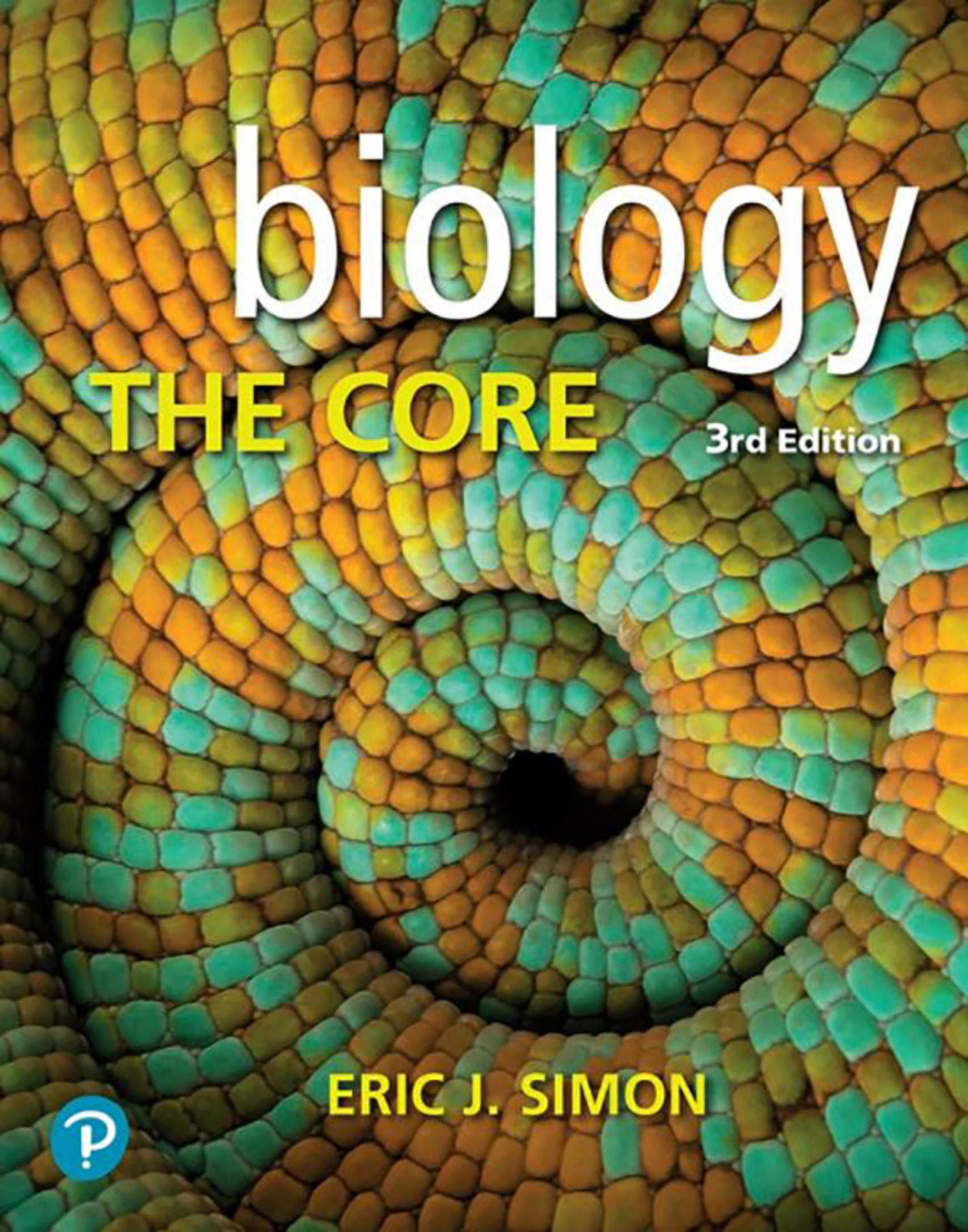
biology
THE CORE
3rd Edition
ERIC J. SIMON

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ABOUT THE AUTHOR

Eric J. Simon is a professor

in the Department of Biology and Health Science at New England College in Henniker, New Hampshire. He teaches introductory biology and human biology to non-science majors, as well as a tropical marine biology course that introduces non-science-majors to underwater field work in Belize. Dr. Simon received a B.A. in biology and computer science and an M.A. in biology from Wesleyan University and a Ph.D. in biochemistry from Harvard University. His research focuses on innovative ways to use technology to improve the teaching and learning of science, particularly to non-science majors. He lives in rural New Hampshire with his wife, two boys, a rotating set of Cavalier King Charles Spaniels, a few dozen chickens, and a leopard gecko. Dr. Simon is the lead author of the introductory non-majors biology textbooks *Campbell Essential Biology* (7th ed.) and *Campbell Essential Biology with Physiology* (6th ed.), and a co-author of the introductory biology textbook *Campbell Biology: Concepts and Connections* (9th ed.), all published by Pearson Benjamin Cummings.

"I dedicate this book to my inspirational partners at Benjamin Cummings and Pearson Education, including (in order of appearance) Beth Wilbur, Frank Ruggirello, Chalon Bridges, Ginnie Simione-Jutson, Josh Frost, Lauren Harp, Evelyn Dahlgren, and Alison Rodal. Thank you all for providing me with tremendous support and continuous inspiration to improve biology education."

PREFACE

To the Student,

Being a college student today means juggling many priorities: work, school, extracurricular activities, family. If you're reading this book, you've probably enrolled in your first college science course, and it may be the only one you'll ever take. With so many priorities competing for your attention, you may be unsure how to fit studying biology into your busy life. Good news: This book is written specifically for you!

Over the years, I've seen students in my classes striving to succeed while also wishing to be as productive as possible with their study time. *Biology: The Core* was designed from the ground up to help you learn efficiently and thrive in this course. Only the most important and relevant information—the core of biology content—is included. These biological concepts are displayed in highly visual, consistent, and approachable two-page modules that guide you along a clear learning path, so that reading your textbook is more a pleasure than a chore.

You might also be wondering how this course—and biology in general—applies to your own life. Luckily, this is easy to address, since issues like nutrition, cancer, vaccines, and genetically modified foods directly affect you and those you care about. For the Third Edition, new modules were added that address these and other current issues directly, so that you may better see how biology is relevant to your life. Other modules help you critically evaluate the scientific-sounding claims that constantly bombard you, and how to distinguish valid scientific claims from bogus ones.

The *Biology: The Core* textbook is paired with a robust online library, Mastering Biology, that contains videos, animations, current events, and interactive tutorials that help you draw connections between the course material and the world around you. Questions you might have about many topics will be addressed in this online complement to your textbook. It is filled with helpful multimedia tools that allow you to gain a thorough understanding of the content so that you can succeed in your course. References to Mastering Biology at the top of many modules point you to the most helpful online tools.

I hope that *Biology: The Core* meshes with your goals and your priorities, acting as a useful guide for this course and addressing questions you run into in your broader life. Please feel free to drop me an email to tell me about your experience with *Biology: The Core* or to provide feedback (good or bad!) regarding the text or online resources.

Best wishes for a successful semester—and enjoy the big adventure of biology! It's not only in the pages of this book, but everywhere around you.

ERIC J. SIMON, PH.D.

To the Instructor,

In a world with so many options for non-major biology textbooks, what makes this one different? The answer is: a focus on today's students. We've all watched our non-science-major students struggle with the depth of material and relating biology to their lives. Which concepts do non-science students *need to know* in order to understand the relevance of biology? If we pare down the content and focus on the most important take-home lessons—the information that we hope students will remember 10 years after your course—what remains is the core: a set of essential biological concepts that presents the big picture, providing students with a scientific basis for the issues they will confront throughout their lives.

Biology: The Core is a different kind of textbook, one that presents information in small chunks using a nonlinear, engaging, visual style. The book contains only the most essential content for each topic. All information is presented in stand-alone two-page modules that fully integrate text and art into a single teaching tool. Modules can be read in any order and each module stands alone (without references to other modules), allowing you the flexibility to assign topics in whatever sequence best suits your course.

For the Third Edition of *Biology: The Core*, content was revised based on feedback received from professors and students using the text from around the country. The specific changes are detailed on the next page, but the overall approach is to ensure that the core content is approachable and clearly connected to students' lives. Included in this new edition are a series of "Core Issue" modules. These ten special modules highlight current topics that your students may hear about frequently—vaccines, antibiotic resistance, diabetes, and cancer, to name a few—and tie them to the core content, showing students the relevancy of basic biology knowledge.

