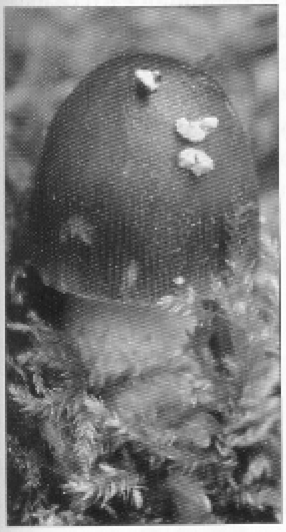
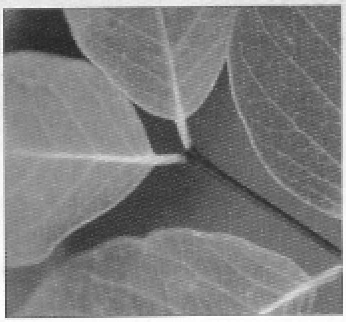
Life

Preface

The goal of *Life* has always been to engage the non-scientist or possible scientist in understanding how life works. We try to do that in a way that is fun, meaningful, and valuable in helping students make informed decisions on an ever-growing array of issues, from teaching evolution to human cloning and stem cells. This sixth edition continues our presentation of cutting edge life science and the technology that it spawns, with timely additions, such as discussions of animal behavior during the recent tsunami and removal of drugs such as Vioxx™ from the market.



The sixth edition of *Life* reunites four biologists whose areas of expertise complement beautifully. Geneticist and science journalist Ricki Lewis originated the text, using a unique style that weaves solid biology content with intriguing tales of scientific discovery and real-life cases and applications. Veterans from the fifth edition of *Life* are Douglas Gaffin and Mariëlle Hoefnagels of the University of Oklahoma and Bruce Parker of Utah Valley State College. Ricki has taught a variety of courses and has provided genetic counseling to a private medical practice since 1984. Doug, Mariëlle, and Bruce are active instructors who teach undergraduate biology to hundreds of majors and nonmajors each semester, and all have earned recognition on their campuses as outstanding teachers.



Devotion to, and passion about, teaching and communicating unite our team. We thoroughly enjoy telling interesting stories that are so easy to find at all levels of biology, from molecules to ecology—the stories that, when told correctly, mesmerize even the most reluctant students, causing them to perk up and think, "Wow, I never knew that! So that's why . . . !" We all love to watch students get excited about learning a subject they once viewed as too intimidating. Our areas of research expertise mesh beautifully, including animal physiology and behavior, plant-microorganism interactions, genetics, developmental biology, molecular biology, and biochemistry.

Together, the *Life* authors cover the breadth of general biology and make it easy for you to present the latest information to your students, using the most accessible multimedia tools available. The unique mix of scientific expertise and journalistic experience results in a textbook that is not only substantial, but also accessible.

An interesting feature of the human mind is that it organizes and comprehends information better if first shown an overview of what it is about to encounter—much like knowing the overall route and destination before beginning a cross-country road trip. An expanded Chapter Preview at the beginning of each chapter gives a concise introduction to the key principles and ideas to be encountered in that chapter—giving students the chance to preview the information and understand where they are going in that chapter.

Responding to reviewer requests, this new edition splits the chapter on chemistry into two separate chapters, adds a chapter on Genetic Technology, and significantly enhances the narrative into one voice.

New chapter construction designed to assist the student includes a set of Reviewing Concepts summaries at the end of each major heading topic, followed by a Connections discussion at the end of the chapter. The Connections piece is intended to help the students connect topics previously discussed with topics yet to come. This section also stresses the major themes of *Life* and helps the student to understand why the information they have just covered is pertinent to their lives and to what else they have learned.

Some researchers have said that a student needs to repeat something at least three times to be able to remember it. The new layout of the textbook provides the students with a clearer opportunity to understand and retain the concepts of each chapter. The Chapter Preview is followed not only by the text, but also by Reviewing Concepts at the end of each section, and by a detailed summary at the end of each chapter. Students will have encountered the major ideas of each chapter at least four times when they finish each chapter!

The new elements that made the fifth edition friendlier and less cluttered were preserved. Figure and table references appear in bold type so that students can easily find related discussion. Scale bars have been added to micrographs so that students can appreciate the relative size of structures and organisms. New in-text cross-references aid recall and catalyze the conceptual connections that underlie biology.

For those looking for the end-of-chapter pieces of the fifth edition, the "Thinking Scientifically" and "References and Resources" sections have been retained as web-based resources. Likewise most of the Boxed Readings have been moved to the web and the Biotechnology Boxes found in the text of the fifth edition have been moved to the web or incorporated into the text of the new chapter on Genetic Technology. This has streamlined the text and allowed for more focus on the information in the text without losing the overall public interest level of the material.

The end-of-chapter material has been completely revised to provide the students with a built-in study guide for the textbook. The study guide questions are directly linked to the material covered in the text to help the student relate the questions to the sections of the text containing the answers. The study guide includes a much more extensive list of the key terms introduced and used in that chapter. Students taking biology for the first time are practically learning a new language in their effort to converse fluently with some 800 or more new terms. By expanding the key terms list, the "second language" element of the biology course is emphasized for the student.

The remainder of the end-of-chapter material consists of three types of brand-new questions written specifically for this edition. By including these questions at the end of each chapter, the student has an opportunity to immediately review what they have learned, or to refer to the questions while they read to guide their study of the concepts. The answers to all of the study questions are provided as an appendix. By using one of the textbook authors to write both the revisions of the sixth edition and the study guide questions and answers, students are assured of continuity in terminology and content covered by the questions and their answers.

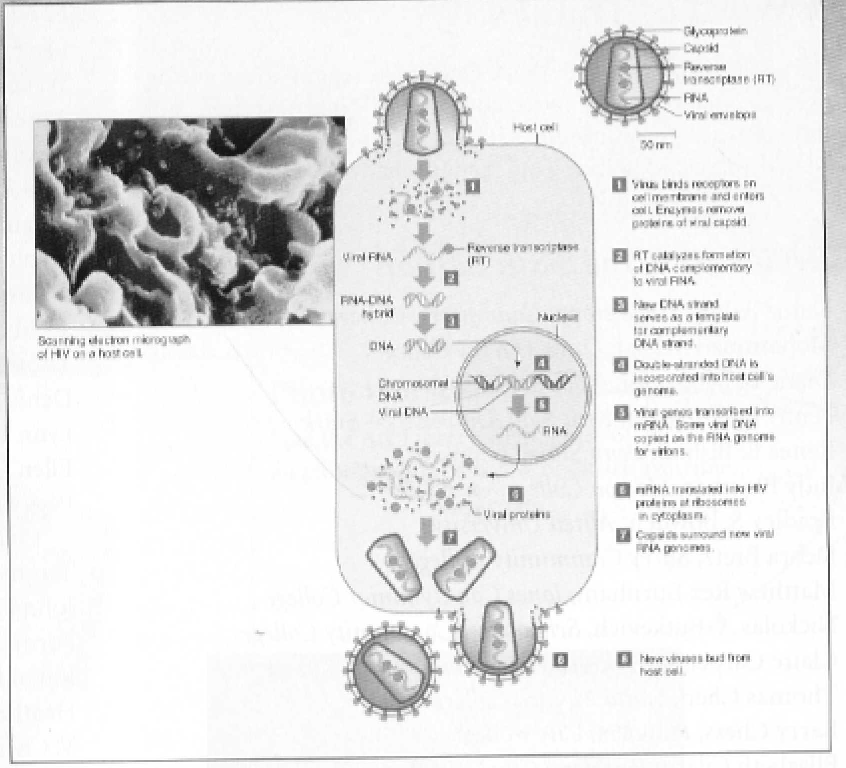
Overview of What's New for *Life*, Sixth Edition

