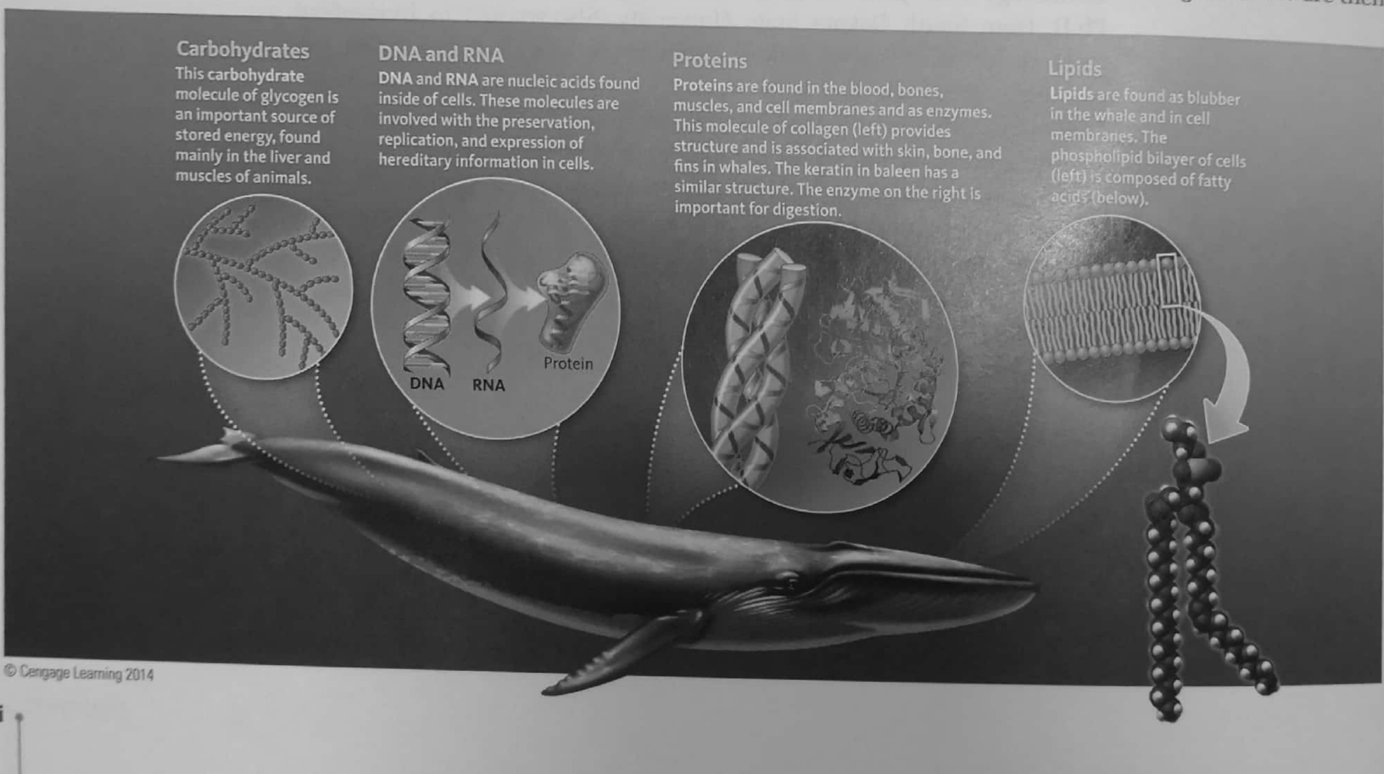
Preface

Welcome to an exciting new way to teach, learn, and experience introductory biology—the study of living things. The title of this book, *Biology: Organisms and Adaptations,* signals our approach to learning core biology concepts—organisms. Our approach was born out of a simple observation: Humans have an innate fascination with the lives and adaptations of living things. People love to explore, discover, and learn about the natural world. This observation provided us with a deep sense of purpose to build a biology book that translates the passions and interests of students and instructors into meaningful and enduring learning. It is our hope that you will find our approach motivating to yourself and your students.

