CAMPBELL
BIOLOGY

CANADIAN EDITION

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Original edition published by Pearson Education, Inc., Upper Saddle River, New Jersey, USA.

10 9 8 7 6 5 4 3 2 1—CKV

Library and Archives Canada Cataloguing in Publication
Campbell biology / Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson, Fiona E. Rawle, Dion Glenn Durnford, Christopher D. Moyes, Sandra J. Walde, Kenneth E. Wilson. — Canadian edition.
Includes index.
ISBN 978-0-321-77830-7 (bound)
1. Biology—Textbooks. I. Reece, Jane B., contributing author
II. Title: Biology.
QH308.2.C34 2013 570 C2013-904728-X

PEARSON

978-0-321-77830-7

About the Canadian Authors

Fiona Rawle: (Units 1–4; editor Units 1–8) received her Ph.D. from Queen's University in Kingston, Ontario. She is a teaching-stream faculty member at the University of Toronto at Mississauga, where she teaches Introduction to Evolution and Evolutionary Genetics, Introductory Genetics, and Molecular Basis of Disease. Fiona's teaching and pedagogical research interests focus on several areas: (1) the development of case studies to immerse students in real-world biological challenges and allow students to connect with material from different perspectives; (2) the development of active learning techniques that can be used in large class settings. Active learning has been shown to increase student comprehension of complex biological topics; and (3) the development of scientific literacy interventions that can be used across the undergraduate biology curriculum. Fiona was the recipient of a 2010 Faculty Award for Teaching Excellence while at Wilfrid Laurier University.

Dion Durnford (Unit 5) is a professor at the University of New Brunswick, in Fredericton. He earned a B.Sc. in Biology from Dalhousie University and a Ph.D. in Botany from the University of British Columbia. His research has focused on the evolution of light-harvesting antenna systems and the role of these proteins in light-harvesting and photo-protection in microalgae. His recent work is examining how microalgae age and their strategies for increasing longevity. Dion was the recipient of the 2002 Faculty of Science Excellence in Teaching award and the 2010 Allan P. Stewart Award for Excellence in Teaching.

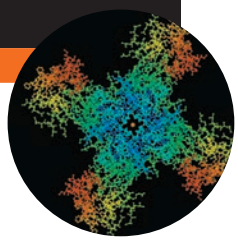
Chris Moyes (Unit 7) is a comparative physiologist, focusing on the muscle biochemistry and energetics. He received his Ph.D. in Zoology from the University of British Columbia (1991) and is currently a Professor in the Department of Biology, Queen's University. He has published more than 100 research papers and contributed to four books. He is co-author of Principles of Animal Physiology, first published in 2006.

Sandra Walde (Unit 8) is a professor of biology and associate dean of science at Dalhousie University. She received her B.Sc. in Biology and Ph.D. in Ecology from the University of Calgary, and then went to the University of California, Santa Barbara, as a post-doctoral fellow. At Dalhousie, she teaches general ecology to first and second year students and population ecology to upper year students. Sandy's research has focussed on dispersal and ecological interactions in aquatic and terrestrial communities. She feels lucky that her field work has taken her to some beautiful places, including studies of stream invertebrate communities in Alberta and Nova Scotia, and research on native fishes in the lakes of the Patagonian Andes.

Kenneth Wilson (Unit 6) is a professor in the Department of Biology at the University of Saskatchewan. He has a B.Sc. in Biochemistry from the University of Waterloo and a Ph.D. in Plant Sciences from the University of Western Ontario. His research focuses on the perception of environmental stresses in plant cells and the regulation of photosynthesis. However, he has published research papers on topics ranging from the acclimation of plants to ultraviolet light, to the identification of algal species for use as sources of biodiesel. He teaches Introductory Biology, Plant Physiology and Genetics, as well as supervising graduate student research projects. In 2010, he received the Provost's Award for Outstanding Teaching and the College of Arts and Sciences Teaching Excellence Award from the University of Saskatchewan.