Over the last few years, in my communication with many instructors around the country, I've also observed that those of us teaching biology to non-majors are increasingly emphasizing science literacy skills above all else. For this reason, the Third Edition places particular emphasis on teaching students to think scientifically and helping them appreciate and apply critical thinking skills to their own lives. A largely rewritten Chapter 1 brings many of these important skills together.

The printed text is paired with Mastering Biology, an online tutorial platform that allows you to reinforce the book content and expand on the basic concepts presented in each module as needed. The activities and resources in Mastering Biology also offer you the flexibility to incorporate a wide variety of applications and current issues—including several ones new to this edition—into your teaching. Unlimited by the particular set of examples printed in a static textbook, a rich collection of online resources—including Current Topic PowerPoint presentations, news videos, Current Events news articles, and interactive tutorials—enables you to connect the core content to interesting, relevant, and timely issues that are important to you and your students. Forty—including 18 brand new, Guided Video Tours found within Mastering Biology—are designed to help students learn to use the textbook and to hone their study skills.

I hope that the aims of *Biology: The Core* resonate with the teaching and learning goals of your non-major introductory biology course. Feel free to send an email telling me about your course and your students, to provide feedback regarding the text or the online resources, or just to chat about the non-major course in general—it's my favorite topic of conversation!

Best wishes for a successful semester,

ERIC J. SIMON, PH.D.
SimonBiology@gmail.com

Biology: The Core, Third Edition, contains many helpful updates

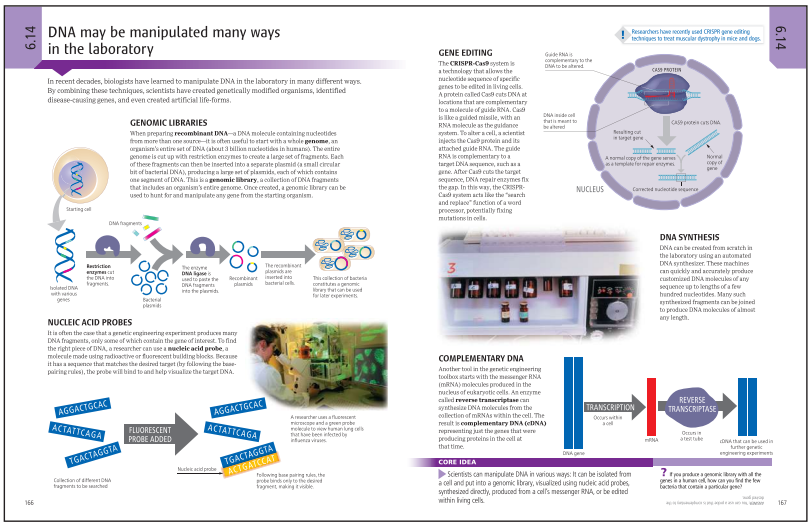
The Third Edition of *Biology: The Core* was created in response to extensive feedback from professors and students. The goal of the new edition is to enhance teaching and learning for non-major students by increasing the relevancy of the material and placing a greater emphasis on science literacy skills.

CHAPTER 1 AN INTRODUCTION TO THE SCIENCE OF LIFE

For many students, this introductory biology course is their only exposure to college-level science. Many instructors believe that the most important goal of such a course is to communicate how science is conducted and how the process of science can be used to make important decisions. In the Third Edition of *Biology: The Core*, we dedicate an entire chapter to covering this vital topic, with modules that present the process of science in a more realistic and relevant context. Chapter 1, "An Introduction to the Science of Life," promotes critical thinking and demystifies how science works. A new presentation of the process of science emphasizes the lack of formality in the process and how it proceeds in the real world.

Additional updated and new modules help students distinguish hypotheses from theories and explain the meaning of the word "fact"; discuss basic research methods; distinguish scientific thought from pseudoscience; and explain how to recognize reliable sources and the process of peer review. This chapter should help students obtain a clearer picture of how scientific thinking differs from other ways of viewing the world and how it can be applied in their own lives.

Module 1.4 presents the process of science as it actually occurs.



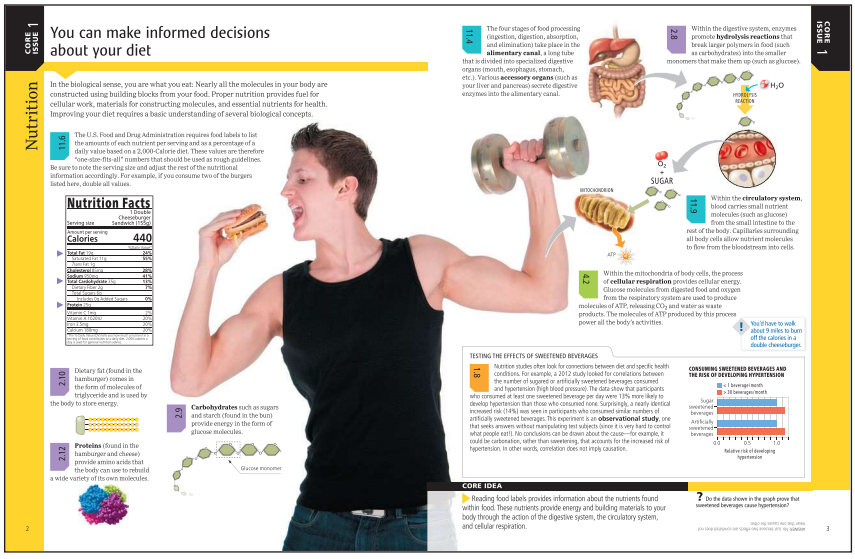
NEW EXAMPLES AND PEDAGOGICAL IMPROVEMENTS

In addition to those already mentioned, many changes in the book were implemented to increase accuracy and currency. For example, module 6.14 includes new information about the CRISPR-Cas9 gene editing system.

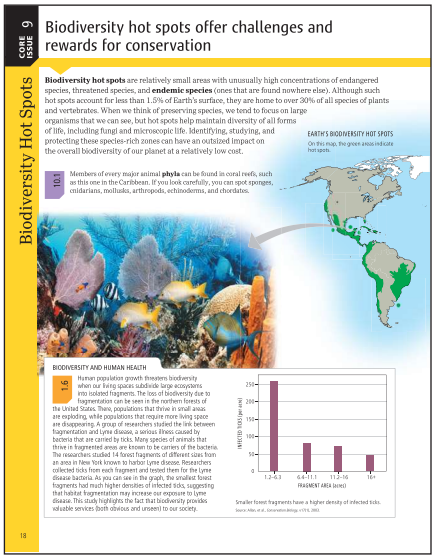
Other examples of content updates include new data on the links between obesity and cancer, changes to human population growth patterns, and new data on the reliability of various methods of contraception. Throughout the book, photos and art were improved and updated to make them more attractive and better able to convey the pedagogical points. Every module contains a "fun fact" intended to invoke a "That's cool!" reaction from your students; many of these have been updated to be even more engaging.

CORE ISSUE MODULES

New to this edition are ten Core Issue modules. Each one presents a current relevant topic. This edition includes modules on nutrition, cancer, vaccines, athletic cheating, genetically modified organisms, agriculture, MRSA, climate change, biodiversity hot spots and diabetes. Each Core Issue module helps relate the basic biology content to the issue at hand.



In this example, the Core Issue: Nutrition module shows how the digestive system (Module 11.4) delivers small molecules (Modules 2.9–2.12) through the circulatory system (Module 11.9) to the mitochondria (Module 4.2).



Additionally, every Core Issue module includes a description of one or more relevant scientific studies. Data is presented, and the larger lessons of that study are discussed in relation to the material presented in Chapter 1. For example, the Core Issue: Biodiversity Hot Spots module introduces a study showing the relationship between forest fragmentation in the northeastern United States and the prevalence of mosquitoes that carry Lyme disease. For each Core Issue module, the chosen study illustrates one or more science skill presented in Chapter 1. In this example, students are led to understand independent and dependent variables, as originally discussed in module 1.6.

NEW MULTIMEDIA

The *Biology: The Core* textbook is designed to pair with the online resources (videos, animations, current issues, practice assignments, and more) available in Mastering Biology. New references within many modules point students toward the most helpful multimedia supplements. This edition of *Biology: The Core* includes 18 new Guided Video Tours, for a total of 40 videos that walk students through modules, teaching them how to organize their studying. These videos can be particularly helpful to help students working on their own (as part of flipped classrooms or distance learning, for example).