An Organismal Approach

Our vision for a new and richer learning experience means that living things are out front doing the work—enhancing, engaging, connecting, providing applications, and driving a deeper level of understanding. Right from the start, each chapter opens with the story of an organism that illustrates the biological concepts to follow in the chapter. As the central organizing framework, organisms provide you with a powerful tool to:

1. **Interest and motivate your students to engage with biological concepts.**
   All instructors want their students to value their course and the learning it produces. This text directly acknowledges the great impact that positive feelings and emotions (appreciation, motivation, excitement, and curiosity) have on thinking and learning. The organisms have been carefully selected for their relevance and interest.
2. **Provide concreteness, familiarity, and a springboard for learning key concepts.**
   Key biological concepts are presented and learned in relation to familiar, recognizable organisms. A blue whale is classified; has an evolutionary history; lives in a particular habitat; has a body composed of organ systems, organs, tissues, cells, and subcellular components; feeds and metabolizes; mates, reproduces, and inherits traits. Thus the whale serves as a focal point to synthesize and connect the concepts that you have told us you want your students to learn.
   Educational research has shown that learning becomes more durable and transferable when it is constantly reinforced and repeated in different contexts. Traditional approaches often present a concept in the opening units and expect students to recall the details many chapters later in an entirely new context. The advantage of an organismal approach is the opportunity to reinforce processes and adaptations among different organisms throughout the book. We take every opportunity to reinforce the process of meiosis in animal, plant, and fungal systems. The same is true for other essential concepts, such as cell structure, natural selection, niche, gene expression, biomolecules, cell cycle, cellular respiration, and enzymes.
3. **Create a platform for inquiry, application, synthesis, and critical thinking.**
   We introduce a variety of organisms to provide engaging opportunities to develop question-asking skills, scientific thinking, data analysis, and the application and synthesis of biological concepts. Empowered with a deeper sense of anchored and connected understanding, students are then



capable of applying their knowledge and skills to other organisms that they encounter in their region of the country or the world. As an instructor, you have the flexibility of using the organisms provided in the text or using your own favorite organism.

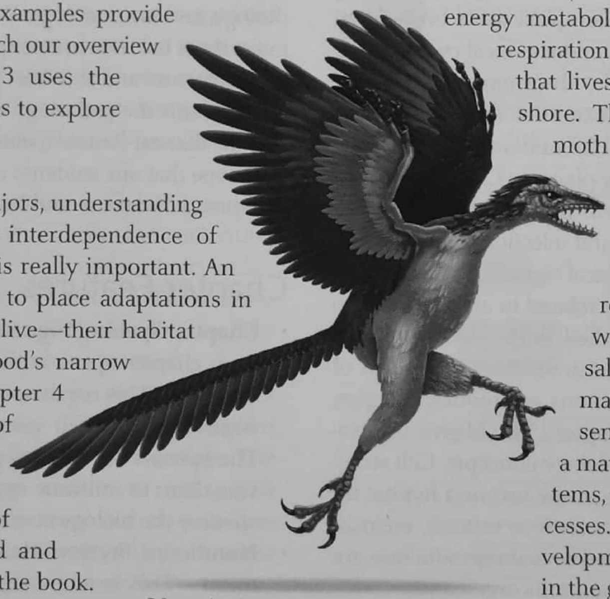
The Organization of the Book

In terms of the biological hierarchy of scale and organization, our approach begins and focuses on the *organism* level. We believe that the most powerful frameworks to shape student understanding of living things are evolution and ecology. Therefore the first unit establishes these foundations and contexts within which the rest of the book is based.

Unit 1. Introduction to Organismal Biology—Establishes the Basic Foundation and the Framework. Unit 1 lays the foundation, in a brief way, for the characteristics of life, hierarchy of scale and organization, cells, biological processes, and biomolecules. Our strategy is to give students enough information so that they can begin to apply it, and we can use it to go into greater depth in later units. For example, we present proteins as molecules that have a variety of shapes and perform many critical functions. We wait until Unit 2 to delve deeper into protein chemistry. This spares students from details at points of instruction where they do not need it. In addition to laying the groundwork, Unit 1 establishes two major themes or frameworks:

Evolutionary Biology—Evolutionary concepts provide a coherent explanation for the unity and diversity of living things. This central concept in biology is first introduced in Chapter 1 as a potent example of evidence-based scientific reasoning. We then follow a large-scale view (macroevolution) to a smaller-scale view (microevolution) in Chapters 2 and 3. Students love dinosaurs, and Chapter 2 uses *Archaeopteryx* and the evolution of birds to introduce large-scale evolutionary processes and concepts. These examples provide the frame to understand and launch our overview of biological diversity. Chapter 3 uses the mimicry of passion-vine butterflies to explore the processes of natural selection.