- **Chapter Preview** introduces each chapter.
- **Reviewing Concepts** appear at the end of each major heading.
- Chemistry chapter divided into two chapters to help clarify for students.
- New **Genetic Technology** chapter.
- **Connections** help students tie everything together.
- Built-in **Student Study Guide** at the end of each chapter.
- New end-of-chapter questions.
- Extensive list of key terms.

Today's Science for Today's Students

Each chapter begins with a brief essay designed to stimulate the student's interest. Many of the essays are new to this edition and add a personal touch, with stories from the authors' own experiences as well as topics that are found in news headlines. Throughout the text the authors have worked to provide the most current and up-to-date insights into the world of biology and biological research from a wide array of disciplines.

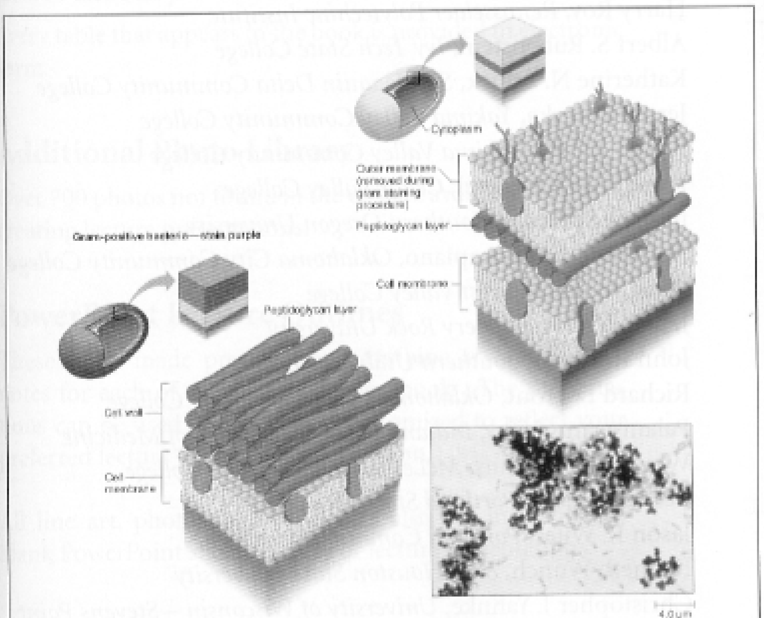
Unit 4, The Diversity of Life, is always a work in progress, as new data and new ways of looking at the living world reveal new classification possibilities. *Life's* "tree of life" illustrations, developed by Douglas Gaffin and found in this unit and others, encapsulate species relationships and evolutionary trends in an easy-to-follow form. While *Life's* classification schemes combine traditional and molecular approaches to taxonomy, we are careful to explain that new molecular data also throw the classification of life into upheaval—and acknowledge that the classification schemes in this book are provisional. It is important for students to realize that biological facts and concepts are not written in stone; that despite popular notions of scientific "proof," science is constantly changing to embrace new information. We would rather present the current state of taxonomic thought, uncertainties and all, than perpetuate dated classifications. For example, we revised and rearranged the animal diversity chapters to reflect the currently accepted split of protostomes into lophotrochozoans and ecdysozoans. The traditional scheme is included for comparison, but the book adopts the new classification scheme.



The Art Program—A Visual Voyage

Life's art is not only visually spectacular, but also pedagogically sound, providing a consistent look from cover to cover. Repeated themes provide continuity, from biochemical reactions to life cycles to feedback loops in animal physiology to evolutionary tree diagrams. Use of color, arrows, and symbols is standardized throughout the text, easing learning and remembering. For example, DNA, membranes, and other cell structures have a consistent look and color throughout. A student can learn that every time a molecular structure appears that is purple, for instance, proteins are the heart of that structure. This approach vividly illustrates the organizational nature of life.

We have also selected unusual and interesting photos to show students glimpses of the natural world that they may never have seen before. The art and photos are combined in page layouts that are attractive and inviting—and above all, help students to learn.



A Word of Thanks

We offer special thanks to the reviewers who spent hours poring over chapter drafts in meticulous detail, spotting errors and inconsistencies, confirming what works and gently critiquing what doesn't, and pointing out sections that we could clarify.

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Digital Content Manager

The Digital Content Manager provides illustrations, photos and tables from the textbook, in addition to supplemental media materials. With the Digital Content Manager instructors will have access to:

Art Library

Color enhanced digital files of all the illustrations in the book, plus the same art saved in unlabeled versions, are included in the Art Library.

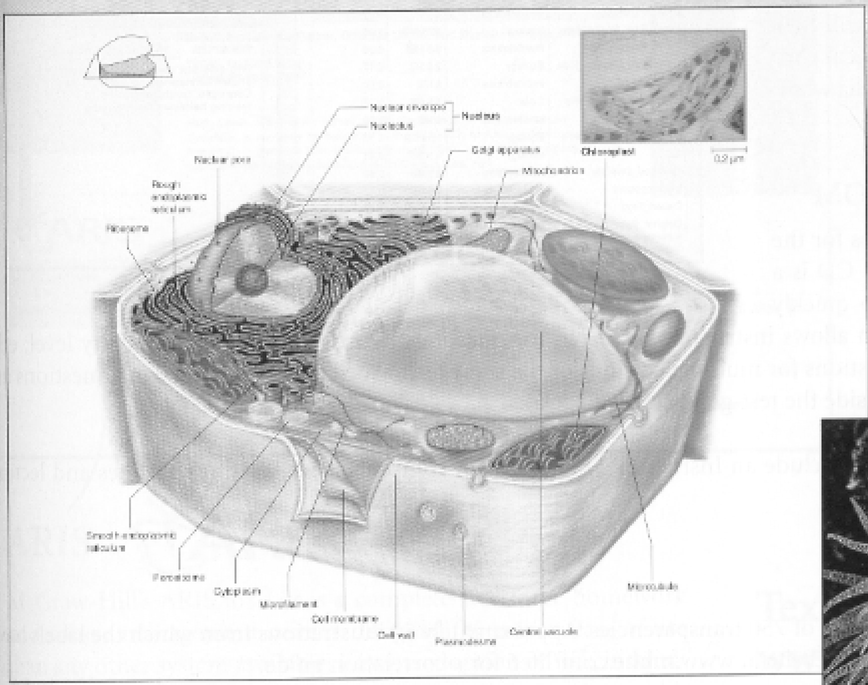


Photo Library

Like the Art Library, digital files of all photographs from the book are available.

