42.15.)

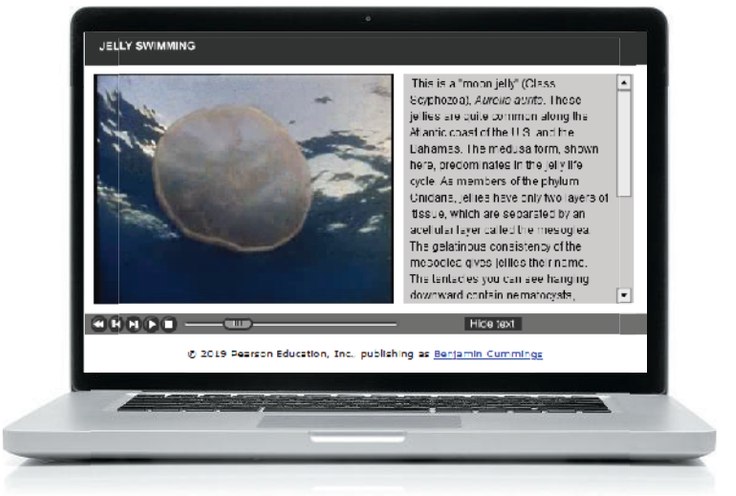
Mastering Biology
BioFlix® Animation: The Carbon Cycle

◀ **Make Connections Questions** in every chapter ask students to relate content to material presented earlier in the course.

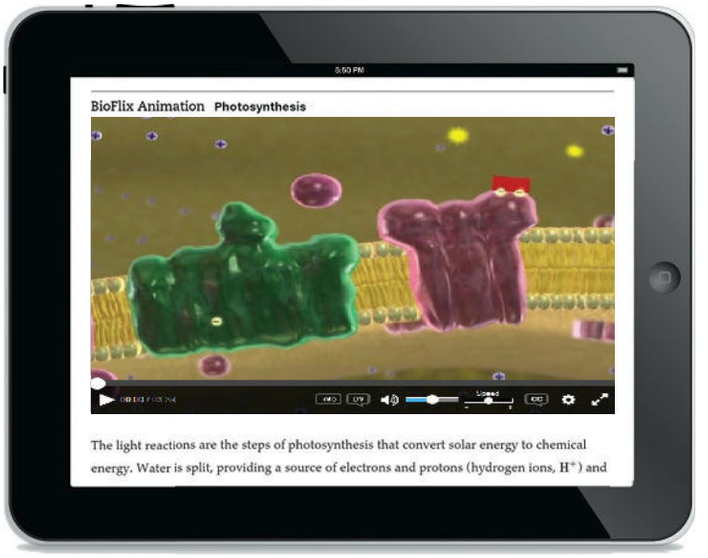
Focus on Student Success with Mastering Biology

NEW! The **eText** includes 400 **Videos, Animations,** and **Figure Walkthroughs** integrated into the digital text, plus **Get Ready for This Chapter Questions**, **Vocab Self-Quizzes**, and **Practice Tests**.

▼ Videos



▼ Animations



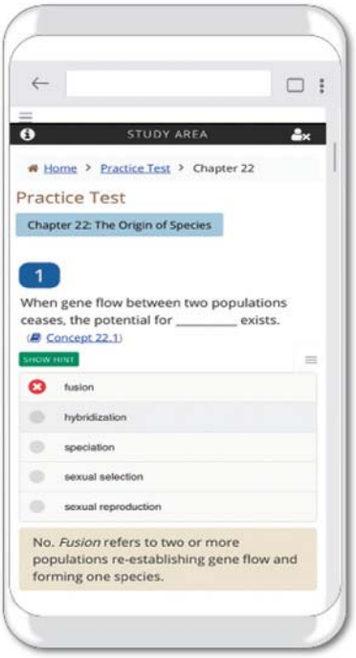
NEW! Additional eText features include:

- Instructor and student note-taking; notes can be shared
- Highlighting
- Bookmarking
- Search
- Links to Glossary terms
- The Pearson eText mobile app can be downloaded from the Apple App Store or Google Play. Includes offline access.

Students who prefer to read a print book can watch videos and animations and test themselves in the **Study Area** as they read.