Mastering Biology

▶ **WATCH** the Video Tutor Session for this module

Icons placed at the top of modules remind students to supplement their learning with online multimedia.

CORE IDEA

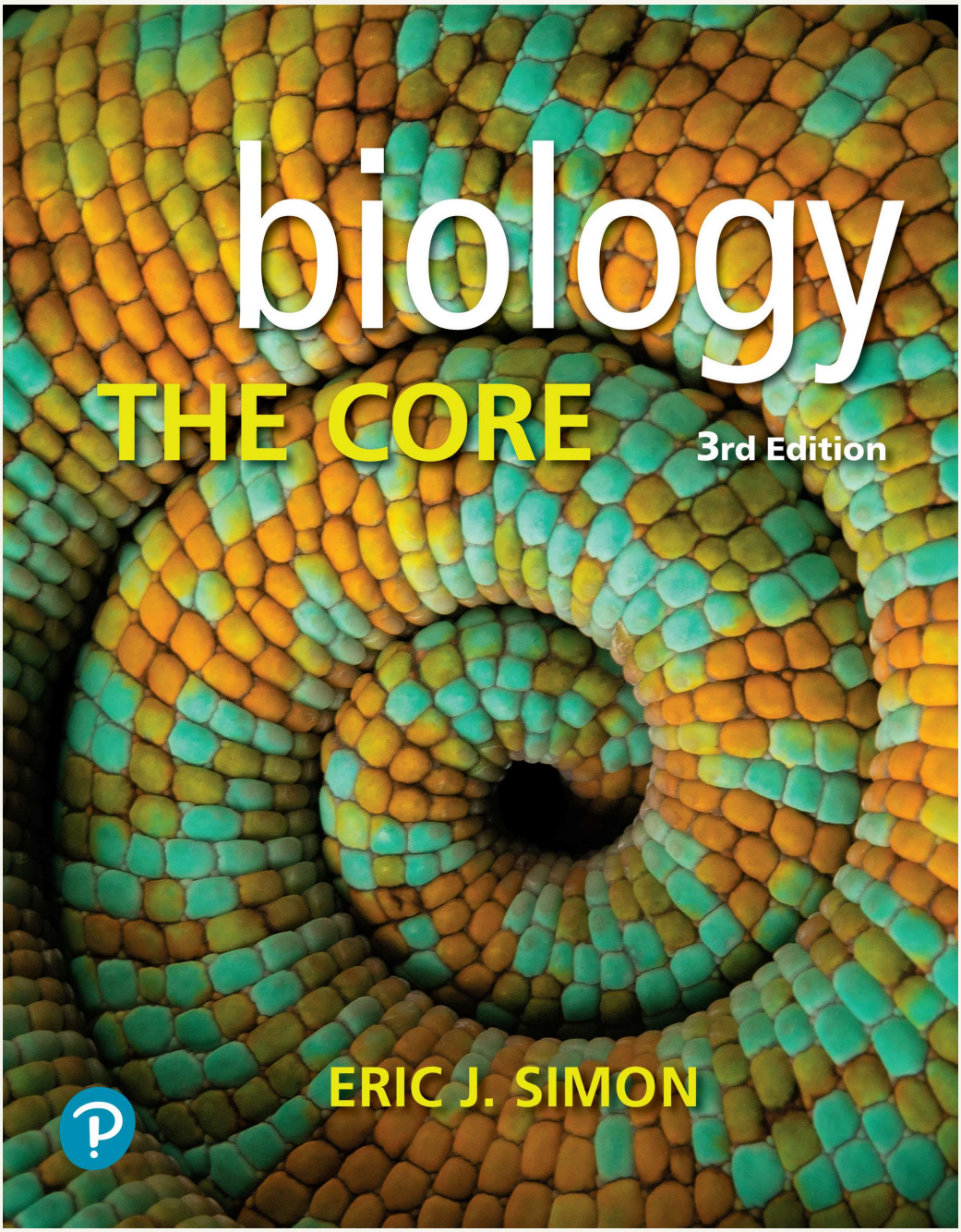
▶ In response to feedback, the Third Edition of *Biology: The Core* improves teaching and learning by making the material clearer and more relevant to non-science-major students.

? How are the Core Issue modules different from every other module in *The Core*?

ANSWER: The Core Issue modules contain cross-references to other modules; every other module in The Core stands alone.

Help students see biology's relevance by focusing on core concepts

Biology: The Core **presents essential biological concepts, using a visual and hybrid approach. The 12-chapter textbook uses dynamic illustrations organized into concise, self-contained two-page modules that focus students' attention on what is most relevant. The text pairs with Mastering Biology to offer flexible assignment options and extensive support materials that allow instructors to tailor the content to the way they teach and maximize student engagement.**



Build your course around . . .

Each core biological concept is presented as a two-page module that can stand on its own and be read in any order. Each module in the text contains only the most essential content for any concept. The efficient organization of each module helps students focus their attention on key information and guides them through—from the clearly stated concept at the start to the "core question" that checks their understanding at the end.

CORE ISSUE 4

The evolution of antibiotic-resistant bacteria poses a significant health threat

MRSA

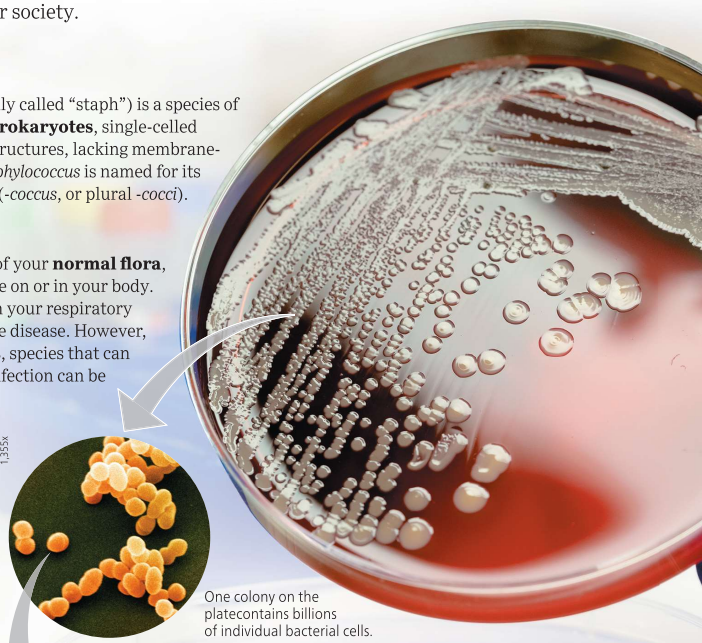
Penicillin and other **antibiotics**—drugs that inhibit or kill bacteria—have saved countless lives. The discovery of penicillin in the 1940s prevented the deaths of millions of people with common infections. However, within a few decades, penicillin had become virtually useless in hospitals because of the evolution of penicillin-resistant bacteria. In response, new antibiotics were developed. By the 1990s, doctors began to discover bacteria that were resistant to many, even all, known antibiotics. Responding to the evolution of such multidrug-resistant strains is one of the most important health challenges facing our society.

ANTIBIOTICS

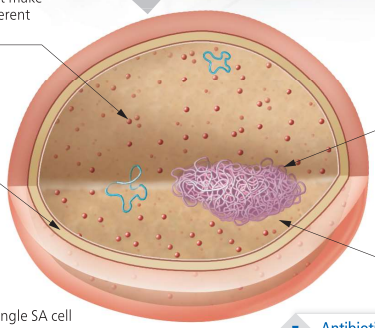
8.2 *Staphylococcus aureus* (SA, commonly called "staph") is a species of bacteria. Like SA, all bacteria are **prokaryotes**, single-celled organisms with relatively simple structures, lacking membrane-enclosed organelles. The genus *Staphylococcus* is named for its shape: irregular clusters (*staph-*) of spheres (*-coccus*, or plural *-cocci*).

8.4 *Staphylococcus aureus* is a member of your **normal flora**, microorganisms that commonly live on or in your body. SA is found on your skin and within your respiratory tract, but it does not normally cause disease. However, certain mutant strains of SA are **pathogens**, species that can cause serious illness. If untreated, a staph infection can be life-threatening.

3.1 An antibiotic is a drug that kills or inhibits the growth of bacteria. How do antibiotics kill bacteria without harming human cells? Most antibiotics work by disabling a necessary component of bacterial cells that is not found in human cells.