Brief Contents

Detailed Contents



Preface

For the past quarter century, *Campbell BIOLOGY* has been the leading textbook in the biological sciences, has been translated into more than a dozen languages, and has provided millions of students with a solid foundation in biology. This success is a testament not only to Neil Campbell's original vision, but also to the dedication of reviewers, who, together with authors and artists, shaped and inspired this work. Science and pedagogy are not static, but as they evolve so does *Campbell BIOLOGY*.

The Canadian edition represents a new milestone in the evolution of this text. As *Campbell BIOLOGY*, the Canadian edition maintains and promotes the goals of Neil Campbell and prior editions—helping students make connections visually across the topics of biology; providing students with a solid foundation in scientific thinking and quantitative reasoning skills; and inspiring students with the excitement and relevance of modern biology, particularly in the realm of genomics. The starting point, as always, is the commitment to crafting text and visuals that are accurate, current, and reflect a passion for teaching and learning about biology.

The Canadian Edition: Key Concepts and Unifying Themes

In creating a Canadian edition of *Campbell BIOLOGY*, we expose students to biology that they encounter in this country—either their permanent home, or their temporary home while attending school. Relating content to local experiences helps students form deeper connections with the subject and makes learning more meaningful. This edition opens a window on Canadian researchers and their work, both in and beyond Canada. It will surprise students with biological research that takes place nearer to them than they realize, and it will impress upon them the fact that one day such research could be conducted by them. They will read about places they recognize; they will learn about flora, fauna, and species they recognize; and they will know their country better by what they see and read in this Canadian edition.

In each chapter of this textbook, a framework of three to six carefully chosen **Key Concepts** provide context for supporting details, helping students distinguish the "forest" from the "trees." The numbered Key Concepts are presented at the beginning of the chapter and then serve as headings for each chapter section. *Concept Check Questions* at the end of each section provide a hierarchical framework for self-assessment that builds students' confidence and then challenges them to push the limits of their understanding with several types of critical thinking questions. The *Summary of Key Concepts* at the end of the chapter refocuses students on the main points. *Campbell BIOLOGY* also helps students organize and make sense of what they learn on a grander scale by emphasizing **evolution and other unifying themes** that pervade biology. These themes are introduced in Chapter 1 and integrated throughout the book.

CONNECTIONS FIGURES: MAKING CONNECTIONS VISUALLY ACROSS TOPICS

The Canadian edition incorporates **Make Connections Figures** that draw together topics from different chapters to show how they relate in the "big picture." By reinforcing fundamental conceptual connections throughout biology, these figures help overcome a student's tendency to compartmentalize information.

Because text and illustrations are equally important for learning biology, integration of text and figures is a hallmark of this text. In addition to the Make Connections Figures, **Exploring Figures** on selected topics epitomize this approach: Each is a learning unit of core content that brings together related illustrations and text. Visual Organizer Figures highlight the main parts of a figure, helping students see key categories at a glance, and Summary Figures visually recap information from the chapter.

CONNECTIONS QUESTIONS: MAKING CONNECTIONS ACROSS CHAPTERS

Make Connections Questions help students recognize that different areas of biology tie together. Each question challenges students to move beyond memorization and gain a deeper understanding of biological principles by asking them to relate chapter content to material they learned earlier in the course. For example, asking to connect DNA replication (Chapter 16) to the cell cycle (Chapter 12), soil formation (Chapter 37) to the properties of water (Chapter 3), and aquatic biomes (Chapter 52) to osmoregulation (Chapter 44). At least three Make Connections Questions appear in each chapter. In addition, online *Make Connections Tutorials* in MasteringBiology® connect content from two different chapters employing art from the textbook.

EVOLUTION COVERAGE: MAKING CONNECTIONS TO EVOLUTION IN EVERY CHAPTER

Evolution is the core theme of biology. Beginning the exploration of this pivotal topic, Chapter 1 states that evolution explains the unity and diversity of life. Weaving this theme throughout the book, the **Evolution section in**

every chapter focuses on evolutionary aspects of chapter material, and each chapter ends with an Evolution Connection Question and a Write About a Theme Question. For example, refer to discussions of enzyme evolution (p. 167), coevolution of flowers and pollinators (p. 864), and evolution of hormone function in animals (p. 1059).