Ecological Approach—For nonmajors, understanding how the world works and the interdependence of organisms and the environment is really important. An ecological frame allows students to place adaptations in the context of where organisms live—their habitat and ecosystem. The coast redwood's narrow geographic range is used in Chapter 4 to present ecological concepts of habitat and the environmental factors that influence the activities and behaviors of organisms. Habitat is established and then used throughout the rest of the book.

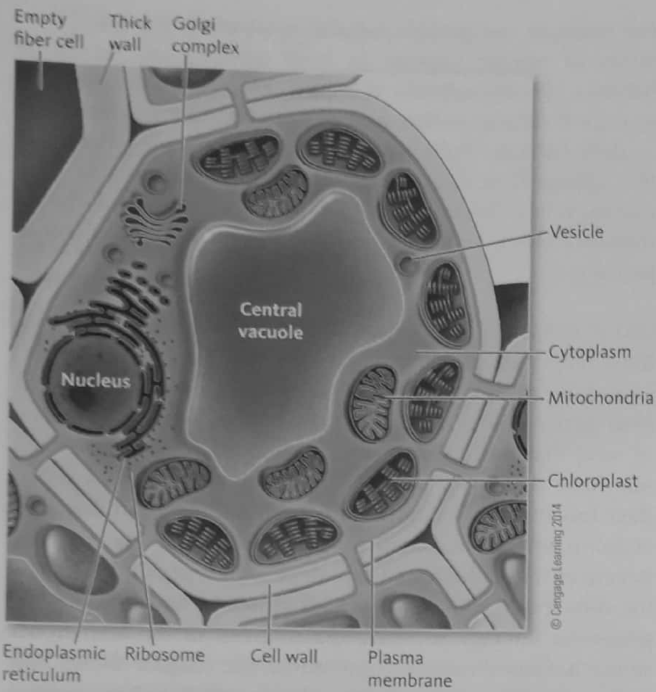


For example, we present cellular respiration (Chapter 9) in terms of oxygen capture in both aquatic and terrestrial habitats. Photosynthesis (Chapter 13) is placed into an ecological context so that students can connect it to resources in their habitat—light, water, and carbon dioxide. We think this approach is much more motivating and concrete than placing it in a chapter devoted to abstract concepts of energy transformation, which emphasizes the detailed biochemical pathways.

Unit 2. Adaptations of Animals—The Most Familiar Organisms. Most nonmajor students report that they find animals more interesting than other kinds of living things. Students see animals as dynamic and exciting because they move and behave in ways that they can relate to. In Chapter 6, the leatherback sea turtle is used to illustrate how animal structures reflect their function. The chapter starts with the most familiar level of animal structure—organ systems. We then use the digestive system of the leatherback turtle to present types of tissues and the cells that compose them. Cell structure and function are presented through an acid-producing cell of the leatherback stomach. Once structure is presented, the chapter shows how structures of the multicellular animal work together, communicate, and respond to change—in other words, homeostasis.

How these structures arise from a single fertilized cell is answered in Chapter 7, where the American lobster is used to show students patterns of growth and development, control, DNA structure and replication, and the cell cycle. Once again, the overarching context is a growing, developing organism that serves as a focal point to understanding the abstract mechanisms that produce that organism's body. Gene expression (transcription and translation) is not presented in abstract terms but rather as the driving process that results in the lobster's growth and differentiation.

