

Glenda CHIDRAWI Stephanie HOLLIS

preliminary course

BIOLOGY IN FOCUS



Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States

Biology in Focus
Preliminary Course
1st Edition
Glenda Chidrawi
Stephanie Hollis

Acquisitions editor: Libby Houston
Managing editor: Jo Munnelly
Production editor: Kathryn Murphy
Editor: Kathryn Murphy
Rights & permissions manager: Jared Dunn
Editorial assistant: Vida Long
Text and cover design: Jenny Pace Walter
Illustrator: Alan Laver, Shelly Communications
Proofreader: Joy Window
Indexer: Glenda Browne
Typeset in ITC Garamond, Helvetica & Eurostile by Sunset Digital Pty Ltd,
Brisbane

Any URLs contained in this publication were checked for currency during the production process. Note, however, that the publisher cannot vouch for the ongoing currency of URLs.

First published in 2008 by McGraw Hill Australia.
Reprinted 2009 by McGraw Hill Australia.
This edition published in 2010 by Cengage Learning Australia.

Acknowledgements

Additional owners of copyright are acknowledged on the acknowledgements page.

Text © 2008 Glenda Chidrawi & Stephanie Hollis
Illustrations and design © 2010 Cengage Learning Australia Pty Limited

Copyright Notice

This Work is copyright. No part of this Work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means without prior written permission of the Publisher. Except as permitted under the Copyright Act 1968, for example any fair dealing for the purposes of private study, research, criticism or review, subject to certain limitations. These limitations include: Restricting the copying to a maximum of one chapter or 10% of this book, whichever is greater; providing an appropriate notice and warning with the copies of the Work disseminated; taking all reasonable steps to limit access to these copies to people authorised to receive these copies; ensuring you hold the appropriate Licences issued by the Copyright Agency Limited ("CAL"), supply a remuneration notice to CAL and pay any required fees. For details of CAL licences and remuneration notices please contact CAL at Level 15, 233 Castlereagh Street, Sydney NSW 2000, Tel: (02) 9394 7600, Fax: (02) 9394 7601
Email: info@copyright.com.au
Website: www.copyright.com.au

For product information and technology assistance,
in Australia call **1300 790 853**;
in New Zealand call **0800 449 725**

For permission to use material from this text or product, please email
aust.permissions@cengage.com

National Library of Australia Cataloguing-in-Publication Data

Chidrawi, Glenda.
Biology in focus : preliminary course / Glenda Chidrawi, Stephanie Hollis.

9780170197878 (pbk.)

Includes index.

For secondary students doing the NSW stage 6 biology syllabus.

Biology--Textbooks.
Hollis, Stephanie, 1968-

570.71

Cengage Learning Australia

Level 7, 80 Dorcas Street
South Melbourne, Victoria Australia 3205

Cengage Learning New Zealand

Unit 4B Rosedale Office Park
331 Rosedale Road, Albany, North Shore 0632, NZ

For learning solutions, visit **cengage.com.au**

Printed in China by China Translation & Printing Services.
2 3 4 5 6 7 8 15 14 13 12 11

Contents

To the student	vii
List of Board of Studies verbs	viii
Prescribed Focus Areas—an introduction	ix
Biology Skills—an introduction	x
Acknowledgments and credits	xiii

A LOCAL ECOSYSTEM **1**

Chapter 1 Characteristics of ecosystems are determined by biotic and abiotic factors **2**

The distribution, diversity and numbers of plants and animals found in ecosystems are determined by biotic and abiotic factors

1.1 Ecology	2
1.2 Terrestrial and aquatic environments	4
1.3 The distribution and abundance of a species	9
1.4 Measuring the distribution of a species in an ecosystem	11
1.5 Measuring abundance of a species in an ecosystem	13
Secondary source investigation: Justification of different sampling techniques	17
1.6 Energy use in ecosystems	19
Revision questions	22

Chapter 2 Unique aquatic and terrestrial ecosystems **23**

Each local aquatic or terrestrial ecosystem is unique

2.1 Trends in population estimates	23
2.2 Predator and prey populations	25
2.3 Allelopathy, parasitism, mutualism and commensalism	28
2.4 Decomposers in ecosystems	32
2.5 Trophic interactions between organisms	33
First-hand and secondary source investigation: Constructing food chains and food webs	38
2.6 Adaptations	39
2.7 Adaptations for survival in Australian ecosystems	41
2.8 Adaptations from the local ecosystem	43
2.9 Competing for resources	45
2.10 The impact of humans	48
First-hand investigation: Field study of a local ecosystem	51
Revision questions	61