IMPACT FIGURES: MAKING CONNECTIONS BETWEEN SCIENTIFIC ADVANCES AND THE REAL WORLD

Impact Figures motivate students by highlighting the dramatic impact of recent discoveries in biology. These figures feature high-interest topics such as the threat of ocean acidification to marine life (Chapter 3), the decoding of chromosome 7 (Chapter 15), and global warming and arctic mammals (Chapter 46). The *Why It Matters* section of each figure explains the relevance of the research to students' lives, global problems, or the field of biology itself. Impact Figures end with a suggestion for *Further Reading* and a *What If?* or *Make Connections question* to develop critical thinking skills.

VISUAL ORGANIZERS AND 3-D ART: MAKING CONNECTIONS VISUALLY

The **Visual Organizer** format highlights the main parts of a figure, helping students see the key categories at a glance. See, for instance, Figure 17.24 on types of small-scale mutations or Figure 27.3, gram staining. Throughout the book, selected figures have been rendered in a more **3-D art style** while keeping an appropriate balance between realism and teaching effectiveness. Figure 52.3, Exploring Global Climate Patterns, is one example.

CHAPTER REVIEWS: MAKING CONNECTIONS AT A HIGHER LEVEL

In the chapter summaries, each concept section concludes with a **Summary of Key Concepts Question** tied to a major learning goal. End-of-chapter questions increase student awareness of different levels of thinking by organizing questions into three levels, based on **Bloom's taxonomy**, which classifies types of thinking that are important in learning. Our levels are (1) Knowledge/Comprehension, (2) Application/Analysis, and (3) Synthesis/Evaluation. (These same levels are used in the *Campbell Biology* Test Bank.) The range of question types helps students develop critical thinking skills and prepare for the kinds of questions that they will encounter on exams. New **Write About a Theme** questions give students practice writing short, coherent essays that connect the chapter's content to one of the book's themes. A **MasteringBiology® preview section** at the end of each chapter lists *Assignments*—tutorials, activities, and questions that educators can assign. This section also directs students to the *eText* and *Study Area* for online self study.

Content Highlights of the Canadian Edition

CHAPTER 1 INTRODUCTION: EVOLUTION AND THE THEMES OF BIOLOGY

The Canadian edition of *Campbell Biology* focuses on the flora and fauna native to Canada and the research conducted here, while continuing the tradition and quality of biology education established by Neil Campbell. The carnivorous sundew plant on the cover of the Canadian edition reflects the tradition of picturing a plant on the cover of *Campbell Biology* and establishes the fact that the Campbell art program remains a distinguishing feature. The Canadian edition also includes a **Make Connections Figure** at the beginning of each unit, a two-page spread, which links concepts between units. It also continues to ensure that research guides content, stating, significantly, that evolution is not simply a theory, but a fact.

UNIT ONE THE CHEMISTRY OF LIFE

Make Connections Figure: The unique properties of water. Basic chemistry is enlivened by content that connects it to evolution, ecology, and other areas of biology. Examples include omega-3 fatty acids, the isomeric forms of methamphetamine, arsenic contamination of groundwater, and the basis of mad cow disease. Chapter 5 includes Concept 5.6 on the transformation of biological inquiry and applications to genomics and proteomics. The first three units include computer models of important proteins in contexts where they support students' understanding of molecular function. Unit 1 also highlights research by the Department of Fisheries and Oceans, as well as the work of John Rubinstein at the University of Toronto on electron cryomicroscopy.