The familiar dairy cow begins a two-chapter sequence that transforms food (Chapter 8) and oxygen (Chapter 9) into energy metabolism in the mitochondria. Cellular respiration is framed in the life of the clam that lives in the intertidal zone at the seashore. The battle between bats and their moth prey sets the stage for learning how nervous, muscular, and skeletal systems work together to enable the animal to eat, move, and find a mate (Chapter 10). Animal reproduction (Chapter 11) is a fitting way to pull Unit 2 together. Coho salmon display the interaction of animal populations in their habitat, their sensory systems in their drive to find a mate, their male and female organ systems, as well as sex cells and cellular processes. Finally, reproduction involves development and nutrient and gas exchange in the growing fetus.



Unit 3. Adaptations of Plants and Fungi—Moving from the Background to the Foreground. The lives of plants and students come together through coffee (Chapter 12); carnivorous pitcher plants (Chapter 13); and the symbol of the American Southwest, the iconic saguaro cactus (Chapter 14) in Unit 3. This unit explores how plants are constructed and presents plant cell structure through a photosynthetic cell in the leaf of a coffee plant. The reader is led to compare it to the animal cell presented in Chapter 6. The cell cycle and mitosis return as the cellular process that causes coffee buds to grow and flower. The complex reactions of photosynthesis are presented in context of the plant's light environment (Chapter 13). We address the long-held student misconception that plants don't respire by tracing sugar from its production in the chloroplast to its breakdown in the mitochondria. Plant activities and chemical cycles of the biosphere are understood through the absorption of water and minerals through roots. The reproduction of the flowering aspen and saguaro are the focal points for understanding asexual and sexual reproduction of flowering plants in Chapter 14. As in Unit 2, the sex lives of flowering plants pull together many core biology concepts, which include natural selection, gene flow, cell structure, mitosis, meiosis, and chemical signaling.

Although fungi are more closely related to animals than to plants, fungi are traditionally studied with plants and are placed in this unit. Fungi are framed in relation to the lives of college students through yeast infections, antibiotics, allergies, pizza baking, and beer brewing. Chapter 15 highlights how interesting organisms integrate key biology concepts. Cell structure is reinforced for the third time in the text as a hyphal tip cell of a mushroom. Other concepts such as mitosis, meiosis, enzyme activity, gene expression, and sexual reproduction are applied to these fascinating and ubiquitous organisms.

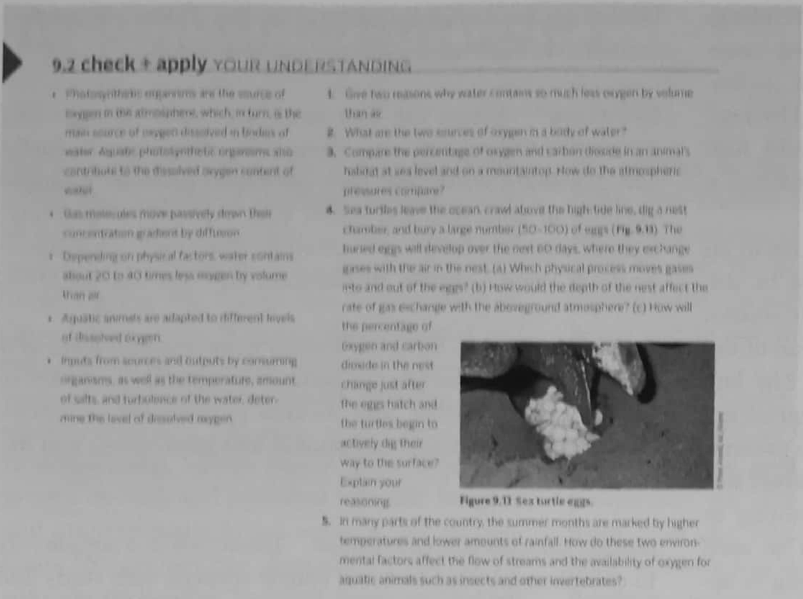
Unit 4. Environmental Connections of Life—Helping Understand Environmental Issues. A strong reason for students to take a nonmajor biology course is for them to become more informed and literate about issues confronting our society. Chapter 16 functions to help students apply organismal biology to global concerns such as clean water, carbon cycling, greenhouse gases, and climate change. Chapter 17 capitalizes on the fact that many students have visited Yellowstone National Park and will easily relate to environmental issues and the challenges faced by this ecosystem. Millions of people visit zoos and aquariums each year, and this chapter discusses their role in conserving global biodiversity.