One colony on the platecontains billions of individual bacterial cells.



A single SA cell

RIBOSOMES
Tetracycline interferes with bacterial ribosomes, cellular structures that make proteins. Your ribosomes are different enough to be unaffected.

CELL WALL
Penicillin disrupts the formation of bacterial cell walls, which your cells lack.

BACTERIAL CHROMOSOMES
Ciprofloxacin works by disrupting an enzyme that helps organize bacterial DNA. Your version of this enzyme is unaffected by the drug.

CYTOPLASMIC ENZYMES
Sulfa drugs inhibit the growth of bacteria by blocking an enzyme used to produce the nutrient folate. You can obtain folate from your diet and so do not need to synthesize it.

! Antibiotic-resistant bacteria infect more than 2 million people and cause 23,000 deaths in the United States each year.

8

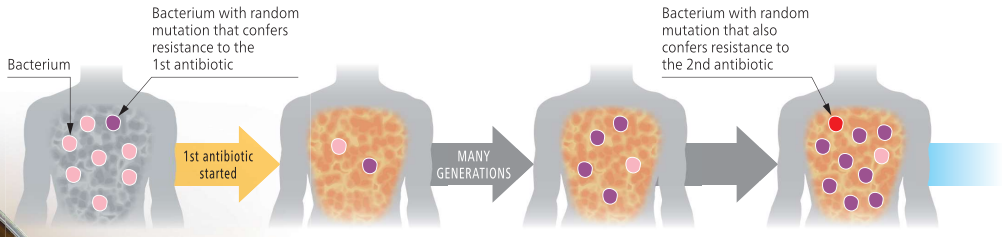
relevant and current high interest topics

CORE ISSUE 4

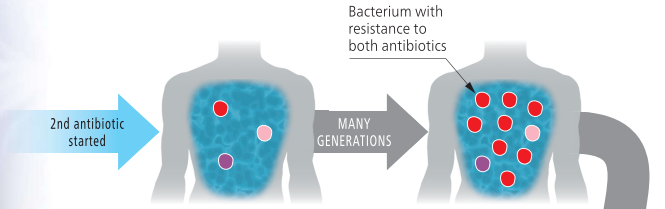
EVOLUTION OF ANTIBIOTIC RESISTANCE

7.2

Soon after their discovery, antibiotics were heralded as "wonder drugs" with the potential to wipe out infections altogether. This has not come to pass due to the evolution of antibiotic resistance. By the early 2000s, doctors began to document a formidable "superbug" known as **MRSA (multidrug-resistant *Staphylococcus aureus*)**. Bacteria can become resistant to multiple drugs in a stepwise fashion.



Exposed to an antibiotic, natural selection favors bacteria with random mutations that make them resistant to the drug. These bacteria will multiply, eventually evolving into a population that is resistant to that antibiotic.



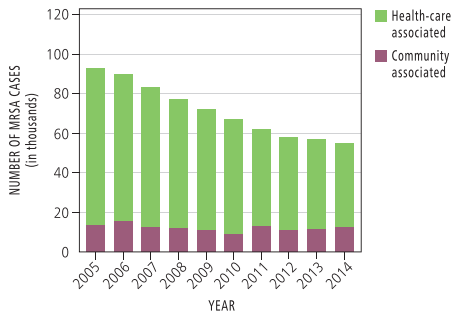
Since the first antibiotic is no longer effective, doctors switch to a second antibiotic. Natural selection may then favor a new strain that is resistant to both antibiotics.

Continued over time, the result can be multidrug-resistant bacteria like MRSA.

TRACKING MRSA

1.7

Staphylococcus aureus is common in health-care facilities, where the extensive use of antibiotics creates a selection pressure in favor of antibiotic resistance. It is not surprising, then, that MRSA was first found in hospital settings. The Centers for Disease Control and Prevention (CDC) has tracked MRSA cases for over a decade. As you can see from the bar graph, the number of cases occurring in health-care settings (green bars) has decreased over that time. This is due to increased awareness and education leading to better preventative measures. But MRSA outbreaks also occur in community settings such as athletic facilities, schools, and military barracks. The CDC data show that the number of these community-associated cases is holding steady (purple bars). These data point to the need for greater education, awareness, and prevention among the general public.



CORE IDEA

Antibiotics are drugs that inhibit or kill bacteria. Most work by disrupting cellular structures found in bacteria but not human cells. Evolution of antibiotic resistance can occur in a stepwise fashion to yield multidrug-resistant bacteria.

? Looking at the bar graph, what does it mean that the total height of the bars is lowering but the purple bars are relatively steady?

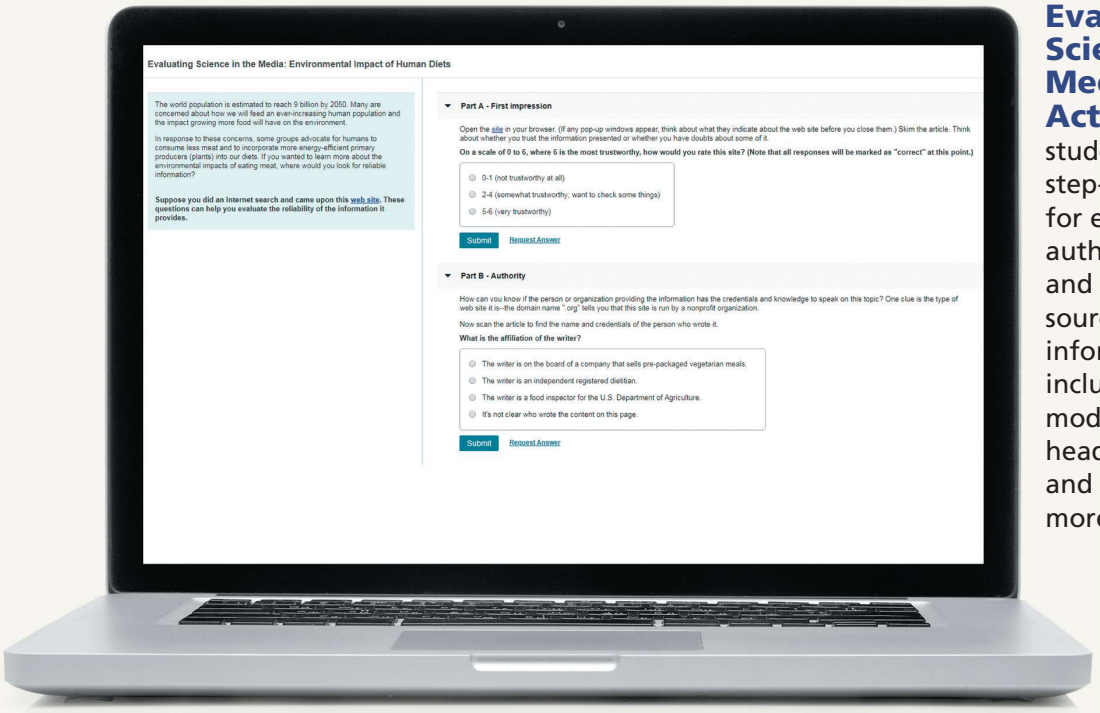
ANSWER: This shows that the number of community-based infections is holding steady even as the number of health-care-associated cases declines.

9

NEW! Core Issue Modules highlight relevant current issues like vaccinations, antibiotic resistance, cancer, and more. Each new module relates the core issue to biological concepts to help students see the relevancy of the course material, as well as connections across chapter concepts.

Each Core Issue Module is supported by a prebuilt assignment in Mastering Biology, while a Topic Guide and a Current Topic Lecture presentation in the Instructor Resources area of Mastering Biology helps instructors bring the issue into the classroom.