UNIT TWO THE CELL

Make Connections Figure: The structure and function of cells. Connections to evolution include an introduction to the endosymbiont theory in Chapter 6 and interesting evolutionary adaptations of cell membranes in Chapter 7. Chapter 6 also introduces discussion of the nonphotosynthetic functions of chloroplasts and disease-causing mutations that reveal information about the function of mitochondrial proteins and the mitochondrion. A section in Chapter 8 on the evolution of enzymes with new functions provides an early introduction to the concept that mutations contribute to molecular evolution. Chapter 9 simplifies the glycolysis figure and emphasizes pyruvate oxidation as a separate step to help students focus on the main ideas. Unit 2 also features the identification of LHON mutations by Eric Shoubridge at McGill University; the International Cancer Genome Consortium, co-founded by Thomas Hudson,

Scientific Director of the Ontario Institute of Cancer Research; and work on membrane proteins by Frances Sharom at the University of Guelph.

UNIT THREE GENETICS

Make Connections Figure: The chromosomal basis and molecular basis of inheritance. *CAMPBELL BIOLOGY* highlights Canadian researchers and their work, both at home and abroad, so that students will connect their studies to the world of research taking place all around them and understand that they, too, can play a key role in scientific discovery. Unit 3 features the work of Stephen Scherer, who produced a detailed annotated map and DNA sequence of human chromosome 7; Calvin Harley and the discovery of telomeres; Michael Houghton, whose research team recently developed a vaccine for the hepatitis C virus at the University of Alberta; the Michael Smith Genome Sciences Centre in Vancouver, which generated the first genome sequence of SARS; Frank Plummer at the National Microbiology Laboratory in Winnipeg, whose team sequenced the full genome of H1N1 flu samples; James Till and Ernest McCulloch, the Canadian scientists who discovered stem cells; and Michael Rudnicki, who led the team that discovered adult muscle stem cells at the Sprott Centre for Stem Cell Research in Ottawa. In addition, genomics research in Canada is featured in an Exploring Figure, which highlights the International Barcode of Life Network led by Paul Hebert at the University of Guelph; single-cell genomics research by Carl Hansen and Marco Marra at the University of British Columbia; GRASP: Genomics Research on Atlantic Salmon Project led by William Davidson and Ben Koop; ARCTIC: Assessment of Risk for Colorectal Tumours in Canada; research into mutations predisposing individuals to type 2 diabetes mellitus led by Robert Sladek at McGill; the Stem Cell Genomics Project led by Michael Rudnicki; and Treenomix: Conifer Forest Health Project led by Jorg Bohlmann and Kermit Ritland.

UNIT FOUR MECHANISMS OF EVOLUTION

Make Connections Figure: The sickle-cell allele and malaria. The evidence for evolution is vast. Unit 4 bolsters this evidence by presenting examples and figures that illustrate key conceptual points throughout. Chapter-opening highlights include profiles of the bombardier beetle and the evolution of its behaviour; the red squirrel and research indicating that populations of this squirrel are evolving; and the flightless cormorant. Chapter 23 traces population changes in greater prairie chickens, which the Canadian *Species at Risk Act* (SARA) lists as extirpated in Canada, although some populations remain in U.S. prairie states. The storyline of this unit ensures that the chapters flow smoothly and build to a clear overall picture of what evolution is and how it works. For instance, connections between Chapters 24 and 25 illustrate how differences in speciation and extinction rates shape the broad patterns in the history of life. Highlighted research includes the work of Robert Reisz on the discovery of the earliest dinosaur nest and of Charles Henderson and others who pinpointed the end-Permian mass extinction.

UNIT FIVE THE EVOLUTIONARY HISTORY OF BIOLOGICAL DIVERSITY

Make Connections Figure: Evolution and the diversity of life. The diversity unit covers the scientific evidence underlying the story of evolution. In dealing with the construction of phylogenies, we concentrate on the interpretation of trees, rather than building them. There is a Research Method Figure on the concept of "DNA barcoding" in Chapter 26. Other figures cover the human microbiome, the Carboniferous period and coal formation, the transition to land, plant evolution, the Burgess Shale, and a discussion of the role of bees in the fertilization of important agricultural crops. In addition, Chapter 27 presents findings on the evolutionary origin of bacterial flagella. Applications and ecological information are woven into discussions of groups of organisms. Examples include material on global growth of photosynthetic protists in Chapter 28, endangered molluscs in Chapter 33, and the impact of a pathogenic chytrid fungus on amphibian population declines in Chapters 31 and 34. This unit also highlights the work on mycorrhizal networks by Suzanne Simard at the University of British Columbia.

