

# CAMPBELL BIOLOGY

## CANADIAN EDITION

**Jane B. Reece**

Berkeley, California

**Lisa A. Urry**

Mills College, Oakland, California

**Michael L. Cain**

Bowdoin College, Brunswick, Maine

**Steven A. Wasserman**

University of California, San Diego

**Peter V. Minorsky**

Mercy College, Dobbs Ferry, New York

**Robert B. Jackson**

Stanford University, Stanford, California

**Fiona Rawle**

University of Toronto Mississauga, Mississauga, Ontario

**Dion Durnford**

University of New Brunswick, Fredericton, New Brunswick

**Chris Moyes**

Queen's University, Kingston, Ontario

**Sandra Walde**

Dalhousie University, Halifax, Nova Scotia

**Kenneth Wilson**

University of Saskatchewan, Saskatoon, Saskatchewan

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# 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.

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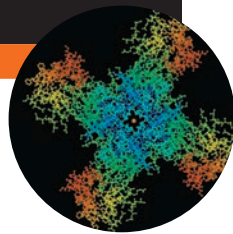
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# Preface

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 non-photosynthetic 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

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## STUDENT SUPPLEMENTS

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

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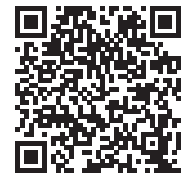
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### QuickMark

<http://www.quickmark.com.tw>



***A Short Guide to Writing About Biology, Seventh Edition,***  
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† See the related Experimental Inquiry Tutorial in MasteringBiology®.

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