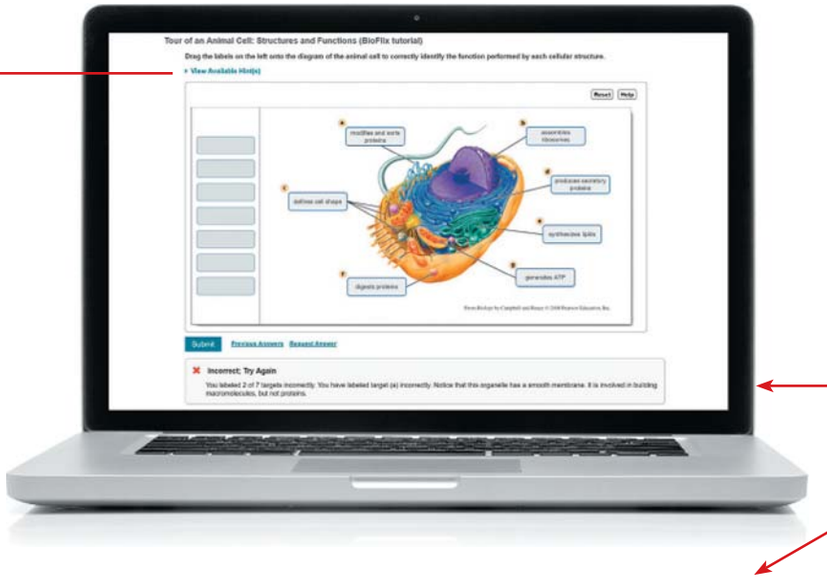
▼ Animations and Videos

▼ Practice Tests



NEW! The eText and Study Area can be accessed from any **computer, tablet, or smartphone**.

Focus on Personalized Coaching in Mastering Biology



Instructors can assign self-paced **Mastering Biology tutorials** that provide students with individualized coaching with specific hints and feedback on the toughest topics in the course.

If a student gets stuck...

1. Specific **wrong-answer feedback** appears in the gray feedback box.

2. **Hints** coach the student to the correct response.

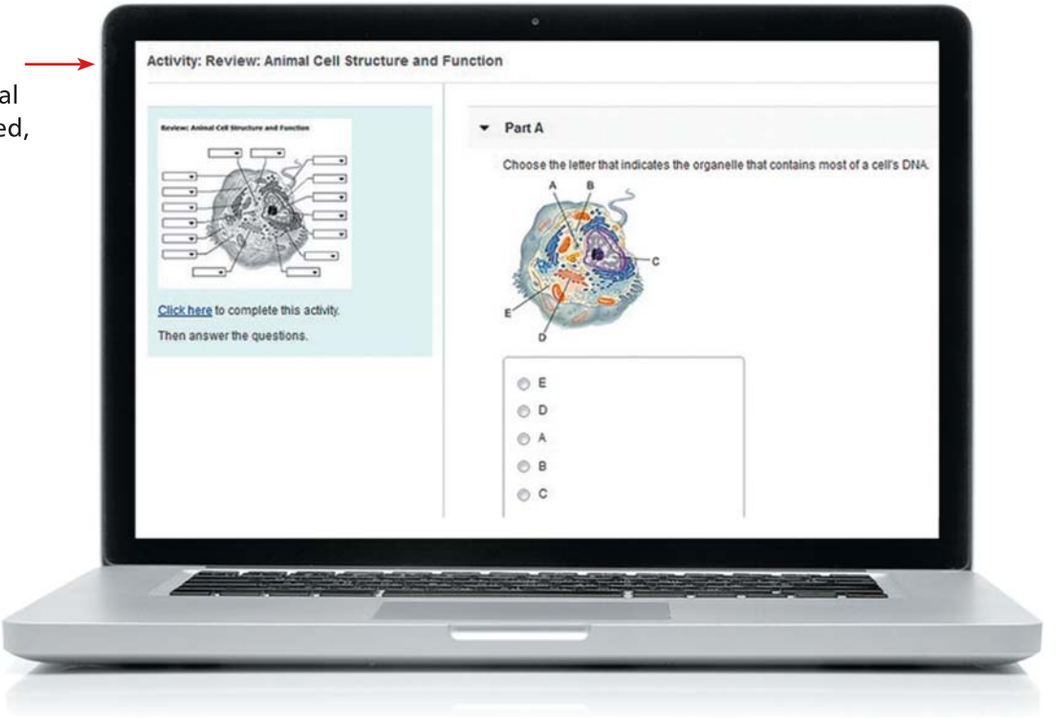
Hint 1. Structure and function of cell organelles

The structure of each organelle in a eukaryotic cell makes it very well-suited for the task it performs. Some examples are described here.