UNIT SIX PLANT FORM AND FUNCTION

Make Connections Figure: Plant form and function. Plant biology sits in a transitional phase. The Canadian edition continues to balance the old and the new to provide students with a basic understanding of plant anatomy and function while highlighting dynamic areas of plant research and the connections between plants and other organisms. Amongst others, we highlight the work of Rob Guy at the University of British Columbia, on balsam poplar trees; Doug Larson at the University of Guelph, on cedars growing out of the rock face of the Niagara Escarpment; and R. Keith Downey at the Ministry of Agriculture in Saskatoon, and Baldur Stefansson at the University of Manitoba in Winnipeg, on canola oil. An Inquiry Figure features the work of Bruce Greenberg and Bernie Glick at the University of Waterloo on the possible effects of soil bacteria.

UNIT SEVEN ANIMAL FORM AND FUNCTION

Make Connections Figure: Life challenges and solutions in animals. This unit strives to introduce physiological systems through a comparative approach that underscores how adaptations are linked to shared physiological challenges. Material on evolution is integrated to highlight diversity

and the underlying functional constraints that affect all systems. There is also a rich history of behavioural research in Canada, and many of the examples used derive from Canadian work, which will encourage students to continue to make connections beyond their studies. An Inquiry Figure features the work of Sarah Iverson at Dalhousie University, on the analysis of lipid profiles to dissect food webs in free-roaming animals, and an Impact Figure features Ralph Steinman's Nobel Prize work on dendritic cells. There is a description of the work of Brenda Milner, the McGill researcher who introduced the world of neuropsychology to patient HM. Additional research highlighted in this unit includes Janet Rossant at the University of Toronto on cell fate determination; Naweed Syed at the University of Calgary on synaptic repair; University of British Columbia researchers exploring the impact of global warming trends on salmon; University of Manitoba research that explores structure-function relationships in hemoglobin of woolly mammoths; Karen Kidd at the University of New Brunswick on environmental estrogens; and Barrie Frost of Queen's University, who explored the navigational mechanisms used by monarch butterflies.

UNIT EIGHT ECOLOGY

Make Connections Figure: Ecological research on wolves in Algonquin Provincial Park. Biologists are increasingly asked to apply their knowledge to help solve global problems that profoundly affect life on Earth. *Campbell BIOLOGY* uses evidence-based pedagogy to support this goal. Inquiry Figures feature examples of coastal eutrophication and Great Lakes invasions. In addition, Impact Figures on coyote expansion and hybridization, elephant poaching, and the work of David Schindler show students how ecologists apply biological knowledge and ecological theory to understand and solve problems in the world around them. Introducing the global nature of climate and its effects on life in Chapter 52 provides a logical foundation for the rest of this unit. Chapters 53 and 54 highlight factors that limit population growth, the ecological importance of disease, positive interactions among organisms, and biodiversity. Chapter 55 explores restoration ecology together with ecosystem ecology because successful restoration efforts depend on understanding ecosystem structure and function. Chapter 56 emphasizes the combined importance of conservation and our changing Earth, including an Exploring Figure on climate change and an emphasis on the science behind climate change.

Campbell BIOLOGY's Hallmark Features

Teachers of majors biology face a daunting challenge: to help students acquire a conceptual framework for organizing an ever-expanding amount of information. The hallmark features of *Campbell BIOLOGY* provide such a framework, while promoting a deeper understanding of biology and the process of science.

Campbell BIOLOGY helps students organize and make sense of what they learn by emphasizing evolution and other unifying themes that pervade biology. Described above and introduced in Chapter 1, these themes are integrated throughout the text. To encourage active reading of the text, *Campbell BIOLOGY* includes numerous opportunities for students to stop and think about what they are reading, often by sketching, annotating a figure, or graphing data. Active learning questions include Make Connections questions, What If? questions, Draw It questions, and Summary questions.

