

Preface to Instructors

From the very first edition, *Biological Science's* unique emphasis on the process of scientific discovery and guiding students to think like biologists has placed this book at the forefront of change in the way we teach biology. The Sixth Edition embraces this legacy and continues to exemplify the principles outlined in the recent *Vision and Change in Undergraduate Biology Education* report. As in previous editions, the cutting-edge biology in the Sixth Edition is pitched at the right level for introductory students, and is as accurate and as exciting as ever for instructors and students alike. New findings from education research continue to inform and inspire the coauthor team's thinking about *Biological Science*—we know more today than ever before about how students learn. These findings demand that we constantly look for new ways to increase student engagement in the learning process. Innovative features new to this edition offer students even more opportunities to actively apply concepts in new situations; evaluate experimental design, hypotheses, and data; synthesize results; and make and interpret models. For instructors, additional resources are provided to help align course activities and learning goals with their assessment strategies.

Core Values

In the Sixth Edition, the coauthor team has strived to extend the vision and maintain the core values of *Biological Science*—to provide a book and online resources for instructors who embrace the challenge of boosting students to higher levels of learning, and to provide a book that helps students each step of the way in learning to think like scientists, regardless of their starting point in the process. Dedicated instructors have high expectations of their students. The Sixth Edition provides tools to help students build their cognitive mastery in both biology content and transferrable skills—to learn at the level called for by the National Academy of Sciences, the Howard Hughes Medical Institute, the American Association of Medical Academies, and the National Science Foundation. Reports such as *Biology 2010*, *Scientific Foundations for Future Physicians*, and *Vision and Change* all place a premium on fundamental concepts and skills as well as connecting core ideas across all levels of biology.

What's New in This Edition

The Sixth Edition contains many new or expanded features, all of them designed to provide students with initial instruction in content and skills, followed by opportunities for lots of practice in applying knowledge and skills to new contexts. The ultimate goal is for students to learn to construct their own knowledge and think like biologists.

- **Relocated and Expanded BioSkills Section** Instructors recognize that biology students need to develop foundational science skills in addition to content knowledge. Since the

Third Edition, *Biological Science* has provided a unique, robust set of materials and activities in an appendix to guide students who need extra help with the skills emphasized in the book. In the Sixth Edition, the BioSkills materials have been placed between Chapters 1 and 2 to emphasize their importance as a resource for success in doing biology, and to make it easier for students to access them throughout the course. The BioSkills are grouped within five broad categories depicted in a new opening road map: Quantifying Biology, Using Common Lab Tools, Visualizing Biology, Reading Biology, and Monitoring Your Own Learning. Four new BioSkills have been added: Using Spectrophotometry, Using Molecular Biology Tools and Techniques, Reading and Making Visual Models, and Recognizing and Correcting Misconceptions. Existing BioSkills have been updated to support new features in the Sixth Edition. For example, the explanation of statistical tests has been expanded, and *P* values are introduced to provide students with essential quantitative skills for interpreting data in the end-of-chapter case studies. BioSkills include practice questions, are cross-referenced throughout the text, and can be assigned online in MasteringBiology®.

- **Making Models Boxes** Reports like *Vision and Change* cite the importance of developing model-based reasoning skills. To help attain this goal, Making Models boxes have been added throughout the book to explicitly teach students how to use visual models to learn and do biology. Each Making Models box has three components: instruction in interpreting or creating a specific type of model, an example of that type of model, and an application question so that students can immediately practice their skills. In addition to the guidance in the text, online video versions are accessible via QR code so students can watch and interact with a dynamic presentation of modeling. Lastly, the video version is also included in an assignable MasteringBiology activity that tests students with higher-level questions.
- **Put It All Together Case Studies** The end-of-chapter question sets for every chapter now include a case study. Case studies briefly introduce contemporary biology research in action, followed by questions that ask students to apply the chapter's content and skills to the research topic. Instructor resources include clicker questions to give instructors the opportunity to use the case studies as discussion prompts in the classroom. A constant hallmark of this text is its emphasis on experimental evidence—on teaching how we know what we know. The case studies expand this emphasis, requiring students to evaluate real data and to see how ongoing scientific research is related to core biological ideas.
- **Big Picture on Biological Diversity** Introduced in the Fourth Edition, Big Picture concept maps integrate words and visuals to help students synthesize information about challenging topics

that span multiple chapters and units. In response to requests from instructors and students, a new Big Picture has been added on the Diversity of Life, illustrating the relationships among the major taxonomic groups in the tree of life.