PATTERNS IN NATURE **63**

Timeline: A short history of biology **64**

Chapter 1 Cells and the cell theory **66**

Organisms are made of cells that have similar structural characteristics

1.1 The discovery of the cellular basis of living things	67
1.2 Technological advances and the development of the cell theory	73
Secondary source investigation: The impact of technology on the development of the cell theory	78
1.3 Cell structure and functioning	81
First-hand investigation: Observing plant and animal cells using a light microscope	85
1.4 The ultrastructure of cells (electron microscope)	87
Secondary source investigation: Electron micrographs of cell organelles	95
Revision questions	98

Chapter 2 Membranes, chemicals and movement in and out of cells	100
<i>Membranes around cells provide separation from and links with the external environment</i>	
2.1 Chemicals in cells	100
First-hand investigation: Investigating chemicals in cells	106
2.2 Cell membranes, diffusion and osmosis	108
2.3 Current model of the cell membrane	109
First-hand investigation: The selectively permeable nature of cell membranes	112
2.4 Osmosis, diffusion and active transport	113
First-hand investigation: Demonstrating osmosis and diffusion	119
2.5 Surface area: volume ratio and rate of movement	120
First-hand investigation: Investigating the surface area to volume ratio and rate of movement	122
Revision questions	124
Chapter 3 Obtaining nutrients	125
<i>Plants and animals have specialised structures to obtain nutrients from their environment</i>	
3.1 Functional organisation in multicellular organisms: cells to systems	126
3.2 Autotrophs and heterotrophs	130
3.3 Autotrophic nutrition	132
First-hand investigation: Investigating requirements for photosynthesis	134
3.4 Photosynthesis: biochemistry	136
3.5 Autotrophic nutrition: obtaining water and inorganic minerals	139
3.6 Autotrophic nutrition: obtaining light and gases	141
3.7 Heterotrophs obtaining nutrients	145
3.8 Teeth and surface area	147
First-hand investigation: Investigating surface area and rate of reaction	149
3.9 Digestive systems of vertebrates	150
Secondary source investigation: Digestive systems of mammals	153
Revision questions	154
Chapter 4 Gaseous exchange and transport	155
<i>Gaseous exchange and transport systems transfer chemicals through the internal and between the external environments of plants and animals</i>	
4.1 Movement of chemicals in plants and animals	155
4.2 The need for transport systems in multicellular organisms	157
4.3 The roles of respiratory, circulatory and excretory systems	157
4.4 Gaseous exchange in animals	161
4.5 Transport in animals	169
4.6 Gaseous exchange and transport in plants	171
First-hand investigation: Investigating the movement of materials in xylem	174
First-hand investigation: Transpiration in plants	178
Secondary source investigation: The use of radioactive isotopes to trace transport in plants and animals	179
Revision questions	181
Chapter 5 Cell division	182
<i>Maintenance of organisms requires growth and repair</i>	
5.1 Where mitosis occurs	183
5.2 Mitosis: the process and its importance	187
5.3 DNA outside the nucleus	192
First-hand investigation: Investigating mitosis using a microscope	193
Revision questions	194