Unit 5. Genetic Connections of Life—Helping Understand the Genetic Past and Future. The physical appearance and adaptations (phenotype) of animals, plants, and fungi serve as the basis to understanding the underlying genetic principles of inheritance (Chapter 18). This is why the unit is titled "Genetic Connections" and comes toward the latter half of the book. The familiar human is the lead organism used to get students to consider their own genetic history and future. Corn, the staple of American food products, is the organism used to introduce the application of genetics to genetic engineering of foods and ethical considerations (Chapter 19). Finally, this unit explains how genetic techniques help convict criminals, conserve biodiversity, and enhance our health care.

Unit 6. Applying Biological Concepts to Human Health and Disease—Promoting Health through Understanding. Students are very engaged when we discuss their personal health and welfare. This final unit applies concepts established throughout the book in the relationship between humans and their health. Chapter 20 begins with the story of the MRSA superbug and the issue of antibiotic resistance. Infectious diseases caused by bacteria, viruses, and protozoans take center stage to reinforce and apply concepts of cell structure, ecology, pathology, and immunology. While we acknowledge that the vast majority of bacteria are nonpathogenic, this chapter focuses on their structure and activities that cause disease. The last chapter (21) explains the pathology and public health issues relating to chronic disease—cancer, obesity, and heart disease. It is our sincere hope that our students will use this information to prevent the spread of disease and lead healthy, prosperous lives.

Chapter Features

- **Chapter Opening Vignettes with Enhanced Illustrations**—Each chapter opens with a story that profiles a fascinating organism. This organism may be familiar to some students, depending on their geography and personal experiences. The openers function to pique students' curiosity and motivate them to continue reading. They also illustrate and foreshadow the biology concepts to follow in the chapter.
- **Numbered Section Headings Present a Concept Statement**—This is a text-signaling device that telegraphs the


9.2 check + apply YOUR UNDERSTANDING

- Photosynthetic organisms are the source of oxygen in the atmosphere, which, in turn, is the main source of oxygen dissolved in bodies of water. Aquatic photosynthetic organisms also contribute to the dissolved oxygen content of water.
- Gas molecules move passively down their concentration gradient by diffusion.
- Depending on physical factors, water contains about 20 to 40 times less oxygen by volume than air.
- Aquatic animals are adapted to different levels of dissolved oxygen.
- Inputs from sources and outputs by consuming organisms, as well as the temperature, amount of salts, and turbulence of the water, determine the level of dissolved oxygen.

1. Give two reasons why water contains so much less oxygen by volume than air.
2. What are the two sources of oxygen in a body of water?
3. Compare the percentage of oxygen and carbon dioxide in an animal's habitat at sea level and on a mountaintop. How do the atmospheric pressures compare?
4. Sea turtles leave the ocean, crawl above the high tide line, dig a nest chamber, and bury a large number (50–100) of eggs (**Fig. 9.11**). The buried eggs will develop over the next 60 days, where they exchange gases with the air in the nest. (a) Which physical process moves gases into and out of the eggs? (b) How would the depth of the nest affect the rate of gas exchange with the aboveground atmosphere? (c) How will the percentage of oxygen and carbon dioxide in the nest change just after the eggs hatch and the turtles begin to actively dig their way to the surface? Explain your reasoning.

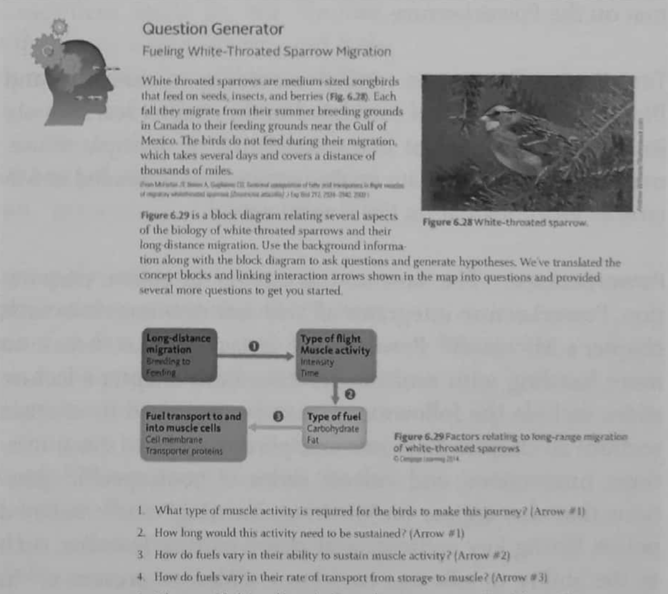
Figure 9.11 Sex turtle eggs.