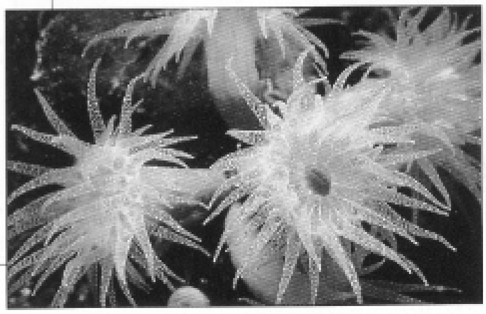


Table Library

Every table that appears in the book is provided in electronic form.

TABLE 42.1

Learning in Humans and Pets

Type of Learning	Example
Habituation	Being able to concentrate on written work with music playing in the background but jumping when the phone rings
Classical conditioning	Craving popcorn in a movie theater
Operant conditioning	A student learns what to do to earn high grades in school
Imprinting	Infant responds to mother's breast, voice, and face
Insight learning	A child places a box on roller skates to build a vehicle
Latent learning	A cat explores its new home and darts to safety when the doorbell rings

Additional Photo Library

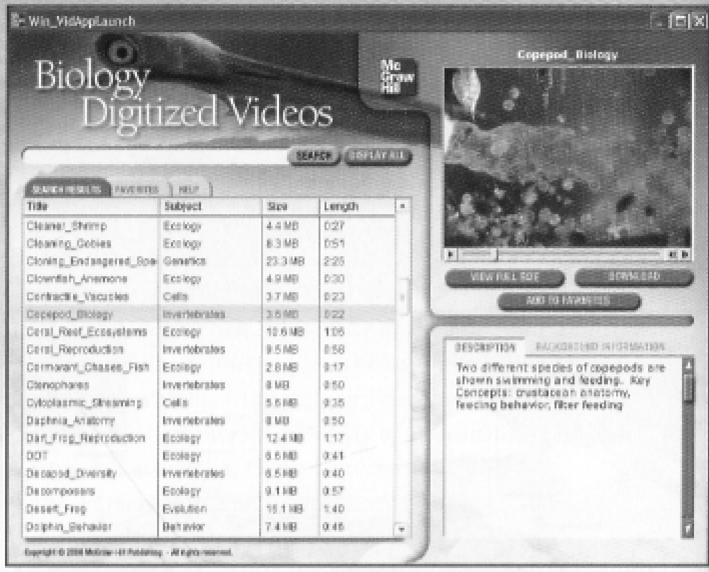
Over 700 photos not found in the text are available for use in creating lecture presentations.

PowerPoint Lecture Outlines

These ready-made presentations combine art and lecture notes for each of the chapters of the book. The presentations can be used as they are or customized to reflect your preferred lecture topics and organization.

All line art, photos, and tables are also pre-inserted into blank PowerPoint slides for ease of lecture presentations.

NEW! McGraw-Hill: Biology Digitized Video Clips



McGraw-Hill is pleased to offer adopting instructors a new presentation tool—digitized biology video clips on DVD! Licensed from some of the highest quality science video producers in the world, these brief segments range from about five seconds to just under three minutes in length and cover all areas of general biology from cells to ecosystems. Engaging and informative, McGraw-Hill's digitized biology videos will help capture students' interest while illustrating key biological concepts and processes such as mitosis, how cilia and flagella work, and how some plants have evolved into carnivores.

Instructor's Testing and Resource CD-ROM

This cross-platform CD provides a wealth of resources for the instructor. Among the supplements featured on this CD is a computerized test bank that uses testing software to quickly create customized exams. The user-friendly program allows instructors to search for questions by topic, format, or difficulty level; edi existing questions or add new ones; and scramble questions for multiple versions of the same test. Word files of the test bank questions ar provided for those instructors who prefer to work outside the test-generator software.

Other assets on the Instructor's Test and Resource CD include an Instructor's Manual with comprehensive teaching outlines and lectur suggestions.

Transparencies

All of the illustrations from the text are included in this set of 750 transparencies. Approximately 50 illustrations from which the labels hav been removed are also included. Be sure to visit the text website at www.mhhe.com/life6 for a correlation guide.

Student Interactive CD-ROM

This CD includes chapter-based quizzes, animations of complex processes, and PowerPoints of all the images found in the textbook. It is organized chapter-by-chapter and provides a link directly to the text's Online Learning Center. This Interactive CD-ROM offers an indispensable resource for enhancing topics covered within the text.

iLabs

Interactive Laboratories and Biological Simulations

No setup. No mess. No limits! Interactive Laboratories and Biological Simulations, or iLaBS, teach students real-life biomolecular applications and techniques using accurate and intriguing programs. Students can explore cutting-edge technologies like DNA fingerprinting and restriction mapping, repeating lab procedures until they are comfortable with the techniques. Because they can generate multiple sets of data, students gain practice in data interpretation and problem solving. iLaBS also provide the opportunity for students to virtually experience time consuming or complicated labs without the necessity for physical facilities.

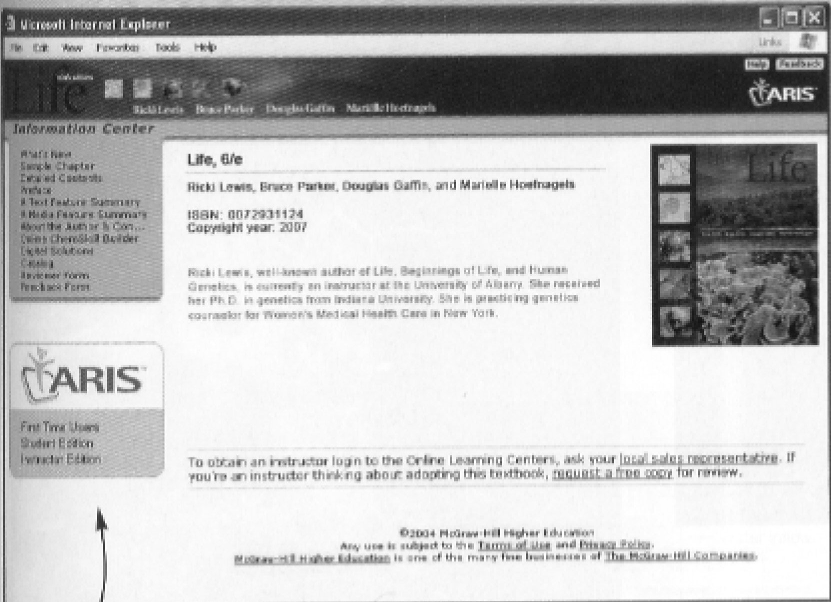
New Features:

Now available on CD-ROM makes iLaBS more accessible. Accompanying student workbook gives detailed instructions on how to complete each lab, as well as providing background information and test questions for each.