LIFE ON EARTH	195
Chapter 1 Evidence for the origin of life	196
<i>Analysis of the oldest sedimentary rocks provides evidence for the origin of life</i>	
1.1 Origin of organic molecules on early Earth	196
1.2 Implications of the existence of organic molecules	198
1.3 Evolution of chemicals of life: theories and their significance to the origin of life	198
Secondary source investigation: Urey and Miller's experiments	200
1.4 Urey and Miller's experiments	201
1.5 Technology has increased our understanding of the origin and evolution of life	203
Revision questions	204
Chapter 2 Evolution of life and the fossil record	205
<i>The fossil record provides information about the subsequent evolution of living things</i>	
2.1 Evolution of living things	205
Secondary source investigation: Evolution of life timeline	207
2.2 Evidence suggesting when life on Earth originated	209
First-hand and secondary source investigation: Plant and animal fossils	210
2.3 Change from an anoxic to an oxic atmosphere	212
Secondary source investigation: Impact of increased understanding of the fossil record	212
2.4 The effect of scientific developments on ideas about the origins of life	213
Revision questions	214
Chapter 3 Understanding of present-day organisms and their environments	215
<i>Further developments in our knowledge of present-day organisms and the discovery of new organisms allows for better understanding of the origins of life and the processes involved in the evolution of living things</i>	
3.1 Technology and increased knowledge of procaryotic organisms	215
3.2 Environment and the role of organisms in Archaea and Bacteria groups	216
Secondary source investigation: Similarities in environments past and present	218
Secondary source investigation: Alternative environments in which life may have originated	219
Revision questions	221
Chapter 4 Classification of past and present life on Earth	222
<i>The study of present-day organisms increases our understanding of past organisms and environments</i>	
4.1 The need to classify organisms	222
First-hand investigation: Construction and use of dichotomous keys	223
4.2 Classification systems	226
4.3 Levels of organisation assist classification	228
4.4 Impact of changes in technology	229
4.5 Binomial system	231
4.6 Difficulties in classifying extinct organisms	231
4.7 Assistance to understanding present and past life	232
Revision questions	232
EVOLUTION OF AUSTRALIAN BIOTA	233
Chapter 1 Australia's past: part of a supercontinent	234
<i>Evidence for the rearrangement of crustal plates and continental drift indicates that Australia was once part of an ancient supercontinent</i>	
1.1 From Gondwana to Australia—how our continent arose	234
Secondary source investigation: Problem solving to infer a moving Australian continent	243
Secondary source investigation: Changing ideas in science—the platypus enigma	247
Revision questions	250

Chapter 2 The evolution of Australian flora and fauna	251
<i>The changes in Australian flora and fauna over millions of years have happened through evolution</i>	
2.1 Variation and evolution	251
First-hand investigation: Variation in living species	255
2.2 The evolution of Australian flora and fauna	256
Secondary source investigation: Timeline—the formation of the Australian continent	257
2.3 Changing habitats	258
2.4 Variations in temperature and water availability	259
2.5 Changing flora and fauna	261
2.6 Current theories to account for changes: Climate change versus the arrival of humans	266
Secondary source investigation: Evidence of the evolution of Australian flora and fauna in fossils	267
First-hand investigation: Comparison of current and extinct Australian life forms	270
2.7 Darwin revisited	272
Secondary source investigation: The Huxley–Wilberforce debate	274
2.8 Current research	275
Revision questions	277
Chapter 3 Reproduction and continuity of species	278
<i>Continuation of species has resulted, in part, from the reproductive adaptations that have evolved in Australian plants and animals</i>	
3.1 Cell division and the production of gametes	278
Secondary source investigation: Differences between mitosis and meiosis	283
3.2 Reproductive adaptations in animals	284
3.3 Relative success of internal and external fertilisation	286
Secondary source investigation: Success of internal and external fertilisation in terrestrial and aquatic environments	287
3.4 Mechanisms of fertilisation and development	288
3.5 Reproductive adaptations in plants	291
First-hand investigation: Features of pollination in native flowering plants	302
3.6 Evolutionary advantages of sexual and asexual reproduction	305
3.7 Conditions under which asexual reproduction is advantageous	307
Revision questions	309
Chapter 4 Understanding past environments helps us to understand the future	310
<i>A study of palaeontology and past environments increases our understanding of the possible future range of plants and animals</i>	
4.1 Understanding past environments	310
4.2 Distribution of flora and fauna in present and future environments	314
Secondary source investigation: Reasons for evolution, survival and extinction in Australian species	318
4.3 Understanding and managing the present environment	320
Secondary source investigation: Current effort to monitor biodiversity	321
Revision questions	324
Glossary	325
Index	338

To the student

Biology in Focus: Preliminary Course is written specifically to address the rigorous content of the New South Wales Stage 6 Biology syllabus. This book follows the syllabus in a logical order to ensure that all dot points are covered completely. The first-hand and secondary source investigations from column 3 of the syllabus are dealt with at appropriate points in the text.