- **Rough endoplasmic reticulum**: This organelle plays an important role in the synthesis of secretory proteins. The outer surfaces of rough ER are studded with ribosomes, the sites where proteins are made. As a protein chain grows from a bound ribosome, it is threaded through a pore in the ER membrane. Once inside, protein folding occurs.
- **Golgi apparatus**: The Golgi is composed of a series of flattened membranous discs called cisternae. Each cisterna forms an enclosed space that houses a distinct set of enzymes used to process proteins in a sequential manner as they are prepared for transport to different sites.
- **Mitochondria**: The inner membrane of a mitochondrion has extensive infoldings, which greatly increase the surface area available for key reactions in the energy-producing processes of cellular respiration.

Hint 2. Which organelles are involved in protein secretion?

3. Optional **Adaptive Follow-Up Assignments** provide additional coaching and practice as needed, continuously adapting to each student's needs.



▼ **Mastering Biology** offers thousands of tutorials, activities, and questions that can be assigned as homework. A few examples are shown below.

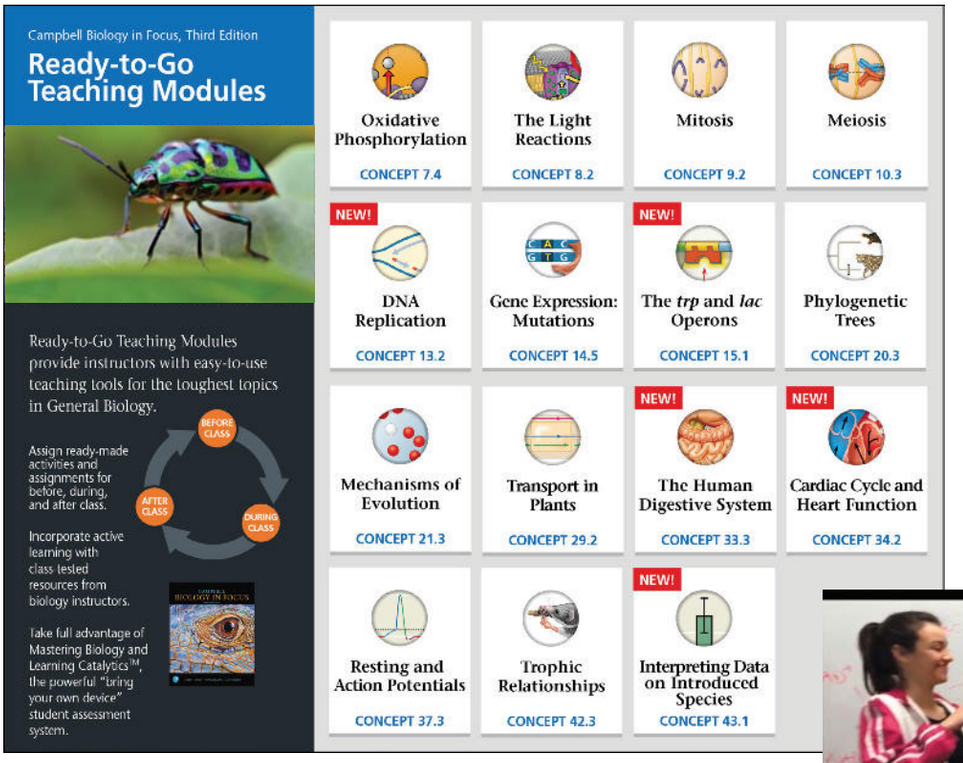
BioFlix Tutorials use 3-D, movie-quality animations and coaching exercises to help students master tough topics outside of class. Animations are also available in the eText and Study Area and can be shown in class.

EXPANDED! HHMI BioInteractive Short Films, documentary-quality movies from the Howard Hughes Medical Institute, engage students in topics from the discovery of the double helix to evolution, with assignable questions.