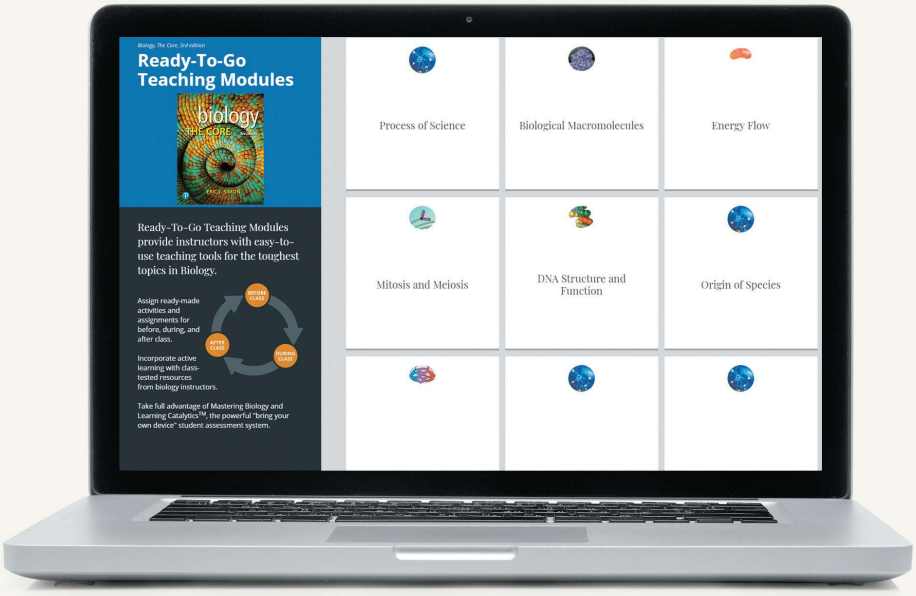
Develop students' scientific literacy skills



Evaluating Science in the Media Coaching Activities guide students through a step-by-step process for evaluating the authority, motivation, and reliability of online sources of scientific information. Topics include genetically modified organisms, head injuries, tanning and skin cancer, and more.

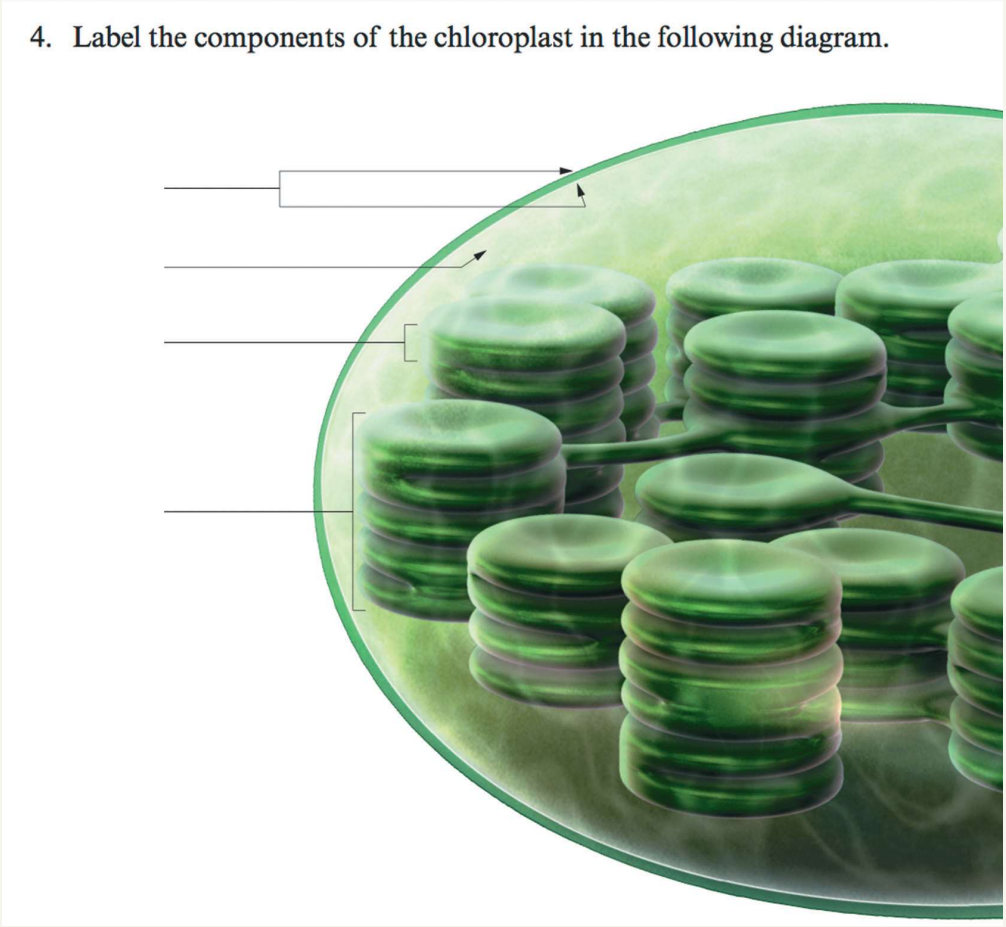
GraphIt! Coaching Activities help students read, interpret, and create graphs that explore real environmental issues using real data. All 10 activities explore current topics such as the carbon footprint of food, fresh water availability, and ocean acidification in an entirely new mobile experience with accessible design.

Engage students with active learning

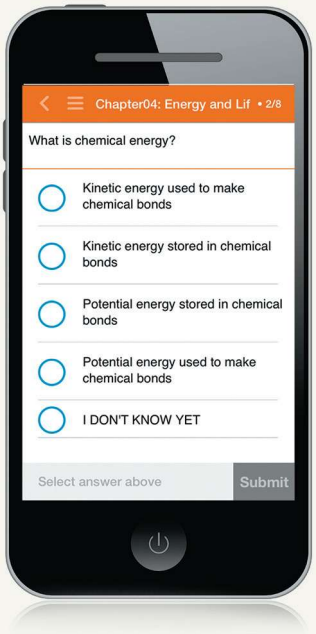


NEW! Ready-to-Go Teaching Modules make use of teaching tools for before, during, and after class, including new ideas for in-class activities. Each of the 10 modules for ***The Core*** highlights a specific current issue and suggests how to incorporate Mastering Biology, active learning resources including Learning Catalytics, and instructor resources. These modules can be accessed through the Instructor Resources area of Mastering Biology.

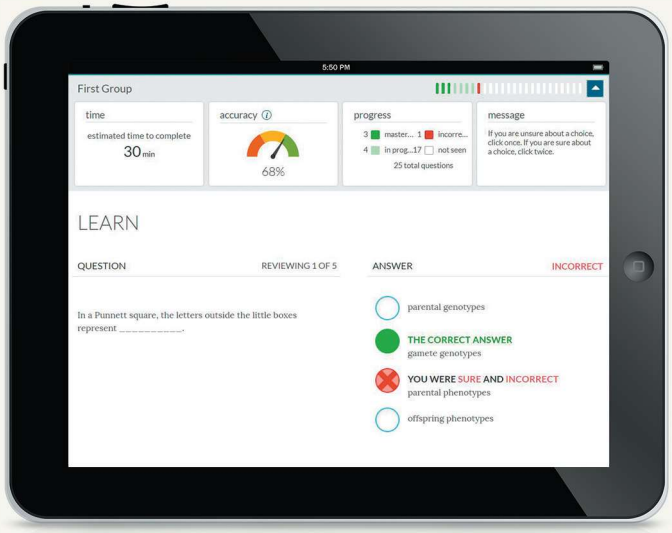
UPDATED! Guided Reading Activities are organized around each module and provide students with basic questions that guide them through the module, using an active reading approach. The worksheets offer an easy, low-tech way to assign work outside of or during class as a group work activity. These are available in the Mastering Biology Study Area, in the Instructor Resources, and in Pearson Collections.



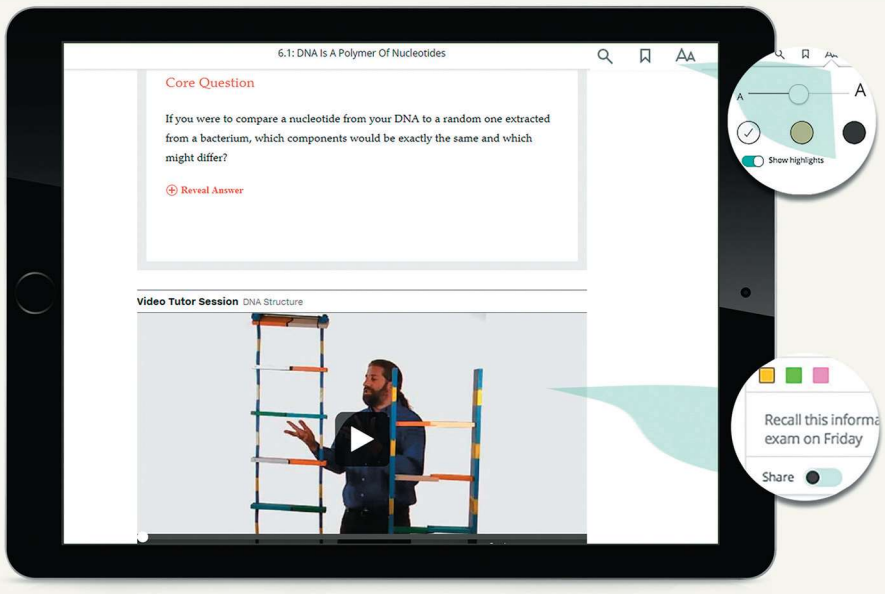
Reach every student with Pearson eText and Dynamic Study Modules



Dynamic Study Modules help students study effectively—and at their own pace. Each module poses a series of questions about a course topic, which adapt to each student's performance and offer personalized, targeted feedback to help them master key concepts.