One of the features of modern biology is the rate at which new terminology is created. Knowledge of some of these terms is essential to understand the subject. Throughout the text, when important terms are introduced they are in **bold type**. These words are defined in the glossary at the back of the book.

A major feature of the New South Wales Biology syllabus is the use of keywords (see the list of definitions of verbs on page viii) in constructing examination questions. An understanding of how to use these key words is essential for success in the HSC. The revision questions in each chapter are designed to test your command of the keywords as well as your understanding of the content of the course.

There is an emphasis in the text on Prescribed Focus Areas (PFAs) and Biology Skills. For more information on how they are dealt with in the text please refer to pages ix–xii. The text is also supported by a NelsonNet student website that contains lists of relevant website references; student worksheets; extension and classroom activities; and sample answers to end of chapter revision questions. See www.nelsonnet.com.au

When preparing for exams, remember that the syllabus is the ultimate guide to what you need to know. But you can be reassured that *Biology In Focus: Preliminary Course* contains the information you need to complete the course work.

Please note: All resources listed throughout the book as available on the Student Resource CD-ROM can now be found on the NelsonNet student website.

List of Board of Studies verbs

Account	Account for: state reasons for, report on Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship among them; draw out and relate implications
Apply	Use, utilise, employ to a particular situation
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Calculate	Ascertain/determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes/categories
Compare	Show how things are similar or different
Construct	Make; build, put together items or arguments
Contrast	Show how things are different or opposite
Critically (analyse/evaluate)	Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis/evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note/indicate as being distinct or different from; to note differences between
Evaluate	Make a judgement based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about
Justify	Support an argument or conclusion
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example a point of view, idea, argument, suggestion) for consideration and action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express concisely the relevant details

Prescribed Focus Areas—an introduction

Many areas of the Preliminary Biology course lend themselves to the study of the *process of science* by focussing on five Prescribed Focus Areas (PFAs), as outlined in the table below. The application of these PFAs has become an important part of the New South Wales Board of Studies Biology Syllabus. PFAs are targeted for examination questions in both the Preliminary and HSC Biology courses.

Examples of how to apply each of the PFAs 1–5 have been provided in this textbook. Wherever an icon appears in the textbook, it signals that a PFA is being addressed and provides the opportunity for students to analyse course content in relation to a particular PFA and to become skilled at applying their area of learning to the particular PFA.

On the NelsonNet teacher website special reference has been given to ‘unpacking’ each PFA (breaking the ‘dot point’ down into its component parts) and to assisting teachers to facilitate students in developing the skills needed to address PFAs. Templates or ‘scaffolds’ have been provided that simplify the process of applying each PFA and these may be used by teachers and/or students in conjunction with any module of work.

In addition to this, the NelsonNet teacher website contains a table which links specific syllabus areas (‘dot points’) throughout the Preliminary course with each PFA. See www.nelsonnet.com.au.

Please note: All resources listed throughout the book as available on the Teacher Resource CD-ROM can now be found on the NelsonNet teacher website.



Linking syllabus ‘dot points’ to PFAs

Table of objectives and outcomes—Prescribed Focus Areas

Objectives	Preliminary Course outcomes
<i>Students will develop knowledge and understanding of:</i>	<i>A student:</i>
1 the history of biology	P1 outlines the historical development of major biological principles, concepts and ideas
2 the nature of biology	P2 applies the processes that are used to test and validate models, theories and laws of science, with particular emphasis on first-hand investigations in biology
3 applications and uses of biology	P3 assesses the impact of particular technological advances on understanding in biology
4 implications of biology for society and the environment	P4 describes applications of biology which affect society or the environment
5 current issues, research and developments in biology	P5 describes the scientific principles employed in particular areas of biological research

Biology Skills—an introduction

During the Preliminary Course, it is expected that students will further develop skills in planning and conducting investigations, communicating information and understanding, scientific thinking and problem-solving and working individually and in teams. Each module specifies content through which skill outcomes can be achieved. Teachers should develop activities based on that content to provide students with opportunities to develop the full range of skills.