NEW! Grants in the Galápagos Videos filmed by Peter and Rosemary Grant come with assignable activities in **Mastering Biology**.

Focus on Active Learning

Ready-to-Go Teaching Modules help instructors efficiently make use of the best teaching tools before, during, and after class.



With the Ready-to-Go Teaching Modules, instructors can easily incorporate **active learning** into their courses using suggested activity ideas and questions.

◀ **NEW!** We've added five more teaching modules.

All the modules can be accessed through the Instructor Resources area of **Mastering Biology**.

▶ **Videos** demonstrate how the activities can be used in class.

Learning Catalytics™ allows students to use their smartphone, tablet, or laptop to respond to questions in class.

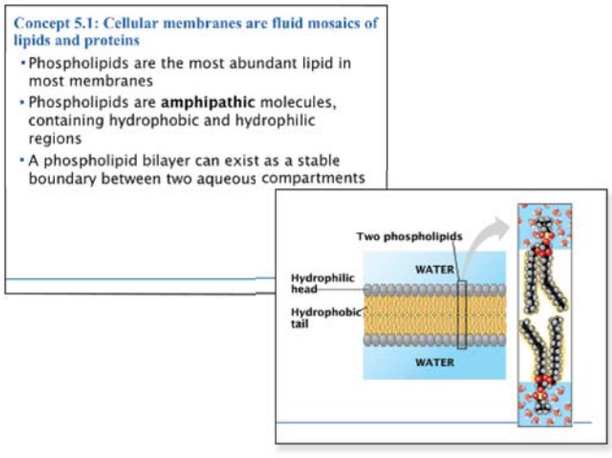
For more information, visit learningcatalytics.com

More Instructor Resources

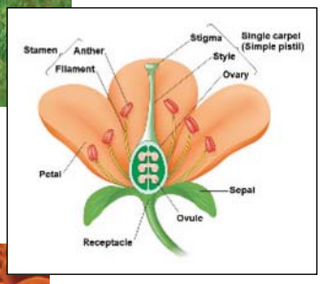
The Instructor Resources Area of Mastering Biology

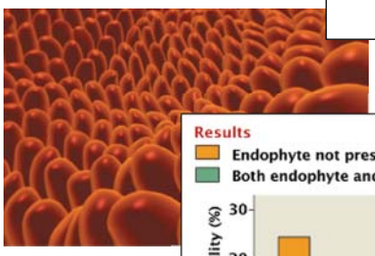
- **5 NEW!** Ready-to-Go Teaching Modules help instructors efficiently make use of the available teaching tools for the toughest topics. Before-class assignments, in-class activities, and after-class assignments are provided for ease of use. Instructors can incorporate active learning into their course with the suggested activity ideas and clicker questions or Learning Catalytics questions.
- Editable figures (art and photos) and tables from the text in PowerPoint®
- PowerPoint Lecture Presentations for each chapter with lecture notes, editable figures (art and photos), tables, and links to animations and videos
- Accessible PowerPoint Lecture Presentations with alt text for every image; students can access alt text with a screen reader if needed.
- JPEG images, including labeled and unlabeled art, photos from the text, and extra photos
- Clicker Questions in PowerPoint
- **EXPANDED!** 400 instructor animations and videos, including BioFlix® 3-D Animations, HHMI Videos and Animations, and much more
- Test Bank questions in TestGen® software and Microsoft® Word. This invaluable resource contains over 4,500 questions, including scenario-based questions and art, graph, and data interpretation questions. **NEW!** Every image has alt text, which students can access with a screen reader if needed.
- **NEW!** **Mastering Biology** Item Library Reference Guide: An at-a-glance reference to assignable resources
- **NEW!** Statistics Worksheets for Biology
- Instructor Answers to Scientific Skills Exercises, Problem-Solving Exercises, Interpret the Data questions, and essay questions; includes rubric and tips for grading short-answer essays
- Instructor Guides for Supplements: *Investigating Biology Lab Prep Guide*; and *Investigating Biology* Lab Data Tables

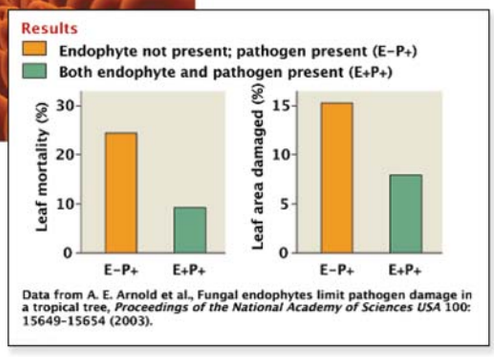
▼ **Customizable PowerPoint Lectures** provide a jumpstart for instruction.