Students can easily review their answers and monitor their own progress and understanding of key concepts as they move through each module.



Pearson eText is a simple-to-use, mobile optimized, personalized reading experience available within Mastering. It allows students to easily highlight, take notes, and review key vocabulary all in one place—even when offline. Integrated videos engage students and give them help when they need it. Pearson eText is available within Mastering Biology when it comes with a new book; students can also purchase Mastering with Pearson eText online. For instructors not using Mastering, Pearson eText can also be adopted on its own as the main course material.

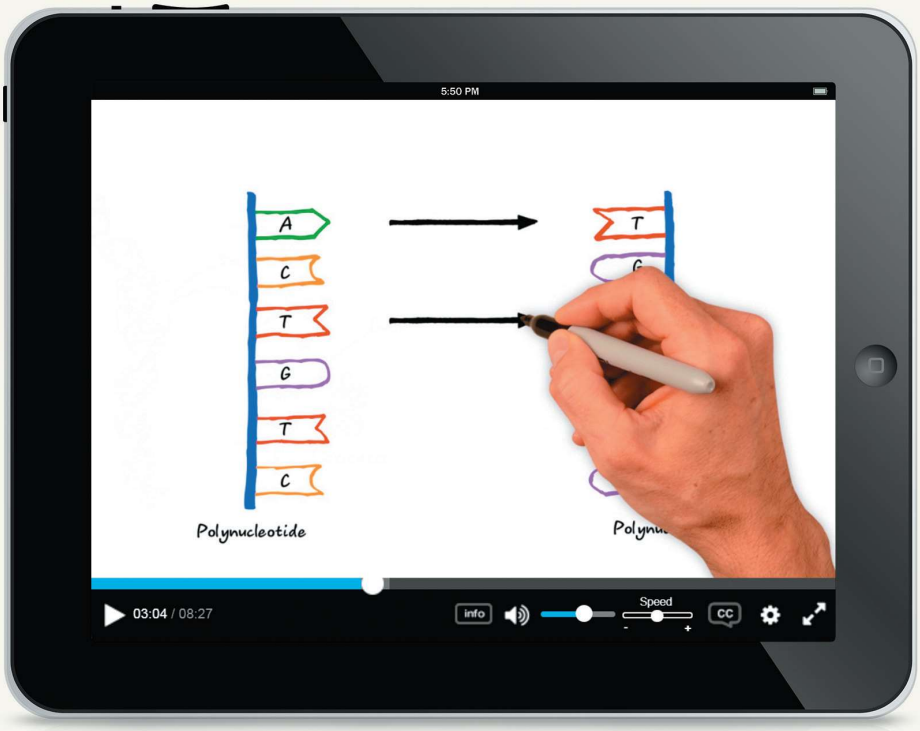
Deliver trusted content in Mastering Biology

NEW and UPDATED! Guided Video Tours, developed and narrated by author Eric Simon, present a brief "mini-lecture" that walks students through key concepts and module content presented in the text. All Guided Video Tours can be assigned as a coaching activity with personalized feedback in Mastering Biology, and are also embedded in the eText.

NEW! Topic Overview videos, created by the author, introduce key concepts and vocabulary. These brief, engaging videos introduce topics that will be explored in greater depth in class.

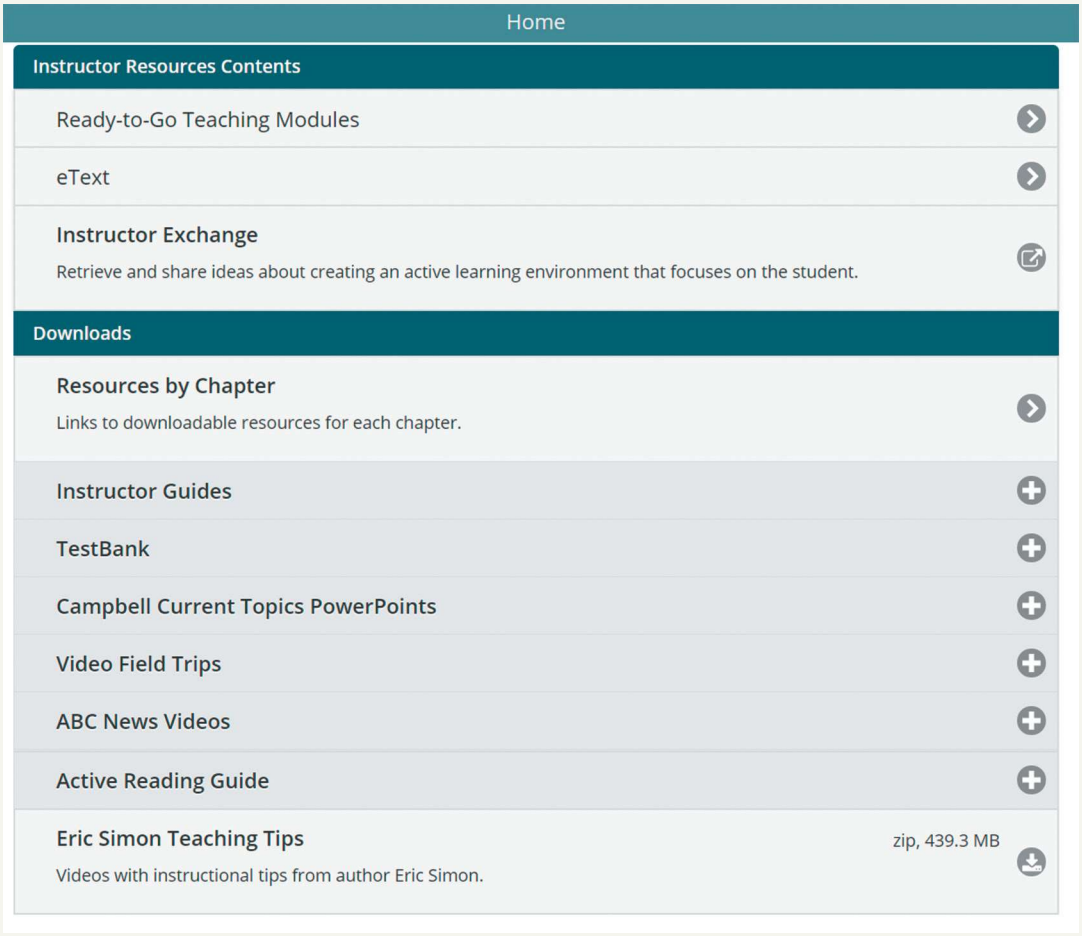
Topics include:

- Macromolecules
- Ecological Organization
- Mechanisms of Evolution
- An Introduction to Structure and Function
- Interactions Between the Respiratory and Circulatory Systems
- DNA Structure and Function
- And more!



Resources to help you build your class, your way

Biology: The Core includes a full suite of instructor support materials in the Instructor Resources area in Mastering Biology to help you build your course. Resources include Ready-to-Go Teaching Modules; current topic lecture slides and topic guides that help you integrate biology content with relevant current topics; an active learning resource guide; animations, videos, and lecture presentations to show in class; all images from the text; a testbank; and free access to our unique Instructor Exchange website, where you can share ideas with other non-majors biology faculty.



ACKNOWLEDGMENTS

There are many people to thank and acknowledge for their contributions to the Third Edition of *Biology: The Core*. One of the most gratifying aspects of writing a book is the opportunity to interact with so many skilled professionals at Pearson Education and so many talented biology colleagues from around the country. While any problems or mistakes within this book or any of the materials related to it are solely my responsibility, the successful aspects are due to the efforts of many people.