Preliminary Course outcomes	Content
<i>A student:</i>	<i>Students will learn to:</i>
<p>P11 identifies and implements improvements to investigation plans</p>	<p>11.1 identify data sources to:</p> <ul style="list-style-type: none"> a) analyse complex problems to determine appropriate ways in which each aspect may be researched b) determine the type of data which needs to be collected and explain the qualitative or quantitative analysis that will be required for this data to be useful c) identify the orders of magnitude that will be appropriate and uncertainty that may be present in the measurement of data d) identify and use correct units for data that will be collected e) recommend the use of an appropriate technology or strategy for data collection or gathering information that will assist efficient future analysis
	<p>11.2 plan first-hand investigations to:</p> <ul style="list-style-type: none"> a) demonstrate the use of the terms 'dependent' and 'independent' to describe variables involved in the investigation b) identify variables that need to be kept constant, develop strategies to ensure that these variables are kept constant and demonstrate the use of a control c) design investigations that allow valid and reliable data and information to be collected d) design and trial procedures to undertake investigations and explain why a procedure, a sequence of procedures or repetition of procedures is appropriate e) predict possible issues that may arise during the course of an investigation and identify strategies to address these issues if necessary
	<p>11.3 choose equipment or resources by:</p> <ul style="list-style-type: none"> a) identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation b) carrying out a risk assessment of intended experimental procedures and identifying and addressing potential hazards c) identifying technology that could be used during investigating and determining its suitability and effectiveness for its potential role in the procedure or investigations d) recognising the difference between destructive and non-destructive testing of material and analysing the potentially different results of these two procedures

Preliminary Course outcomes	Content
<i>A student:</i>	<i>Students will learn to:</i>
<p>P12 discusses the validity and reliability of data gathered from first-hand investigations and secondary sources</p>	<p>12.1 perform first-hand investigations by:</p> <ul style="list-style-type: none"> a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources c) disposing carefully and safely of any waste materials produced during the investigation d) identifying and using safe work practices during investigations <p>12.2 gather first-hand information by:</p> <ul style="list-style-type: none"> a) using appropriate data collection techniques, employing appropriate technologies, including data loggers and sensors b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate <p>12.3 gather information from secondary sources by:</p> <ul style="list-style-type: none"> a) accessing information from a range of resources, including popular scientific journals, digital technologies and the Internet b) practising efficient data collection techniques to identify useful information in secondary sources c) extracting information from numerical data in graphs and tables as well as from written and spoken material in all its forms d) summarising and collating information from a range of resources e) identifying practising male and female Australian scientists, the areas in which they are currently working and information about their research <p>12.4 process information by:</p> <ul style="list-style-type: none"> a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered b) apply mathematical formulae and concepts c) best illustrate trends and patterns by selecting and using appropriate methods, including computer-assisted analysis d) evaluate the relevance of first-hand and secondary information and data in relation to the area of investigation e) assess the reliability of first-hand and secondary information and data by considering information from various sources f) assess the accuracy of scientific information presented in mass media by comparison with similar information presented in scientific journals
<p>P13 identifies appropriate terminology and reporting styles to communicate information and understanding in biology</p>	<p>13.1 present information by:</p> <ul style="list-style-type: none"> a) selecting and using appropriate text types, or combinations thereof, for oral and written presentations b) selecting and using appropriate media to present data c) selecting and using appropriate formats to acknowledge sources of information d) using symbols and formulae to express relationships and using appropriate units for physical quantities e) using a variety of pictorial representations to show relationships and present information clearly and succinctly f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately g) identifying situations where use of a curve of best fit is appropriate to present graphical information

Preliminary Course outcomes	Content
<i>A student:</i>	<i>Students will learn to:</i>
<p>P14 draws valid conclusions from gathered data and information</p>	<p>14.1 analyse information to:</p> <ul style="list-style-type: none"> a) identify trends, patterns and relationships as well as contradictions in data and information b) justify inferences and conclusions c) identify and explain how data supports or refutes an hypothesis, a prediction or a proposed solution to a problem d) predict outcomes and generate plausible explanations related to the observations e) make and justify generalisations f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena h) identify examples of the interconnectedness of ideas or scientific principles <p>14.2 solve problems by:</p> <ul style="list-style-type: none"> a) identifying and explaining the nature of a problem b) describing and selecting from different strategies those which could be used to solve a problem c) using identified strategies to develop a range of possible solutions to a particular problem d) evaluating the appropriateness of different strategies for solving an identified problem <p>14.3 use available evidence to:</p> <ul style="list-style-type: none"> a) design and produce creative solutions to problems b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations d) formulate cause and effect relationships
<p>P15 implements strategies to work effectively as an individual or as a member of a team</p>	<p>The Preliminary course further increases students' skills in working individually and in teams.</p>

Acknowledgments and credits

Acknowledgements

Special thanks to our Acquisitions Editor **Libby Houston**, for her guidance, invaluable support and friendship. Libby's enthusiastic response to our sometimes unconventional ideas, as well as her clear, analytical thinking, helped turn our ideas into reality.