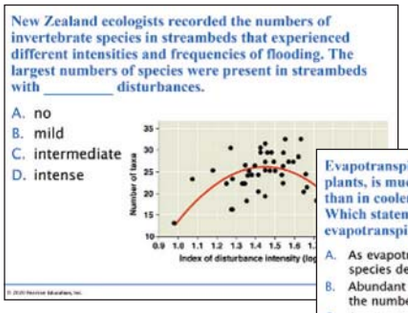
▼ **All of the art, graphs, and photos from the text** are provided with enlarged, customizable labels. More than 1,600 photos from the text and other sources are included.

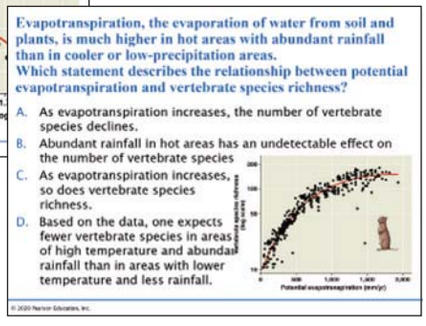






▼ **Clicker Questions** can be used to stimulate effective classroom discussions (for use with or without clickers).





Learning Management Systems

Integration with various learning management systems is available for **Mastering Biology**. Contact your sales representative for details.

Student and Lab Supplements

FOR STUDENTS

Spanish Glossary for Biology
by Laura P. Zanello, University of California, Riverside
978-0-32183498-0 / 0-321-83498-4
For all the glossary terms, this resource provides definitions in Spanish.

Into The Jungle: Great Adventures in the Search for Evolution
by Sean B. Carroll, University of Wisconsin, Madison
978-0-32155671-4 / 0-321-55671-2
These nine short tales vividly depict key discoveries in evolutionary biology and the excitement of the scientific process.

Get Ready for Biology
by Lori K. Garrett, Parkland College
978-0-32150057-1 / 0-321-50057-1
This engaging workbook helps students brush up on important math and study skills and get up to speed on biological terminology and the basics of chemistry and cell biology. Also available in **Mastering Biology**.

***A Short Guide to Writing About Biology*, Ninth Edition**
by Jan A. Pechenik, Tufts University
978-1-292-12083-6 / 1-292-12083-5
This best-selling writing guide teaches students to think as biologists and to express ideas clearly and concisely through their writing.

***An Introduction to Chemistry for Biology Students*, Ninth Edition**
by George I. Sackheim, University of Illinois, Chicago
9780805395716 / 0805395717
This text/workbook helps students review and master all the basic facts, concepts, and terminology of chemistry that they need for their life science course.

FOR LAB

***Investigating Biology Laboratory Manual*, Eighth Edition**
by Judith Giles Morgan, Emory University, and M. Eloise Brown Carter, Oxford College of Emory University
978-1-292-06130-6 / 1-292-06130-8
With its distinctive investigative approach to learning, this best-selling laboratory manual is now more engaging than ever, with full-color art and photos throughout. The lab manual encourages students to participate in the process of science and develop creative and critical-reasoning skills.

Preparation Guide for Investigating Biology
Contains materials lists, suggested vendors, instructions for preparing solutions and constructing materials, schedules for planning advance preparation, and more. Available for downloading through the Instructor Resources area of **Mastering Biology**.

Mastering Biology LabBench
The LabBench pre-labs feature 13 online tutorials in **Mastering Biology** that will both prepare students for their lab work and reinforce key biological principles.