5. In many parts of the country, the summer months are marked by higher temperatures and lower amounts of rainfall. How do these two environmental factors affect the flow of streams and the availability of oxygen for aquatic animals such as insects and other invertebrates?

topic structure to students and helps them grasp the main point of the section. This feature allows instructors to refer to specific sections by number when assigning reading and preparation work.

- **Check & Apply Your Understanding**—At the conclusion of every section are bulleted key concepts followed by five questions that help students self-assess their understanding of the concepts presented. The first two questions assess basic knowledge, followed by questions of increasing difficulty. The fifth question asks students to transfer their conceptual understanding to other organisms or situations. These higher-level questions can also be used in lectures as one-minute papers or "clicker questions" asking students to make a specific choice regarding a scenario.
- **End of Chapter Review**—This section is designed to challenge and promote thinking and applying concepts.
  - **Self-Quiz Questions**—These questions are organized around each of the chapter's key concepts. For each concept, a series of matching and multiple-choice questions are posed. They are designed to assess semantic and conceptual knowledge and foster factual base building and independent learning.
  - **Applying the Concepts Questions**—These questions ask students to connect chapter concepts to each other and to other disciplines and to transfer their understanding to new organisms or situations. These questions can be easily incorporated into lectures to help students apply the material they have learned.
  - **Data Analysis Exercise**—This activity promotes higher thinking skills involving strategic knowledge (problem solving), application, and quantitative thinking skills. The *Data Analysis* feature challenges students to read graphs and tables from actual scientific papers. Here they analyze the freezing tolerance of lizards, photosynthesis in yucca plants, and the growth rate of giant pumpkins.
  - **Question Generator**—One of the basic skills required for the development of scientific reasoning is asking questions. We intentionally work to develop students' question-asking skills through this feature. It's very important for students to realize that biologists don't pull their research questions out of thin air; rather, they arise from a base of knowledge and an understanding of how concepts are connected. Through the *Question Generator,* we present an intriguing aspect of the biology of an organism, which is related to chapter concepts. We then show students a diagram of concept relationships and use it to model how they can generate effective questions and develop this higher-level thinking skill.

Stunning Art Program. The biological hierarchy is a very effective schema to help students integrate their knowledge into understanding. As instructors, we move fluently among levels of the biological hierarchy. Students need time to locate the level at which they are working and how it connects upward and downward in scale. Our text's stunning art program takes students on a Google Earth–type visual journey from the organism level down to the tissues, cells, and molecules. The hydrogen bonds of a keratin molecule are visually connected to the feathers of a peregrine falcon. Through their connective thinking, students begin to reason and think like biologists.


Question Generator

Fueling White-Throated Sparrow Migration

White-throated sparrows are medium-sized songbirds that feed on seeds, insects, and berries (**Fig. 6.28**). Each fall they migrate from their summer breeding grounds in Canada to their feeding grounds near the Gulf of Mexico. The birds do not feed during their migration, which takes several days and covers a distance of thousands of miles.

Figure 6.28 White-throated sparrow.

Figure 6.29 is a block diagram relating several aspects of the biology of white-throated sparrows and their long-distance migration. Use the background information along with the block diagram to ask questions and generate hypotheses. We've translated the concept blocks and linking interaction arrows shown in the map into questions and provided several more questions to get you started.