We would also like to thank our editor **Kathryn Murphy** for her dedication, effective suggestions and her amazing attention to detail.

I, Glenda, would like to acknowledge with gratitude my teacher, friend and mentor **Mrs Joyce Austoker-Smith**, who encouraged me so many years ago to embark on writing textbooks and mentored me through the early years.

I, Stephanie, would like to acknowledge and extend my thanks for the academic input voluntarily provided by **Dr Greg Hollis** towards aspects of biodiversity throughout the text.

We would both like to extend personal thanks to our families, friends and colleagues for their patience as well as their immeasurable support and encouragement while we were writing this book.

We also thank **Robert Farr** for his professional input and assistance with developing the Prescribed Focus Areas, **Jared Dunn** for his assistance with sourcing of photographs and the illustrator for their valuable artistic contribution. As a result of the combined effort of all, we believe that these resources will ease the workload of teachers and make Biology exciting and more meaningful to students.

Credits

Biology Stage 6 Syllabus © Board of Studies NSW for and on behalf of the Crown in rights of the State of New South Wales, 2002

Photographs

Cover image: Coloured SEM of diatoms, courtesy of Photolibrary

A Local Ecosystem

Corbis: p. 1; Digital Vision: Fig. 1.3 (left), Fig. 2.29(a, b, c); WH Dunn: Fig. 1.3 (right), Table 1.2 (desert); iStockphoto: Table 1.2 (grassland), Fig. 1.5, Fig. 2.7(a), Fig. 2.9, Fig. 2.20(a), Fig. 2.25; Michael Artup: Table 1.2 (shrubland); Jared Dunn: Table 1.2 (woodland, temperate forest, rainforest), Fig. 2.20(b), Fig. 2.29(d); Glenda Chidrawi: Fig. 1.8, Fig. 2.31; Courtesy of Brandon Bales, Department of Biology and Microbiology, South Dakota State University: Fig. 1.10(h); Newspix: Fig. 1.11; ANT Photo Library: Fig. 2.3, Fig. 2.20(d); David Albrecht: Fig. 2.4(a); Associate Professor Michael Keogh, University of Melbourne: Fig. 2.4(b), Fig. 2.23, Fig. 2.24; Dr Peter Harrison, Southern Cross University: Fig. 2.4(c), Fig. 2.8; Eiko Bron: Fig. 2.6; Big Stock Photo: Fig. 2.7(b), Fig. 2.22, Fig. 2.26, Fig. 2.27(b), Fig. 2.29(e); Photolibrary: Fig. 2.7(c, d); T Itoh and RM Brown Jr, *Planta Journal*, Vol. 160, pp. 372–81, Springer-Verlag, 1984: Fig. 2.10(a); Courtesy of the University of Chicago, model by Tyler Keillor: Fig. 2.19(b); Auscape: Fig. 2.20(c); Clare Barnes: Fig. 2.21; Gerry Marantelli: Fig. 2.27(a); Dr Greg Hollis, Senior Biodiversity Officer, Department of Sustainability and Environment: Fig. 2.30

Patterns in Nature

Corbis: p. 63; Digital Vision: Fig. 1.1 (left); Photodisc: Fig. 1.1 (right); Photolibrary: Fig. 1.3, Fig. 1.5, Fig. 1.8(a); Glenda Chidrawi: Fig. 1.7(a), pp. 98–99; Faculty of Biological Sciences, University of Leeds: Fig. 1.9 (right); Rob Farr: Fig. 1.6, Fig. 1.12(a, b, c), Fig. 1.15(a, b), Fig. 3.15(a), Fig. 3.16(b), Fig. 4.12 (bottom left), Fig. 4.14 (top right); Fig. 4.15 (top left), Fig. 5.6 (centre); Photoresearchers Inc: p. 95, Table 1.5 (centre top, centre bottom); Visuals Unlimited: p. 96, Table 1.5 (centre bottom); Professor Adrienne Hardham, Australian National University: p. 97, Table 1.5 (centre bottom); Artville: Fig. 3.6; Professor J Pickett-Heaps, University of Melbourne: Fig. 5.5.