- **Integrated Chapters** Three newly consolidated chapters reorganize and integrate information to better serve instructors and students. Chapter 20 (The Molecular Revolution: Biotechnology and Beyond) merges the most essential information on genome analysis that was previously discussed in separate chapters, while moving details of fundamental techniques to the BioSkills. Core material on the general principles of development, particularly those related to genetics and evolution, now forms the closing chapter of a streamlined unit on Gene Structure and Expression (Chapter 21). Content on plant and animal development has been moved from the former developmental biology unit to the respective reproduction and development chapters of the How Plants Work (Chapter 38) and How Animals Work (Chapter 47) units.
- **Skill-Based Question Tags** *Biological Science* has long emphasized skill development, and reports like *Vision and Change* also encourage this focus for introductory majors. To help students and instructors identify opportunities to practice key skills, questions are tagged to indicate the following: *Process of Science* questions explore the application of the scientific process; *Model* questions ask students to interpret or construct visual models; *Society* questions explore the relationship between science and society; *Quantitative* questions help students perform quantitative analysis and mathematical reasoning; and *Caution* questions address topics for which students often hold common misconceptions. Answers to *Caution* questions include information that addresses the misconception.
- **Detailed Assessment Matrix** At the beginning of the revision process, we thoroughly evaluated the assessment program and focused on revising it throughout the creation of the Sixth Edition. To aid our analysis, we looked at the question data collected in MasteringBiology, and we created an assessment matrix for each chapter that identifies how each question is related to learning outcomes, Bloom's level, common misconceptions, and *Vision and Change* core concepts and competencies. We hope the tool will assist instructors in selecting the most appropriate assessment items to align with the goals of their course.
- **Expanded Use of Summary Tables** The art program is further enhanced in this edition by additional illustrated summary tables that deliver content in a streamlined way and facilitate comparison and analysis by students. For example, the diversity boxes from the Fifth Edition's The Diversification of Life unit have been redesigned as photographic summary tables. These tables make subject areas more accessible to visual learners and reinforce a chapter's key concepts.

Hallmark Features of the Text

We are excited to introduce new features to the Sixth Edition. At the same time, we are committed to strengthening the hallmark features that make this book unique.

- **Road Maps** Starting with the Fifth Edition, each chapter opens with a concept map that visually groups and organizes information to help students anticipate key ideas as well as recognize meaningful relationships and connections among ideas. While the Road Maps help students look forward as they engage with a chapter, **Big Picture** concept maps integrate words and visuals to help students synthesize information about challenging topics that span multiple chapters or units. Together, these two features help students navigate chapter content and see the forest for the trees.
- **Opportunities for Practice** "Blue Thread" questions, integrated throughout the text, are designed to help students identify what they do and do not understand. The idea is that if students really understand a piece of information or a concept, they should be able to do something with it. As in the Fifth Edition, all questions in the text are assigned a Bloom's taxonomy level to help both students and instructors understand whether a question requires higher-order or lower-order cognitive skills.
- **In-text "You Should Be Able To" questions** focus on topics and concepts that professors and students have identified as most key or difficult in each chapter.
- **Caption questions and exercises** challenge students to examine the information in a figure or table critically—not just absorb it.
- **Check Your Understanding boxes** present two to three tasks that students should be able to complete in order to demonstrate a mastery of summarized key ideas.
- **End-of-chapter questions** are organized in three levels of increasing difficulty so students can build from lower- to higher-order cognitive levels of assessment.
- **Focus on Real Data** Students now have expanded opportunities to develop skills at working with real data from the primary literature. Sources of the data presented in Research Boxes, graphs, and end-of-chapter Case Studies are cited to model good practice for students and to provide a resource for students and instructors who wish to evaluate the original data more deeply.