Scientific Skills and Problem-Solving Exercises

Scientific Skills Exercises

Ch. 1 Interpreting a Pair of Bar Graphs, *p. 64*

Ch. 2 Interpreting a Scatter Plot with a Regression Line, *p. 87*

Ch. 3 Analyzing Polypeptide Sequence Data, *p. 117*

Ch. 4 Using a Scale Bar to Calculate Volume and Surface Area of a Cell, *p. 128*

Ch. 5 Interpreting a Scatter Plot with Two Sets of Data, *p. 159*

Ch. 6 Making a Line Graph and Calculating a Slope, *p. 184*

Ch. 7 Making a Bar Graph and Evaluating a Hypothesis, *p. 205*

Ch. 8 Making Scatter Plots with Regression Lines, *p. 226*

Ch. 9 Interpreting Histograms, *p. 246*

Ch. 10 Making a Line Graph and Converting Between Units of Data, *p. 260*

Ch. 11 Making a Histogram and Analyzing a Distribution Pattern, *p. 277*

Ch. 12 Using the Chi-Square (χ^2) Test, *p. 296*

Ch. 13 Working with Data in a Table, *p. 307*

Ch. 14 Interpreting a Sequence Logo, *p. 343*

Ch. 15 Analyzing DNA Deletion Experiments, *p. 365*

Ch. 16 Analyzing Quantitative and Spatial Gene Expression Data, *p. 377*

Ch. 17 Analyzing a Sequence-Based Phylogenetic Tree to Understand Viral Evolution, *p. 405*

Ch. 18 Reading an Amino Acid Sequence Identity Table, *p. 422*

Ch. 19 Making and Testing Predictions, *p. 444*

Ch. 20 Using Protein Sequence Data to Test an Evolutionary Hypothesis, *p. 463*

Ch. 21 Using the Hardy-Weinberg Equation to Interpret Data and Make Predictions, *p. 473*

Ch. 22 Identifying Independent and Dependent Variables, Making a Scatter Plot, and Interpreting Data, *p. 493*

Ch. 23 Estimating Quantitative Data from a Graph and Developing Hypotheses, *p. 513*

Ch. 24 **NEW!** Calculating and Interpreting Means and Standard Errors, *p. 547*
Making a Bar Graph and Interpreting Data*

Ch. 25 Interpreting Comparisons of Genetic Sequences, *p. 555*

Ch. 26 Interpreting Genomic Data and Generating Hypotheses, *p. 583*

Ch. 27 Understanding Experimental Design and Interpreting Data, *p. 626*

Ch. 28 Using Bar Graphs to Interpret Data, *p. 635*

Ch. 29 Calculating and Interpreting Temperature Coefficients, *p. 653*

Ch. 30 Using Positive and Negative Correlations to Interpret Data, *p. 688*

Ch. 31 Interpreting Experimental Results from a Bar Graph, *p. 712*

Ch. 32 Describing and Interpreting Quantitative Data, *p. 735*

Ch. 33 Interpreting Data from an Experiment with Genetic Mutants, *p. 760*

Ch. 34 Interpreting Data in Histograms, *p. 777*

Ch. 35 Comparing Two Variables on a Common *x*-Axis, *p. 804*

Ch. 36 Making Inferences and Designing an Experiment, *p. 817*

Ch. 37 Interpreting Data Values Expressed in Scientific Notation, *p. 843*

Ch. 38 Designing an Experiment Using Genetic Mutants, *p. 853*

Ch. 39 Interpreting a Graph with Log Scales, *p. 881*

Ch. 40 Using the Logistic Equation to Model Population Growth, *p. 916*

Ch. 41 Using Bar Graphs and Scatter Plots to Present and Interpret Data, *p. 926*

Ch. 42 Interpreting Quantitative Data, *p. 951*

Ch. 43 Graphing Cyclic Data, *p. 980*

* Available only in Mastering Biology. All other Scientific Skills Exercises are in the print book, eText, and Mastering Biology.

NEW! Problem-Solving Exercises

Ch. 3 Are you a victim of fish fraud? *p. 117*

Ch. 14 Are insulin mutations the cause of three infants' neonatal diabetes? *p. 351*

Ch. 22 Is hybridization promoting insecticide resistance in mosquitoes that transmit malaria? *p. 498*

Ch. 27 Can declining amphibian populations be saved by a vaccine? *p. 617*

Ch. 31 How will climate change affect crop productivity? *p. 711*

Ch. 32 Is thyroid regulation normal in this patient? *p. 728*

Ch. 42 Can an insect outbreak threaten a forest's ability to absorb CO_2 from the atmosphere? *p. 949*