Figure 6.29 Factors relating to long-range migration of white-throated sparrows

1. What type of muscle activity is required for the birds to make this journey? (Arrow #1)
2. How long would this activity need to be sustained? (Arrow #1)
3. How do fuels vary in their ability to sustain muscle activity? (Arrow #2)
4. How do fuels vary in their rate of transport from storage to muscle? (Arrow #3)
5. What type of fuel(s) would sustain this muscle activity over several days? (Arrow #2)
6. How rapidly do the different fuels get from storage to the muscle? (Arrow #3)
7. At the muscle cell level, do sparrows have a large number of transporter proteins to speed up fuel uptake? (Green block on diagram)

Use the block diagram to generate your own research question and frame a hypothesis.

Vocabulary Builds Language, and Language Drives Thinking. Biology, like all disciplines, includes many specialized terms that are networked together in specific ways to form its language. It is through this language that biologists and biology students understand and interact with the living world. And it is through biological language that they will construct a mental model, or learn biology.

We realize that the number of new technical terms in an introductory biology course can be overwhelming to students, and they often label biology as a memorization course. We recognize that the introduction and memorization of too many terms often impedes reading and learning. The language in this text has been carefully chosen, and terms are introduced when they are useful to learning. Before presenting and boldfacing a particular term, we asked ourselves several questions: How powerful is the term in explaining or organizing information? How often will the term be used again? Is it essential for furthering the understanding or application of a concept? A term that has been boldfaced has exceeded a threshold of importance. We also acknowledge that instructors using this book look for and are comfortable with specific terms. We boldface and define terms when they are first introduced in each chapter to inform the reader and develop conceptual understanding.

Instructor's Supplements

Instructor's Manual. A great planning tool that includes chapter objectives; key concepts; key terms; lecture outlines; ideas for further inquiry; websites, animations, and videos; suggestions for lecture enrichment and activities; possible answers to the text questions; and more. Content is mapped to learning objectives and includes alternate organisms to help reinforce ideas. Also included in Microsoft® Word format on the PowerLecture.

Test Bank. Test items ranked according to difficulty and Bloom's Taxonomy and correlated to the chapter learning objectives. Over 1,000 test items consisting of multiple-choice, matching, essay, and data analysis questions. Included in Microsoft Word format on the PowerLecture.

PowerLecture. The time-saving answer to course preparation, PowerLecture integrates all relevant resources into each chapter's Microsoft® PowerPoint® lecture so that there's no more hassling with multimedia files. Each chapter's lecture slides include the following resources, organized by chapter section: all chapter diagrams and photos; links to the animations, interactions, and videos; slides of book-specific questions that also appear on JoinIn on TurningPoint®; bulleted points listing key content; and many editing features, such as the ability to edit text on lecture slides, to present art in segments, and to edit labels, remove labels, or present one label at a time. Available Online or on disc, PowerLecture also includes the Instructor's Manual and Test Bank.

ExamView® Access the Test Bank questions through this interactive testing software. ExamView allows you to easily edit questions, write your own questions, generate multiple versions of your test, and create your own online quizzing. ExamView can also be converted to work with your BlackBoard or WebCT course. Included on the PowerLecture DVD.

Aplia with eBook. Aplia for Biology helps students learn and understand key concepts via focused assignments and active learning opportunities that include randomized, automatically graded questions; exceptional text interaction; and immediate feedback.

Biology CourseMate with eBook. Interested in a simple way to complement your text and course content with study and practice materials? Cengage Learning's Biology CourseMate brings course concepts to life with interactive learning, study, and exam preparation tools that support the printed textbook. With CourseMate, you can use the included Engagement Tracker to assess student preparation and engagement. In addition, CourseMate includes an interactive eBook where students can take notes, highlight, search, and interact with embedded media. Use it as a supplement to the printed text or as a substitute—the choice is your students' with CourseMate.

Student Supplements

Study Guide. Chapter summaries, key concepts, key terms, along with multiple-choice, fill-in-the-blank, matching, discussion questions, and more, all of which reinforce the text's learning objectives to help students with retention and achieve better test results.

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Biology CourseMate with eBook. Cengage Learning's Biology CourseMate brings course concepts to life with interactive learning, study, and exam preparation tools that support the printed textbook. In addition to interactive teaching and learning tools, CourseMate includes an interactive eBook. Students can take notes and highlight, search, and interact with embedded media specific to their book. Biology CourseMate goes beyond the book to deliver what students need!