Finally, *Campbell BIOLOGY* features scientific inquiry, an essential component of any biology course. Complementing stories of scientific discovery in the text narrative and the unit-opening interviews, *Campbell BIOLOGY's* standard-setting **Inquiry Figures** deepen the ability of students to understand how we know what we know, and Scientific Inquiry questions give students opportunities to practice scientific thinking.

INSTRUCTOR ANCILLARIES

MasteringBiology®

MasteringBiology is an instructor-assigned homework system that makes it easy to organize classes and sections, personalize students' educational experience, and push learning to the next level.

Designed to help with maximization of lecture time, MasteringBiology offers customizable, easy-to-assign, and automatically graded assessments and pedagogical tools that motivate students to learn outside of class, and arrive prepared for lecture.

With MasteringBiology, educators can assign a variety of material: Case Studies, Quizzes, BioFlix® Tutorials with 3-D Animations, Experimental Inquiry Tutorials, Interpreting Data Tutorials, BLAST Tutorials, Make Connections Tutorials, Misconception Questions, and more.

Adaptive Follow-Up Assignments within MasteringBiology provide coaching and practice that continually adapt to each student's needs, making efficient use of study time.

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LearningCatalytics™, available through MasteringBiology, is an interactive classroom solution and response system that leads to just-in-time teaching opportunities. Educators can create multiple-choice questions, or open-ended questions that require graphical, textual, or numerical answers, and students can use their smartphones, tablets, or laptops to respond.

MasteringBiology®: Virtual Biology Labs

This online environment promotes critical thinking skills using virtual experiments and explorations that may be difficult to perform in a wet lab environment due to time, cost, or safety concerns. Designed to supplement or substitute wet labs, this product offers students unique learning experiences and critical thinking exercises in the areas of microscopy, molecular biology, genetics, ecology, and systematics.

Testbank

A testbank offering over 4000 questions is available either in Word (Test Item File) or in a computerized format (Pearson TestGen). Pearson TestGen is a powerful program that enables educators to view and edit existing questions, create new questions, and generate quizzes, tests, exams, or homework. With Pearson TestGen, educators can also administer tests on a local area network, have tests graded electronically, and then have the results prepared in electronic or printed reports.

PowerPoint Slides

Every chapter features a Microsoft PowerPoint® slide deck that highlights, illuminates, and builds on key concepts for your lecture or online delivery. Think-pair-share questions appear after major topics to help with the incorporate active learning opportunities. Each deck can be tailored to suit individual into lectures.

Image Libraries

Image libraries of labelled and unlabelled art help with the creation of vibrant lecture presentations. Most figures, tables, charts, and photos from the text are provided in electronic format and are organized by chapter for convenience. These images can be imported easily into Microsoft PowerPoint®.

Clicker Questions

Clicker questions—multiple choice and true/false—provide in-the-moment opportunities to engage and to assess students' understanding during lecture.

CourseSmart for Instructors

CourseSmart goes beyond traditional expectations—providing instant, online access to the textbook. Faculty can save time with a digital eTextbook that provides the ability to search for the most relevant content at the very moment needed. Whether it's evaluating textbooks or creating lecture notes to help students with difficult concepts, CourseSmart can make life a little easier. Visit www.coursesmart.com/instructors/.

STUDENT SUPPLEMENTS

MasteringBiology® Study Area

The Study Area in MasteringBiology® offers a plethora of resources that helps students to review topics, to assess their knowledge of the material, and to chart their progress. It also includes an eText of *Campbell Biology*.

Campbell Biology eText

MasteringBiology® features an interactive eText of *Campbell Biology* that allows for easy highlighting, annotating, and searching with a Google®-based search function.

Students can also access their text via a tablet by downloading the free Pearson eText app and using their MasteringBiology® login credentials.

Study on the Go

At the end of every chapter, students will find a QR code that provides access to Study on the Go, a mobile integration between text and online content. Students can access text-specific resources, including quizzes and flashcards, by using their smartphones to scan the code. Students can visit one of the sites below to download a free app to their smartphone. Once installed, the phone can scan the QR code and link to a website that leads to Pearson's Study on the Go and resources for *Campbell Biology*.