Life on Earth

Corbis: p. 195; Photolibrary: Table 2.2, Fig. 2.2, Fig. 3.1(b), Fig. 3.2, Fig. 4.6; Photodisc: Fig. 2.4(a); Nature Focus: Fig. 2.4(b); Associate Professor Andrew Drinnon, University of Melbourne: Fig. 2.4(c, d); Associate Professor Christina Cheers, University of Melbourne: Fig. 3.4; Vivienne Cassie-Cooper: Fig. 3.5; Australian National Botanic Gardens: Fig. 4.1

Evolution of Australian Biota

Corbis: p. 233; Photolibrary: Fig. 1.4, Fig. 1.16, Fig. 2.1(a), Fig. 2.4, Table 2.4 (bottom left); Fig. 2.12 (top left), Fig. 2.13, Fig. 3.3, Fig. 3.10, Fig. 3.17, Fig. 3.25(a), Fig. 3.27, Fig. 3.29, Fig. 3.34; iStockPhoto: Fig. 1.6(a, d, e), Fig. 1.7(b), Fig. 2.2, Fig. 2.1(b), Fig. 2.8(a, b, c), Fig. 2.10 (b, left), Fig. 2.12 (bottom centre), Fig. 2.14, Fig. 3.4, Fig. 3.19, Fig. 4.6; ANT Photo Library: Fig. 1.6(b), Fig. 2.5(b), Fig. 2.12 (bottom left, bottom right), Fig. 3.6, Fig. 3.7, Fig. 3.18, Fig. 3.22, Fig. 3.30c, Fig. 4.5; Big Stock Photo: Fig. 1.6(c), Fig. 1.7(a), Fig. 2.3(a), Table 2.4 (top left), Fig. 2.5(a), Fig. 2.10(a), Fig. 2.12 (top centre, top right); © Commonwealth of Australia, Geoscience Australia 2007: Fig. 1.14; Dr Greg Kirby, Flinders University: Fig. 2.3(b); IWH Dunn: Fig. 2.8(d); L. Lumsden: Fig. 2.10 (b, right); marinethemes.com/Kelvin Atkinson: Fig. 3.5; Auscape: Fig. 3.8; EYEDEA: Fig. 3.9; Associate Professor Andrew Drinnon, University of Melbourne: Fig. 3.13; Leanne Poll: Fig. 3.14(a); Peter Taylor: Fig. 3.14(b, d); Pauline Ladiges: Fig. 3.14(c); Australian National Botanic Gardens: Fig. 3.15, Fig. 3.21, Fig. 3.32, Fig. 3.33; Greg Jordan, University of Tasmania: Fig. 3.16; Bab and Bert Wells: Fig. 3.20; A Flowers and L Newman: Fig. 3.25(b); Jared Dunn: Fig. 3.26; Dr Greg Hollis, Senior Biodiversity Officer, Department of Sustainability and Environment: Fig. 4.8

Tables and illustrations

A Local Ecosystem

Adapted from Charles J Krebs, *Ecology: The Experimental Analysis of Distribution and Abundance*, Fig. 13.9, p. 246 (Adison Wesley Longman): Fig. 2.2; Courtesy of Ecological Society of America, Washington DC: Fig. 2.5

Patterns in Nature

Thomas, *Biology: A Functional Approach*, third edition (Nelson & Sons, 1971): Fig. 4.5; Raven & Johnson, *Biology*, fourth edition (McGraw-Hill Irwin, 1995): Fig. 5.1, Fig. 5.3

Evolution of Australian Biota

White M, Australia's Prehistoric Plants, (Methuen Australia, 1984): Fig. 1.3; Raven & Johnson, *Biology*, fourth edition (McGraw-Hill Irwin, 1995): Fig. 3.23, Fig. 4.1, Fig. 4.2, Table 4.1, Table 4.2