Three new simulations have been added! Students can now view simulations on The Polymerase Chain Reaction, Sequencing, and Viruses. Instructor's CD-ROM contains all of the content from the student CD, PLUS a preview of iLaBS, tips on how to use iLaBS in the course, answers to the workbook questions, a low text version of the DNA Replication and Regulation of the Lac Operon simulations to make presentation in lecture easier, and bonus materials—simulations of cloning and Southern blotting and bioinformatics exercises on endosymbiosis and sickle cell anemia.

Ask your McGraw-Hill sales representative for more information about iLaBS.

Instructor Website
www.mhhe.com/life6



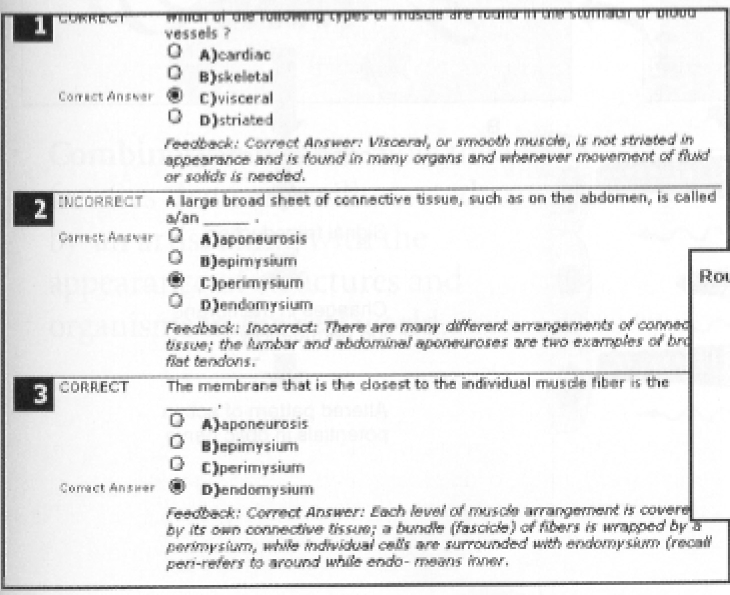
Through the *Life* text website, everything you need for effective, interactive teaching and learning is at your fingertips. Moreover, this vast McGraw-Hill resource is **easily loaded into course management systems such as WebCT or Blackboard.** Contact your local McGraw-Hill representative for details.

Instructor tools located on the enhanced website include:

Instructor's Manual This valuable resource includes chapter objectives and interesting tidbits not found in the textbook, lists areas of difficulty for students along with suggestions for resolving those difficulties effectively, and provides teaching suggestions for various content areas.

ARIS

McGraw-Hill's ARIS for *Life* is a complete electronic homework and course management system, designed for greater ease of use than any other system available. Free on adoption of *Life*, instructors can create and share course materials and assignments with colleagues with a few clicks of the mouse. Instructors can edit questions, import their own content, and create announcements and due dates for assignments. ARIS has automatic grading and reporting of easy-to-assign quizzing, and testing. Once a student is registered in the course, all student activity within McGraw-Hill's ARIS is automatically recorded and available to the instructor through a fully integrated grade book that can be downloaded to Excel.

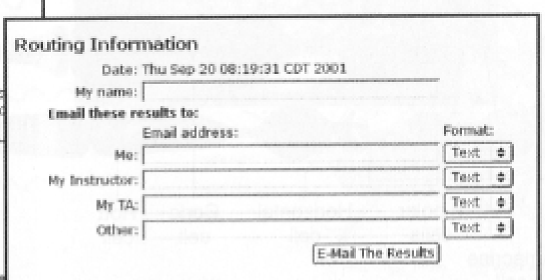


Text Website—For the Student
www.mhhe.com/life6

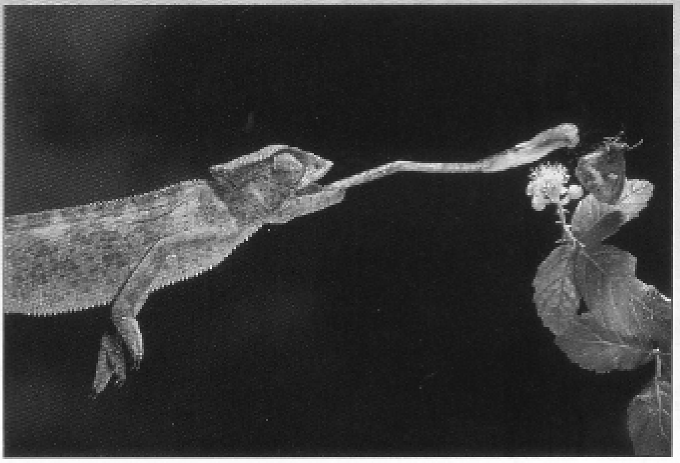
Resources on the *Life* website support each chapter in the text. Some of the learning tools available through the website include:

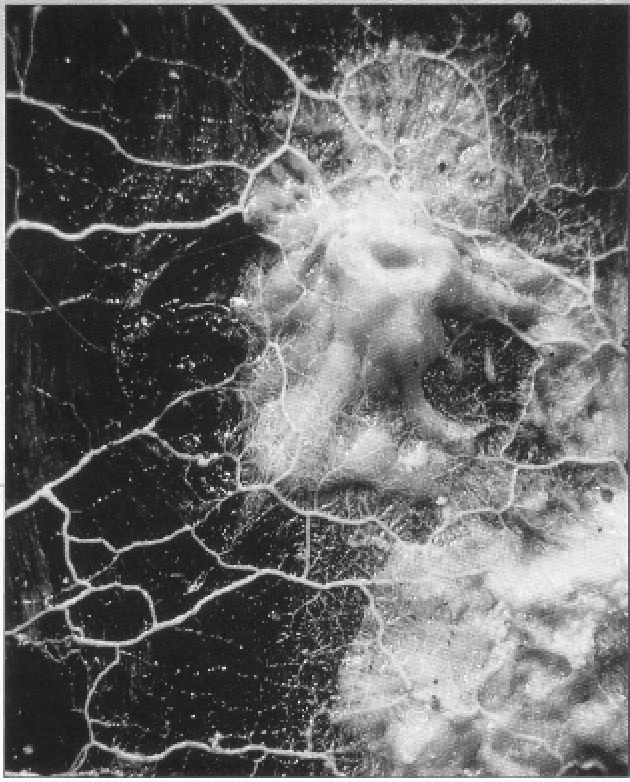
E-learning sessions with animations of key processes, art quizzes, outline summaries, and more featuring McGraw-Hill's Essential Study Partner 2.0.
Thinking Scientifically critical thinking questions challenge you to use concepts of the chapter to solve problems.
Testing Your Knowledge tests your recall of chapter material.
Self-quizzing with immediate feedback.
Electronic flashcards to review vocabulary.