ScanLife

http://getscanlife.com

NeoReader

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http://www.quickmark.com.tw

A Short Guide to Writing About Biology, Seventh Edition,

by Jan A. Pechenik, *Tufts University* (978-0-321-66838-7)

This best-selling writing guide teaches students to think as biologists and to express ideas clearly and concisely through their writing.

Practicing Biology: A Student Workbook, Fourth Edition

by Jean Hietz and Cynthia Giffen, *University of Wisconsin, Madison* (978-0-321-68328-1)

This workbook offers a variety of activities to suit different learning styles. Activities such as modelling and mapping allow students to visualize and understand biological processes. Other activities focus on basic skills, such as reading and drawing graphs.

Into the Jungle: Great Adventures in the Search for Evolution by Sean B. Carroll, *University of Wisconsin, Madison* (978-0-321-55671-4)

These nine short tales vividly depict key discoveries in evolutionary biology with the excitement of the scientific process.

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OUR PARTNERSHIP WITH EDUCATORS AND STUDENTS

A core value underlying our work is our belief in the importance of a partnership with professors and students. One primary way of serving both groups is to provide a text that teaches biology well. In addition, Pearson Canada offers a rich variety of instructor and student resources. In our continuing efforts to improve the book and its supplements, we benefit tremendously from professor and student feedback, not only in formal reviews, but also via conversations, email, and other avenues of informal communication.

The real test of any textbook is how well it helps professors teach and students learn. We welcome comments from both students and professors. Please address your suggestions to Fiona Rawle, Lead Author, fiona.rawle@utoronto.ca, and Lisa Rahn, Senior Acquisitions Editor, lisa.rahn@pearsoned.com.

Featured Figures

Impact Figures

Exploring Figures

Inquiry Figures

* The Inquiry Figure, original research paper, and a worksheet to guide you through the paper are provided in *Inquiry in Action: Interpreting Scientific Papers,* Second Edition.
† See the related Experimental Inquiry Tutorial in MasteringBiology®.

Research Method Figures

Acknowledgments

The authors wish to express their gratitude to the global community of instructors, researchers, students, and publishing professionals who have contributed to this edition.

As authors of this text, we are mindful of the daunting challenge of keeping up to date in all areas of our rapidly expanding subject. We are grateful to the many scientists who helped shape this edition by discussing their research fields with us, answering specific questions in their areas of expertise, and sharing their ideas about biology education: John Archibald, Ronald Brooks, Willie Davidson, Ian Dennis, Marco Festa-Bianchet, Paul Hebert, Jocelyne Heneberry, Thomas Hudson, Dean Jeffries, Ben Koop, Marty Leonard, Robert Montgomerie, Andrew Noske, Brent Patterson, Kay Pruefer, Michael Rudnicki, Linda Rutledge, Gary Saunders, Robert Scheibling, Eric Shoubridge, Suzanne Simard, Robert Sladek, George Wilson, and Brent Zanke.

Additionally, the dedicated reviewers and focus group participants listed on page xxix helped to shape the Canadian edition by sharing their insights, suggestions, and educational experiences. We appreciate and thank these educators for the time and energy that they invested in providing thoughtful feedback. Also, thanks to Sharon Gillies who provided both reviewer feedback and authorial input. Thanks also to the other professors and students, from all over the world, who offered suggestions directly to the authors.

Interviews with prominent scientists have been a hallmark of *Campbell BIOLOGY* since its inception, and conducting these interviews was again one of the great pleasures of revising the book. To open the eight units of this edition, we are proud to include interviews with John Rubinstein, Frances Sharom, Sarah Otto, Robert Reisz, Ford Doolittle, Joerg Bohlmann, Jayne Yack, and David Schindler.

This Canadian edition of *Campbell BIOLOGY* is the result of the combined efforts of many talented and hardworking people. We wish to extend our heartfelt appreciation to the authors of the U.S. Edition, Jane Reece, Lisa Urry, Michael Cain, Peter Minorsky, Steve Wasserman, and Robert Jackson.