Integration of Media

The textbook continues to be supported by MasteringBiology, the most powerful online homework, tutorial, and assessment system available. Tutorials follow the Socratic method, coaching students to the correct answer by offering feedback specific to a student's errors or misconceptions as well as supplying hints that students can access if they get stuck. Instructors can associate content with publisher-provided learning outcomes or create their own. Content highlights include the following:

- **Making Models Activities** Whiteboard videos—accessible online via QR code or the Study Area in MasteringBiology, bring the Making Models feature from the book to life to help students develop their visual modeling skills. The videos are also included in assignable activities that allow students to practice modeling and to apply their understanding to new situations.

- **Case Study Questions** Put It All Together Case Study questions are assignable in MasteringBiology. Additional clicker questions are also provided in instructor resources to facilitate classroom activities.
- **Solve It Tutorials** These activities allow students to act like scientists in simulated investigations. Each tutorial presents an interesting, real-world question that students will answer by analyzing and interpreting data.
- **Experimental Inquiry Tutorials** The call to teach students about the process of science has never been louder. To support such teaching, there are 10 interactive tutorials on classic scientific experiments—ranging from Meselson–Stahl on DNA replication to the Grants’ work on Galápagos finches and Connell’s work on competition. Students who use these tutorials should be better prepared to think critically about experimental design and evaluate the wider implications of the data—preparing them to do the work of real scientists in the future.
- **BioFlix® Animations and Tutorials** BioFlix are movie-quality, 3-D animations that focus on the most difficult core topics and are accompanied by in-depth, online tutorials that provide hints and feedback to guide student learning. Eighteen BioFlix animations and tutorials tackle topics such as meiosis, mitosis, DNA replication, photosynthesis, homeostasis, and the carbon cycle.
- **HHMI Short Films Activities** Documentary-quality movies from HHMI are available in MasteringBiology with assignable questions to make sure students understand key ideas.
- **Galápagos Evolution Video Activities** These incredible videos, filmed on the Galápagos Islands by Peter and Rosemary Grant, bring to life the dynamic evolutionary processes that have an impact on Darwin’s finches on Daphne Major Island. Six videos explore important concepts and data from the Grants’ field research, and assignable activities keep students focused on the important take-away points.

- **End-of-Chapter Questions** A broad range of end-of-chapter questions are available to assign in MasteringBiology.
- **Blue Thread Questions** Over 500 questions based on the Blue Thread questions in the textbook are assignable in MasteringBiology.
- **Big Picture Concept Map Tutorials** A new, more engaging concept mapping tool is the basis for highly interactive, challenging concept map activities based on the Big Picture figures in the textbook. Students build their own concept maps, which are auto-graded, and then answer questions to make sure they understand key ideas and make important connections.
- **BioSkills Activities** Activities based on the BioSkills content in the textbook are assignable in MasteringBiology, including activities to support the new BioSkills.
- **Reading Quiz Questions** Every chapter includes reading quiz questions that can be assigned to ensure students read the textbook and understand the basics. These quizzes are perfect as a pre-lecture assignment to get students into the content before class, allowing instructors to use class time more effectively.

Serving a Community of Teachers

All of us on the coauthor team are motivated by a deep commitment to students and to supporting the efforts of dedicated teachers. Our passion in life is doing and teaching biology. At various points along our diverse paths, we have been inspired by our own teachers when we were students, and now are inspired by our colleagues as we strive to become even better teacher-scholars. In the tradition of all previous editions of *Biological Science*, we have tried to infuse this textbook with the spirit and practice of evidence-based teaching. We welcome your comments, suggestions, and questions.

Many thanks for all you do for your students.