Turn to the inside covers of this text to learn more about the exciting features provided for students through the *Life* website.

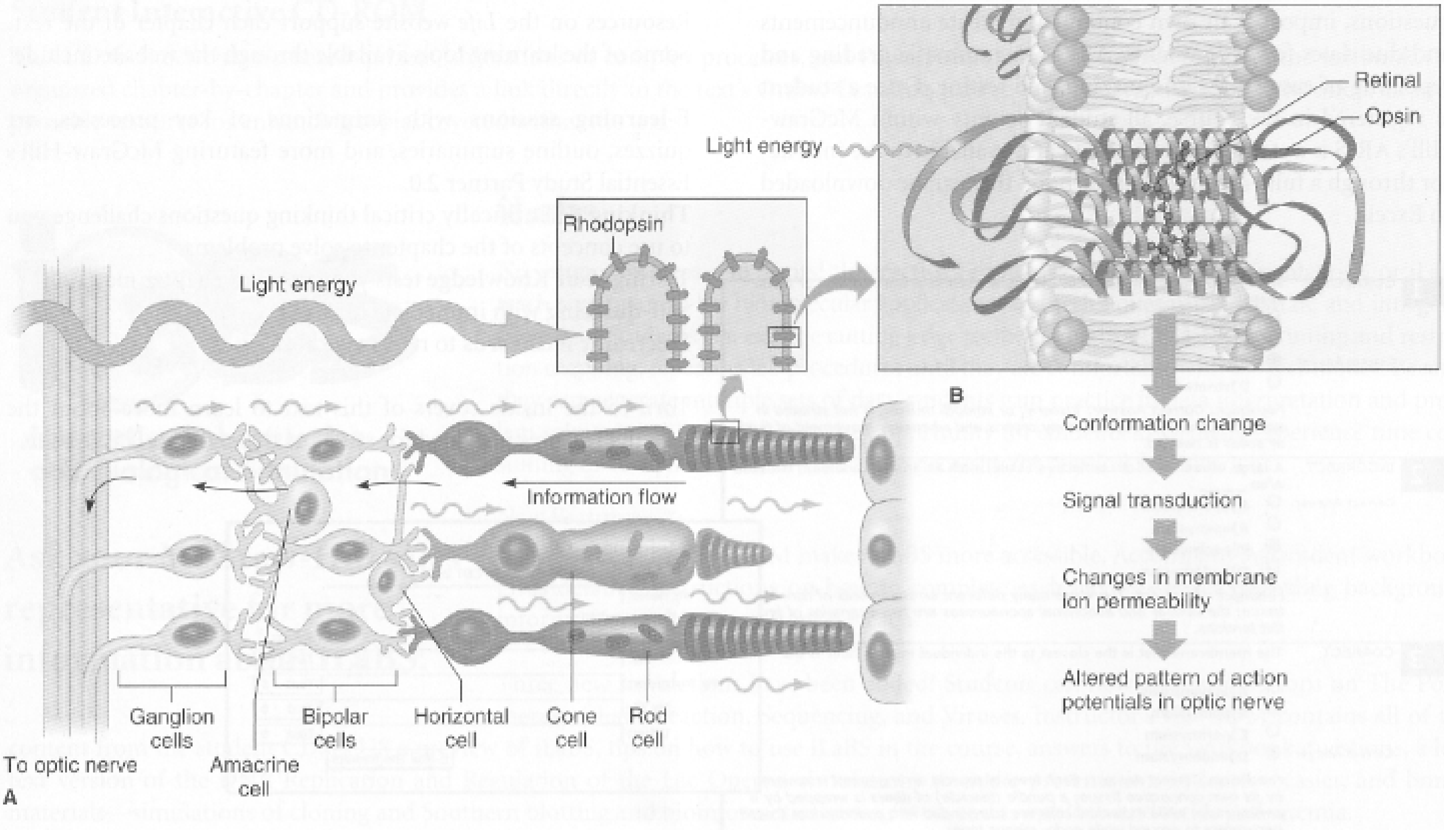


- **Fascinating photos** and stunning micrographs.