A few people deserve special mention for their deep contributions; these people form the core of *The Core*. Alison Rodal, as Courseware Portfolio Manager, worked with me and the rest of the team nearly every day, bringing a broad array of talents to bear on this project. Alison's consistently positive energy and her diplomatic skills were invaluable at several key junctures in the book's development. Alison reminds me every day that our overriding goal is to produce a book that will help students and teachers, and her guidance is invaluable. I will always owe a deep debt of gratitude to Beth Wilbur, Director of Portfolio Management, whose vision, understanding, and unwavering high standards have benefited every project since she brought me into the Pearson family over a decade ago. Courseware Editorial Assistants Sherry Wang, Summer Giles and Chelsea Noack were a continuous help in coordinating reviews and solving countless problems, always with a buoying positive energy. Ginnie Simione Jutson, Courseware Director of Content Development, provided her masterful oversight of all matters editorial and gave invaluable help when it was most needed.

I love my editors! All members of the Pearson editorial team bring decades of experience and talent to every project they take on. Senior Developmental Editor Evelyn Dahlgren has been my rock for this edition, building on the work and talents of Mary Ann Murray in the Second Edition. Evelyn's expertise with both words and art were of great help in preparing this edition. Hilair Chism used her keen sense of art development to design and improve many of the new features found in this edition. You can see Hilair's unique skills shine in Chapter 1 and in the Core Issue modules, both of which glimmer with her talent. Content Producer Ami Sampat proved to be a wise, capable, and gentle guide through the seemingly countless deadlines that comprise the writing of a new edition. Thank you to Indexer Robert Swanson for making the book much more user-friendly (see "Indexer, continued gratitude for"). Design Manager Mark Ong for his work on the Core Issue modules and designer Tani Hasegawa refreshed the design for this third edition and also designed the cover.

Once the text was written and the art developed, the production team took over, turning countless individual ideas into the reality of the book you see before you. For this, we thank Photo Researcher John Paul Belciña of Wanderlust Photos, Pearson Rights & Permissions Project Manager Matt Perry, Proofreaders Pete Shanks and Marleis Roberts, copyeditor Julie Kennedy, and Project Manager Margaret McConnell of Integra, which also provided expert composition services. Mark Mykytiuk and his team at Imagineering lent their talents to art development and art creation.

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After a book is written, the marketing team steps in to ensure that the complete story is told to all who might benefit. For this we thank Product Marketing Manager Alysun Burns and Field Marketing Manager Kelly Galli. Acting as the final facilitators of the long journey from author to student, I thank the entire Pearson Education sales team including all the sales managers, publisher's representatives, and technology specialists who work tirelessly every semester to help students learn and instructors teach.

In closing, I beg forgiveness from those who lent their unique talents to this book but who I failed to mention—I hope you will excuse my oversight and know that you have earned my gratitude.

With deepest, sincerest, and humblest thanks and respect to all who contributed their talents to *Biology: The Core*, Third Edition,

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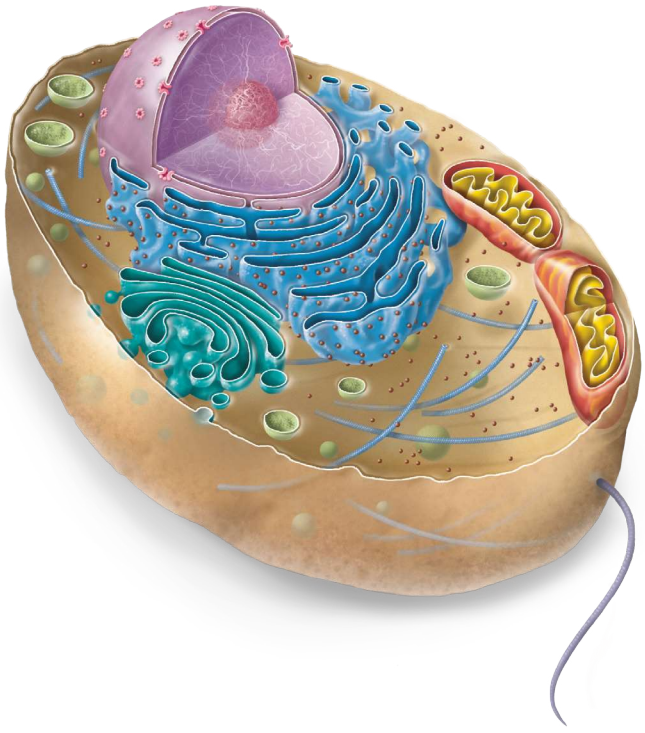
CI Core Issues

1 An Introduction to the Science of Life

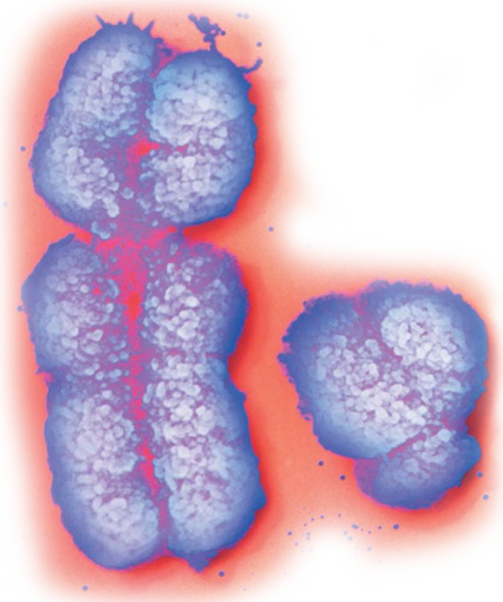
2 The Chemistry of Life

3 The Cell: The Fundamental Unit of Life



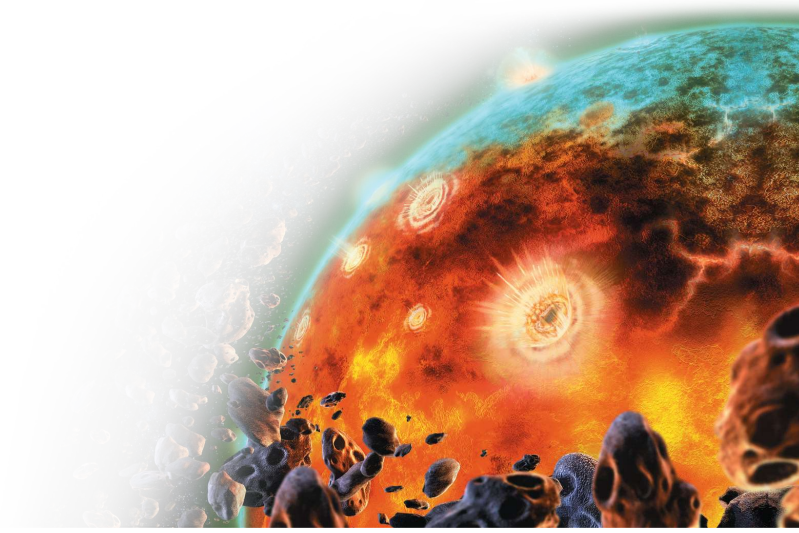
4 Energy and Life

5 Chromosomes and Inheritance



6 DNA: The Molecule of Life

7 Darwinian Evolution

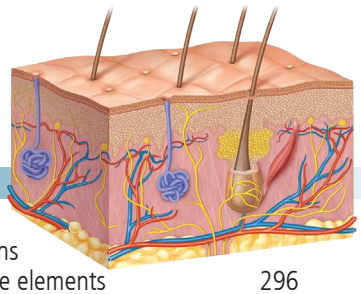


8 Biodiversity 1: Microscopic Organisms

9 Biodiversity 2: Fungi and Plants

10 Biodiversity 3: Animals

11 Human Body Systems



12 Ecology

BRIEF CONTENTS

You can make informed decisions about your diet

In the biological sense, you are what you eat: Nearly all the molecules in your body are constructed using building blocks from your food. Proper nutrition provides fuel for cellular work, materials for constructing molecules, and essential nutrients for health. Improving your diet requires a basic understanding of several biological concepts.

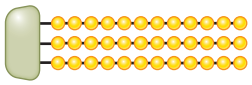
11.6 The U.S. Food and Drug Administration requires food labels to list the amounts of each nutrient per serving and as a percentage of a daily value based on a 2,000-Calorie diet. These values are therefore "one-size-fits-all" numbers that should be used as rough guidelines. Be sure to note the serving size and adjust the rest of the nutritional information accordingly. For example, if you consume two of the burgers listed here, double all values.