Campbell BIOLOGY, Canadian Edition, results from a strong synergy between a team of scientists and a team of publishing professionals. Our editorial team at Pearson Canada demonstrated their talents, commitment, and pedagogical insights. Gary Bennett, Editorial Director, Lisa Rahn, Senior Acquisitions Editor, Kim Ukrainec and Jenna Wulff, Marketing Managers, Darryl Kamo, Senior Developmental Editor, Ben Zaporozan, Media Editor, Sarah Gallagher, Project Manager, Susan Bindernagel, Copyeditor, Anthony Leung, Designer, Qa2/Bill Smith, Permissions Coordinator.

We likewise appreciate the commitment of the biologists who conducted a meticulous quality check of the textbook's pages. We thank Ronald Aiken (Mount Allison University), Heidi Engelhardt (University of Waterloo), Kerri Finlay (University of Regina), Jessica Forrest (University of Ottawa), Vett Lloyd (Mount Allison University), and Reehan Mirza (Nipissing University). Their subject matter expertise and attention to detail helped the publisher maintain *Campbell BIOLOGY*'s tradition of accuracy.

The Pearson sales team, which represents *Campbell BIOLOGY* on campus, is an essential link to the users of the text. They tell us what you like and don't like about the book, communicate the features of the book, and provide prompt service. We thank them for their hard work and professionalism. For representing our book, we thank our sales and marketing partners. They are all strong allies in biology education.

Finally, we wish to thank our families and friends for their encouragement and patience throughout this long project. Our special thanks to Adrian, Lucas, Anna, and Emmie (F.R.); Dax, Dana, and Bev (D.D.); Daniel (S.W.); and Tricia (K.W.).

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David Creasey, *University of Victoria*
Leslie Dafoe, *Sault College of Applied Arts & Technology*
Mrinal Das, *Grant MacEwan University*
Kathy Davies, *Grant MacEwan University*
Rajinder Dhindsa, *McGill University*
Heidi Engelhardt, *University of Waterloo*
Kerri Finlay, *University of Regina*
Sheryl Gares, *University of Alberta*
Chris Garside, *University of Toronto*
Sharon Gillies, *University of the Fraser Valley*
Lawrence Hale, *University of Prince Edward Island*
Jonathan Horsman, *Medicine Hat College*
Anna Hicks, *Memorial University*
William Huddleston, *University of Calgary*
Mariola Maja Janowicz, *Concordia University, College of Alberta*
Joan Kearvell, *Champlain Regional College*
Blaine Legaree, *Keyano College*
Vett Lloyd, *Mount Allison University*
Elaine Dodge Lynch, *Memorial University*
Sharon Mansiere, *Okanagan College*
Paul McMillan, *Capilano University*
Ann Meitz, *Capilano University*
Reehan Mirza, *Nipissing University*
Ivona Mladenovic, *Simon Fraser University*
Betty Mosher, *College of the Rockies*
Michael Mucz, *University of Alberta*
Ken Naumann, *Langara College*
Tracy O'Connor, *Mount Royal University*
Mary Olaveson, *University of Toronto Scarborough*
Robin Owen, *Mount Royal University*
William Paton, *Brandon University*
Carol Pollock, *University of British Columbia*
Melanie Rathburn, *Mount Royal University*
Scott Reid, *University of British Columbia*
Heidi Richter, *University of the Fraser Valley*
Tatiana Rogasevskaia, *Mount Royal University*
Owen Rowland, *Carleton University*
Eleftherios (Terry) Saropoulos, *Vanier College*
Ross Shaw, *Grant MacEwan University*
Andrew Taylor, *Keyano College*
Sophia Ushinsky, *Concordia University*
Patrick von Aderkas, *University of Victoria*
Richard Walker, *University of Calgary*
Michael Weber, *Carleton University*
Frank Williams, *Langara College*
Tony Williams, *Simon Fraser University*
Sherry Wilson, *Kwantlen Polytechnic University*
Jonathan Wright, *Dalhousie University*