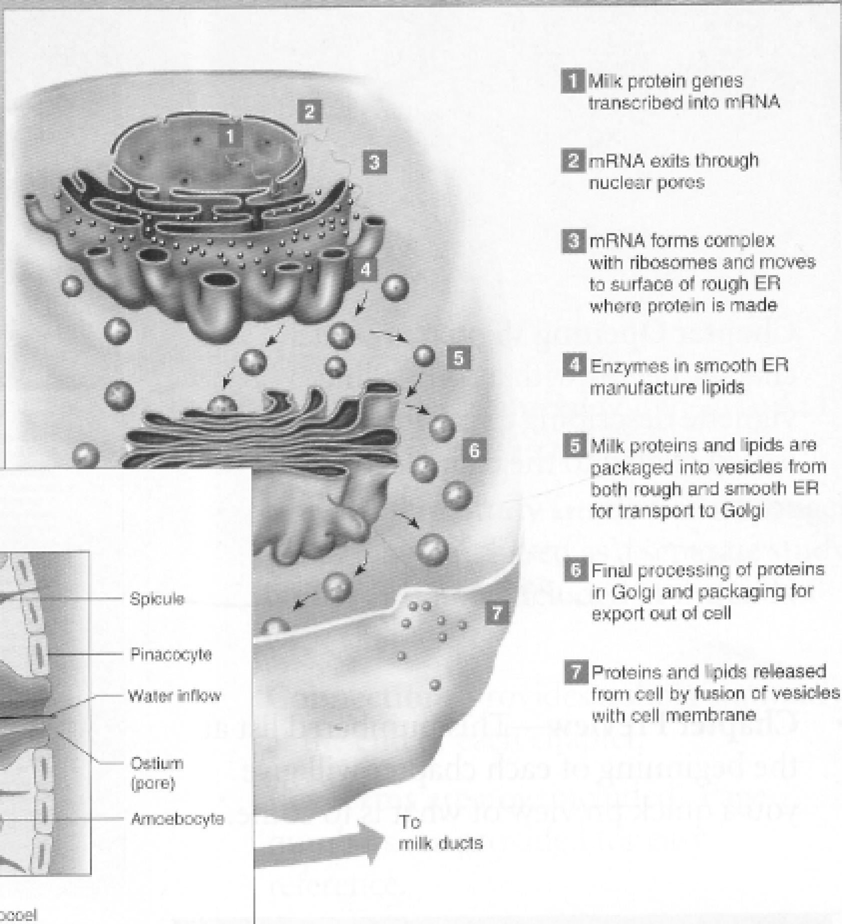


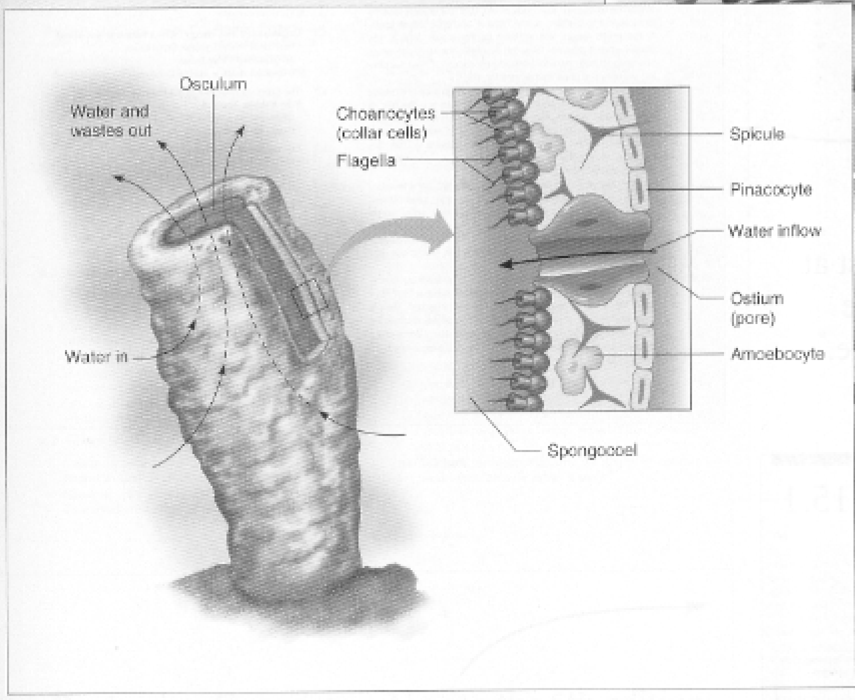


- **Overview Figures** simplify complex interactions and provide a sound study tool.



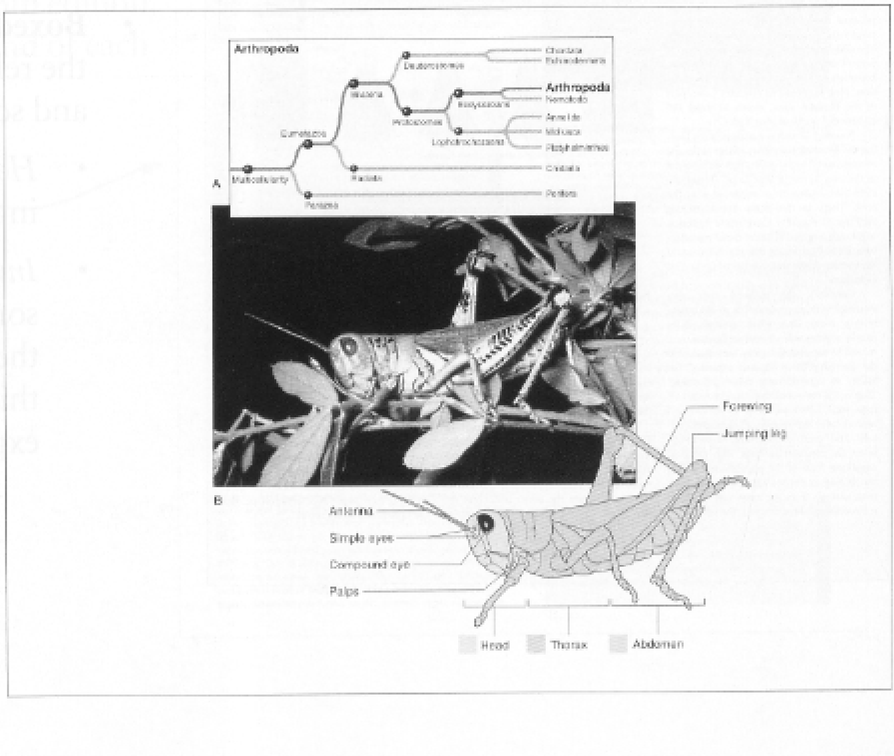
- **Process Figures** include step-by-step descriptions that walk the reader through a compact summary of important concepts.



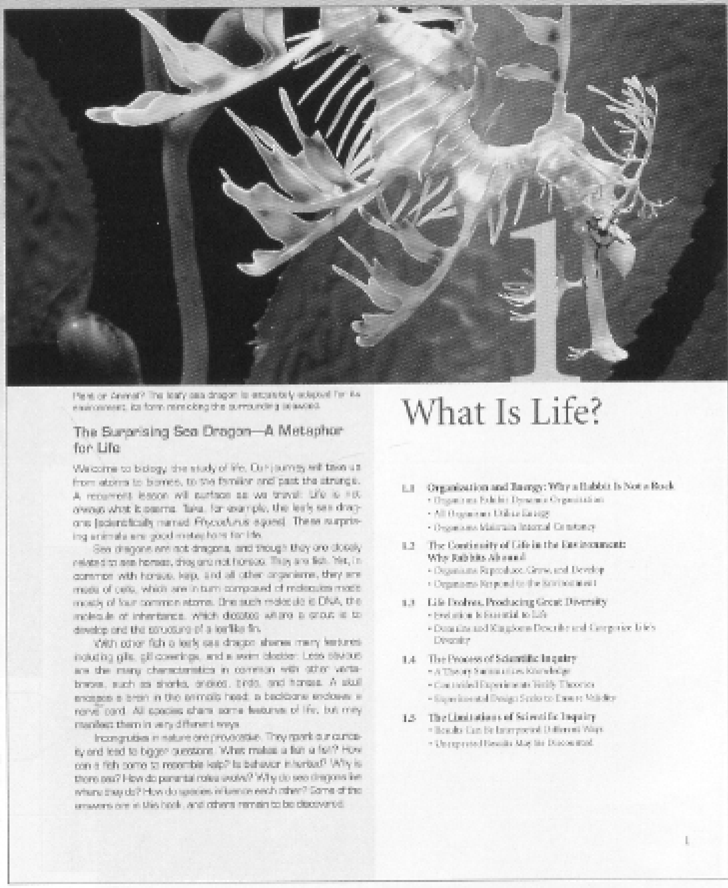


- **Zoom Figures** put structures into context by providing a macroscopic to microscopic view of life and its processes.