Nutrition Facts

Serving size	1 Double Cheeseburger Sandwich (155g)
Amount per serving	
Calories	**440**
	% Daily Value*
Total Fat 19g	**24%**
Saturated Fat 11g	**55%**
Trans Fat 1g	
Cholesterol 85mg	**28%**
Sodium 950mg	**41%**
Total Cardohydrate 35g	**13%**
Dietary Fiber 2g	**7%**
Total Sugars 6g	
Includes 0g Added Sugars	**0%**
Protein 25g	
Vitamin C 1mg	2%
Vitamin A 1020IU	20%
Iron 3.5mg	20%
Calcium 180mg	20%

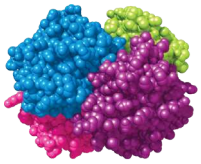
*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

2.10 Dietary fat (found in the hamburger) comes in the form of molecules of triglyceride and is used by the body to store energy.

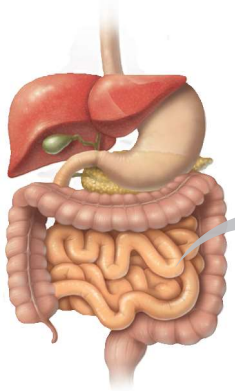


2.9 **Carbohydrates** such as sugars and starch (found in the bun) provide energy in the form of glucose molecules.

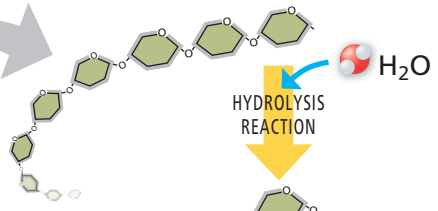
2.12 **Proteins** (found in the hamburger and cheese) provide amino acids that the body can use to rebuild a wide variety of its own molecules.

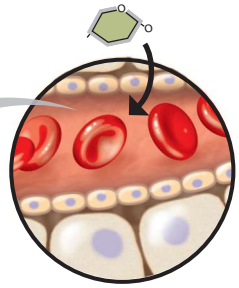


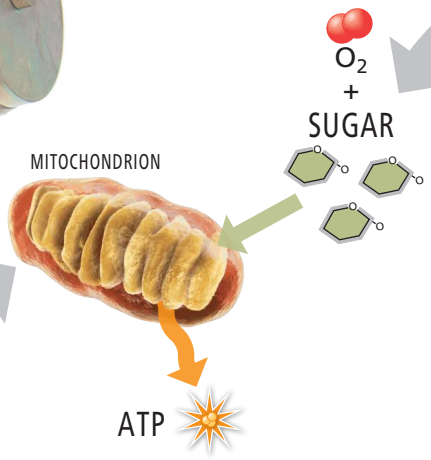
11.4 The four stages of food processing (ingestion, digestion, absorption, and elimination) take place in the **alimentary canal**, a long tube that is divided into specialized digestive organs (mouth, esophagus, stomach, etc.). Various **accessory organs** (such as your liver and pancreas) secrete digestive enzymes into the alimentary canal.



2.8 Within the digestive system, enzymes promote **hydrolysis reactions** that break larger polymers in food (such as carbohydrates) into the smaller monomers that make them up (such as glucose).







11.9 Within the **circulatory system**, blood carries small nutrient molecules (such as glucose) from the small intestine to the rest of the body. Capillaries surrounding all body cells allow nutrient molecules to flow from the bloodstream into cells.

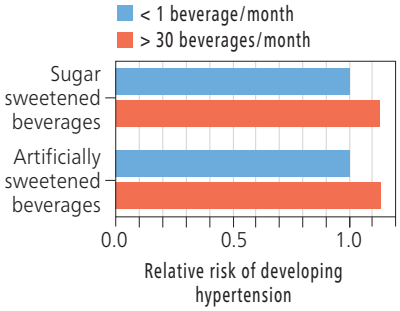
4.2 Within the mitochondria of body cells, the process of **cellular respiration** provides cellular energy. Glucose molecules from digested food and oxygen from the respiratory system are used to produce molecules of ATP, releasing CO_2 and water as waste products. The molecules of ATP produced by this process power all the body's activities.

! You'd have to walk about 9 miles to burn off the calories in a double cheeseburger.

TESTING THE EFFECTS OF SWEETENED BEVERAGES

1.8 Nutrition studies often look for connections between diet and specific health conditions. For example, a 2012 study looked for correlations between the number of sugared or artificially sweetened beverages consumed and hypertension (high blood pressure). The data show that participants who consumed at least one sweetened beverage per day were 13% more likely to develop hypertension than those who consumed none. Surprisingly, a nearly identical increased risk (14%) was seen in participants who consumed similar numbers of artificially sweetened beverages. This experiment is an **observational study**, one that seeks answers without manipulating test subjects (since it is very hard to control what people eat!). No conclusions can be drawn about the cause—for example, it could be carbonation, rather than sweetening, that accounts for the increased risk of hypertension. In other words, correlation does not imply causation.

CONSUMING SWEETENED BEVERAGES AND THE RISK OF DEVELOPING HYPERTENSION



Source: L. Cohen et al., *J Gen Intern Med*, v27(9):1127–34 (2012).

CORE IDEA

Reading food labels provides information about the nutrients found within food. These nutrients provide energy and building materials to your body through the action of the digestive system, the circulatory system, and cellular respiration.

? Do the data shown in the graph prove that sweetened beverages cause hypertension?

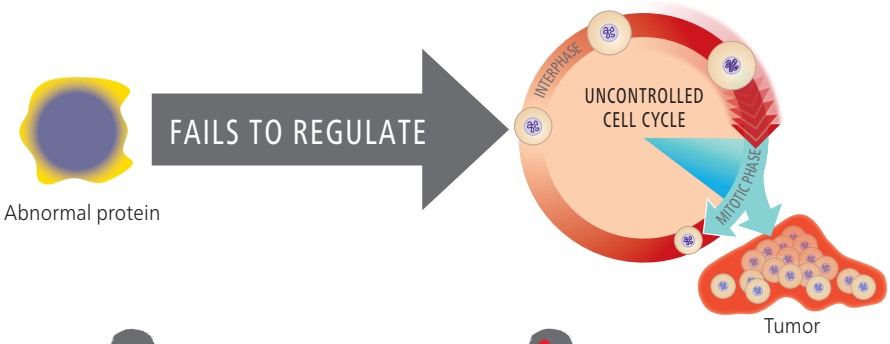
ANSWER: No. Just because two effects are correlated does not mean that one causes the other.

Understanding the biological basis of cancer can help with prevention, treatment, and survival

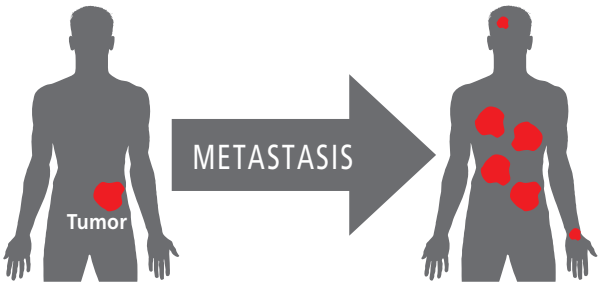
Nearly half of all Americans will be diagnosed with cancer, so chances are you or someone you love will be affected. Cancer is caused by your own body cells going awry. The normal mechanisms that regulate cell growth break down, leading to a runaway mass of body tissue called a tumor. Understanding the biological basis of cancer can increase your chances of living a cancer-free life.

5.3 All cells arise from preexisting cells following an ordered series of steps called the **cell cycle**. Proteins regulate the cell cycle, controlling when cells multiply and when they remain dormant.

6.11 Proteins can speed up the cell cycle, slow it down, or turn it off altogether. If these proteins malfunction, control of the cell cycle is lost. Body cells will begin to grow continuously, forming a mass of cells called a **tumor**.



6.12 If a tumor cannot move beyond its original location, it is called a **benign tumor**. In contrast, a **malignant tumor** is one that can spread. During **metastasis**, cells from the initial tumor circulate through the body, forming new tumors in distant locations. A person with malignant tumors is said to have **cancer**.



6.10 All cases of cancer can be traced to one or more **mutations** in the person's DNA. **Proto-oncogenes** are genes that produce proteins that control the cell cycle. A mutation may change a proto-oncogene into an **oncogene**, a gene that promotes cancer by producing a faulty protein that fails to properly regulate the cell cycle.