- **Combination figures** show the features that can be illustrated by an artist along with the appearance of structures and organisms in the real world.



- **Chapter Opening Vignettes**—Each chapter begins with a compelling vignette describing a real-life scientific issued related to the chapter topic.



Plant or Animal? The leafy sea dragon is exquisitely adapted for its environment, its form mimicking the surrounding seaweed.

The Surprising Sea Dragon—A Metaphor for Life

Welcome to biology, the study of life. Our journey will take us from atoms to biomes, to the familiar and past the strange. A recurrent lesson will surface as we travel: Life is not always what it seems. Take, for example, the leafy sea dragons (scientifically named *Phycodurus eques*). These surprising animals are good metaphors for life.

Sea dragons are not dragons, and though they are closely related to sea horses, they are not horses. They are fish. Yet, in common with horses, kelp, and all other organisms, they are made of cells, which are in turn composed of molecules made mostly of four common atoms. One such molecule is DNA, the molecule of inheritance, which dictates where a snout is to develop and the structure of a leaflike fin.

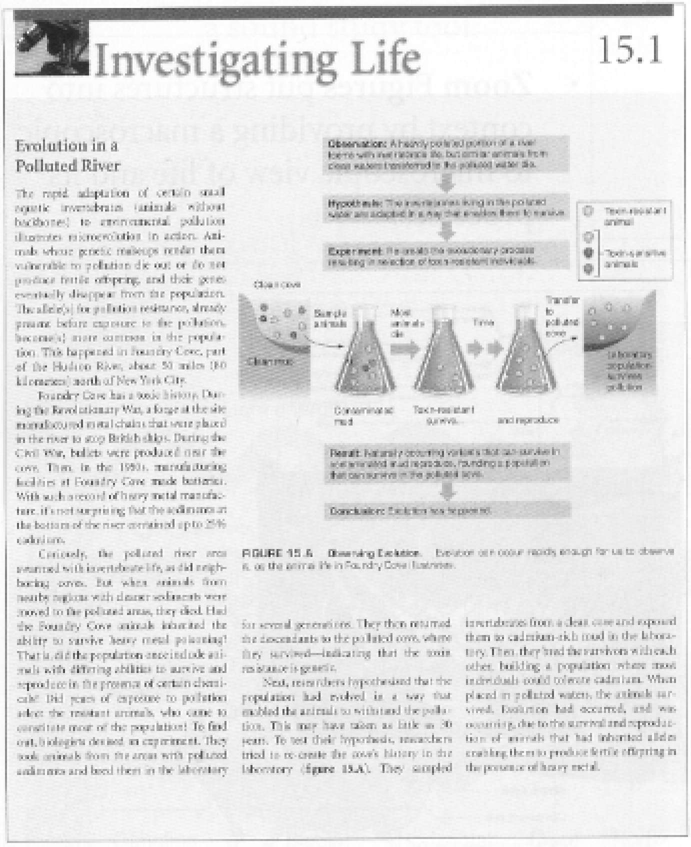
With other fish a leafy sea dragon shares many features including gills, gill coverings, and a swim bladder. Less obvious are the many characteristics in common with other vertebrates, such as sharks, snakes, birds, and horses. A skull encases a brain in the animal's head; a backbone encloses a nerve cord. All species share some features of life, but may manifest them in very different ways.

Incongruities in nature are provocative. They spark our curiosity and lead to bigger questions. What makes a fish a fish? How can a fish come to resemble kelp? Is behavior inherited? Why is there sex? How do parental roles evolve? Why do sea dragons live where they do? How do species influence each other? Some of the answers are in this book, and others remain to be discovered.

What Is Life?

1

- **Chapter Preview**—This numbered list at the beginning of each chapter will give you a quick preview of what is to come.



Investigating Life 15.1

Evolution in a Polluted River

The rapid adaptation of certain small aquatic invertebrates (animals without backbones) to environmental pollution illustrates microevolution in action. Animals whose genetic makeups render them vulnerable to pollution die out or do not produce fertile offspring, and their genes eventually disappear from the population. The allele(s) for pollution resistance, already present before exposure to the pollution, become(s) more common in the population. This happened in Foundry Cove, part of the Hudson River, about 50 miles (80 kilometers) north of New York City.

Foundry Cove has a toxic history. During the Revolutionary War, a forge at the site manufactured metal chains that were placed in the river to stop British ships. During the Civil War, bullets were produced near the cove. Then, in the 1950s, manufacturing facilities at Foundry Cove made batteries. With such a record of heavy metal manufacture, it's not surprising that the sediments at the bottom of the river contained up to 25% cadmium.

Curiously, the polluted river area swarmed with invertebrate life, as did neighboring coves. But when animals from nearby regions with cleaner sediments were moved to the polluted areas, they died. Had the Foundry Cove animals inherited the ability to survive heavy metal poisoning? That is, did the population once include animals with differing abilities to survive and reproduce in the presence of certain chemicals? Did years of exposure to pollution select the resistant animals, who came to constitute most of the population? To find out, biologists devised an experiment. They took animals from the areas with polluted sediments and bred them in the laboratory for several generations. They then returned the descendants to the polluted cove, where they survived—indicating that the toxin resistance is genetic.

Next, researchers hypothesized that the population had evolved in a way that enabled the animals to withstand the pollution. This may have taken as little as 30 years. To test their hypothesis, researchers tried to re-create the cove's history in the laboratory (**figure 15.A**). They sampled invertebrates from a clean cove and exposed them to cadmium-rich mud in the laboratory. Then, they bred the survivors with each other, building a population where most individuals could tolerate cadmium. When placed in polluted waters, the animals survived. Evolution had occurred, and was occurring, due to the survival and reproduction of animals that had inherited alleles enabling them to produce fertile offspring in the presence of heavy metal.

FIGURE 15.A **Observing Evolution.** Evolution can occur rapidly enough for us to observe it, as the animal life in Foundry Cove illustrates.

- **Boxed Readings**—These readings highlight the relevance of chapter contents to health and scientific inquiry.
    - *Health* readings discuss health issues of interest to the student.
    - *Investigating Life* features help removing some of the mystique of science, leading the reader through ways that scientists think when carrying out real experiments and investigations.

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Connections

The processes of cellular respiration are at the heart of everything we do. We can understand much of how the body functions by understanding its biochemical processes. We often think of energy as a somewhat abstract idea. When we recognize we need energy to repair body damage, we rarely connect where that energy is actually used. If you consider that proteins need to be used in wound repair and that amino acids are needed for the protein, you can see how pulling a molecule out of the Krebs cycle to make that protein would result in less energy being extracted from that molecule. All of us have felt low on energy, but what causes those feelings? The body cannot send signals because it lacks the signal molecule. Or the movement of muscles is slower, caused by a delay in getting the ATP needed. Energy, in cellular terms, often means building molecules or moving them around. Chapters 9 and 10 explore some of these cellular processes.

Student Study Guide

Key Terms

acetyl CoA *131*	aerobic respiration *127*	coenzyme A *131*	Krebs cycle *128*
anaerobes *127*	alcoholic fermentation *139*	cristae *128*	lactic acid fermentation *139*
aerobe *126*	anaerobic respiration *127*	electron transport chain *133*	matrix *128*
aerobic cellular respiration *127*	chemiosmotic phosphorylation *128*	glycolysis *127*	pyruvic acid *128*
		intermembrane compartment *128*	substrate-level phosphorylation *128*

Chapter Summary

8.1 Cellular Respiration: An Introduction

1. All living cells use cellular respiration to extract energy from the bonds of nutrient molecules.
2. Aerobic organisms use oxygen as a final electron acceptor during cellular respiration. Anaerobic organisms use different molecules and pathways in the absence of oxygen.

8.2 An Overview of Glucose Utilization

3. The general equation for aerobic respiration is $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 30ATP$
4. Glycolysis is the most common energy-extracting process. It extracts some energy from splitting glucose into two molecules of pyruvate.
5. In eukaryotic cells, cellular respiration, except for glycolysis, occurs in the mitochondria.
6. Cells use phosphorylation to transfer energy from one molecule to another.

8.3 Glycolysis: From Glucose to Pyruvic Acid

7. Cells use enzyme systems to extract energy in a controlled manner by carefully rearranging energy-rich molecules.
8. Glycolysis splits glucose into two molecules of pyruvate while transferring energy to NADH.

8.4 Aerobic Respiration: The Krebs Cycle

9. Enzyme cycles use the product of one reaction as the substrate of the next, then re-form the starting molecule. The Krebs cycle transfers energy to ATP and NADH as the remaining carbons from glucose are rearranged.
10. The enzymes of the first energy-capturing step in the mitochondria release carbon dioxide and reduce NAD^+ to NADH. A carrier coenzyme transfers the remaining carbons to the Krebs cycle.

8.5 The Electron Transport Chain

11. Electron transport uses the energy from NADH and $FADH_2$ to form a proton gradient in the mitochondrial matrix, which is then used to phosphorylate ATP.
12. Oxygen is required at this step as a final acceptor of the energy-depleted electrons.
13. Each NADH yields 2.5 ATP, and each $FADH_2$ yields 1.5 ATP via this process. The net energy extracted from glucose is 30 to 32 ATP.
14. Feedback mechanisms regulate the activity of enzymes to ensure the cell has the energy it needs.

- **End-of-Chapter Material** will include ALL new features for the sixth edition:
    - The **Student Study Guide** will no longer need to be purchased as a separate study guide. It is now included at the end of each chapter!
    - **Connections** provides a short summary at the end of each chapter.
    - **Key terms** are now included. Page numbers are provided for easy reference.

- **Reviewing Concepts**—New to the 6th edition, this short summary appears at the end of each major heading.

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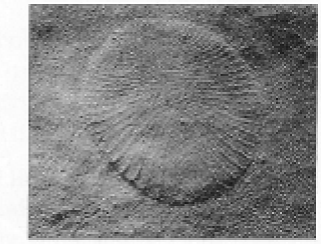
organisms may have been unicellular algae. Australian fossils consisting of an organic residue 1.69 billion (1,690 million) years old are chemically similar to eukaryotic membrane components and may come from a very early unicellular eukaryote.

About 1.2 billion years ago, multicellular life appeared. Exactly how life proceeded from the single-celled to the many-celled is a mystery. Perhaps many unicellular organisms came together and joined, then took on different tasks to form a multicellular organism. Alternatively, a large single-celled organism may have divided into many subunits and diverged in gene expression and function. The earliest fossils of multicellular life are from a red alga that lived about 1.25 billion to 950 million years ago in Canada. Abundant fossil evidence of multicellular algae comes from Siberia, dating from a billion years ago.

Reviewing Concepts

- Fossil evidence suggests the first prokaryotic cell arose 3.8 billion years ago.
- The first photosynthetic cell followed at 3.5 billion years ago.
- This was followed by the diversification of cells to form the precursors of today's different cell types.



1 cm

FIGURE 19.12 Complexity increases. A "typical" Ediacaran organism. *Dickinsonia* grew to a meter in diameter, but only 3 millimeters thick. It had segments and two different ends and internal detail that paleontologists have interpreted as remnants of a simple circulatory or digestive system. But just what it was remains unclear. One group of paleontologists couldn't agree on whether it most resembled a jellyfish, a flatworm, or a fungus! Like other Ediacarans, *Dickinsonia* might not have been anything like the species we are familiar with today.

19.4 The Ediacarans

Paleontologists divide natural history into the Precambrian and everything that came during and after the Cambrian (590 until 505 million years ago), which was the first period of the Paleozoic era. The reason for this distinction is that fossils of all the major phyla of animals appear rather suddenly in sediments from the Cambrian. It seems highly unlikely that the late Precambrian was lifeless; instead, whatever lived then did not leave fossils. Most animal forms from the Precambrian were soft-bodied and did not readily fossilize. Charles Darwin wrote that the Cambrian explosion was misleading and that the Precambrian seas must have "swarmed with living creatures."

As the Proterozoic era became the Paleozoic, from about 600 to 544 million years ago, many parts of Earth were home to organisms called Ediacarans, which have no known modern descendants. The Ediacarans have long puzzled biologists because of their appearances, preserved in sandstones and shales as casts and molds, that are notably different from life as we know it today. Their bodies were apparently soft and very flat—**figure 19.12** shows one representative organism, *Dickinsonia*, that was a meter in diameter but less than 3 millimeters in body thickness. This flattened form may have been an adaptation for extracting maximal oxygen from the ancient seas. Ediacaran bodies were built of sections of tubing, branches, ribs, discs, and fronds. Ediacarans had no complex internal organ systems, no obvious body openings, and they probably could not move very far. Biologists have interpreted Ediacaran fossils to be everything from worms to ferns to fungi, as **figure** 19.13 demonstrates.

The Ediacarans vanished from the fossil record about 544 million years ago, by which time the diversity of life in the Cambrian was exploding. Perhaps their disappearance resulted from change in the very specific conditions under which they were preserved. The height of the Ediacaran reign—from 570 to 560 million years ago—was also the time that phosphatization preserved large numbers of algae, sponges, and unidentified animal embryos in the seas (see figure 18.7E). Instead of Ediacaran life suddenly giving way to familiar animal phyla, these organisms may have more gradually vanished, opening up habitats for the organisms that left the phosphatized remains, and others. As the Ediacarans disappeared, the Cambrian seas filled with a spectacular diversity of life.

Reviewing Concepts

- The first multicellular life is represented by fossils of the Ediacarans, which were simple organisms without any obvious complex organs or systems, just an association of cells to form tissues.