

Cells are the fundamental building blocks of life on this planet. Despite their tiny size, they are wonders of intricacy. Moment by moment, the cells of our bodies are engaged in a dazzling repertoire of biochemical events, including signaling processes, transmission of genetic information, and delicately choreographed movements. Helping our students to appreciate the complexities of this amazing cellular world lies at the heart of our goals as authors of *Becker's The World of the Cell*. The motivations that drove our colleague, Wayne Becker, to write the first edition of this book continue to drive us today. We believe that our students should have biology textbooks that are clearly written, make the subject matter relevant, and help them to appreciate not only how much we already know about cell biology but also the exciting journey of continued discovery that lies ahead. We, as authors, have an extensive history of teaching undergraduate courses in cell biology and related areas, and we treasure our contact with students as one of the most rewarding aspects of being faculty members.

The amazing success of modern cell biology creates both exciting opportunities and central challenges in our teaching. How can we capture the core elements of modern cell biology in a way that draws our students in without overwhelming them? The enormous profusion of information challenges us to keep *Becker's World of the Cell* up to date while ensuring that it remains both manageable in length and readily comprehensible to students studying cell and molecular biology for the first time.

This ninth edition engages students with new innovative features in each chapter and an exciting, fresh look. In addition, a major goal of this edition has been to reorganize the presentation of several key topics. We hope students and instructors will find that the greater emphasis on molecular biology earlier in the text integrates even better with learning about other aspects of cellular function, just as molecular approaches have become ever more tightly integrated into the everyday work of modern cell biologists.

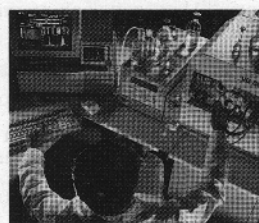
As with the previous editions, we remain committed to three central goals. First, our primary goal is to introduce students to the fundamental principles that guide cellular organization and function. Second, we want students to understand some of the key scientific evidence that has helped us formulate these central concepts. And third, we have sought to accomplish these goals in a book of manageable length that is easily read and understood by beginning cell biology students—and that still fits in their backpacks! We have therefore been necessarily selective both in the examples chosen to illustrate key concepts and in the quantity of scientific evidence included. The result is an update that we hope students and instructors will be as excited about as we are.

What's New in This Edition

- **New look:** The art program has been updated throughout the book to give drawings a more dynamic and inviting look. Striking new chapter-opening images draw students into the topic of each chapter. In addition, new figures based on molecular structures have been added in several key locations.
- **Reorganization of molecular biology material:** The molecular genetics section of the text has been completely reorganized. These chapters now come earlier in the book and contain substantial new material on chromosomes, mechanisms of DNA mutation and repair, and mobile genetics elements.
- **New chapter on molecular techniques:** This new chapter focuses on the tools that have revolutionized molecular biology and biochemistry—the key technologies cell biologists use to analyze and manipulate DNA, genomes, RNA and proteins, and gene function.
- **Reorganization of materials on cell signaling, cell division, and the cell cycle:** Because the molecular genetics material comes earlier in the book, topics that relate to regulation of gene and protein expression are now more naturally integrated into the discussion of cell signaling and cell cycle control. These topics now come immediately before the chapter on cancer.

KEY TECHNIQUE

Determining the Chemical Fingerprint of a Cell Using Mass Spectrometry



A scientist preparing an injection for mass spectrometry.

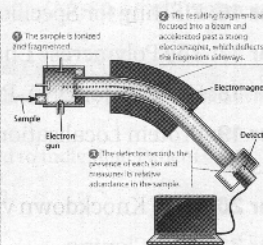


Figure 2A-1 A Mass Spectrometer.

PROBLEM: In cell biology, scientists typically study processes that involve changes in the chemistry of the cell, such as cell growth and division. Researchers often want to be able to identify small molecules in a cellular extract, or they may want to determine the chemical structure of a new compound. How is such analysis accomplished?

Key Tools: Mass spectrometer, a sample to be analyzed, a computer to analyze the results.

Details: Mass spectrometry can identify chemical compounds within a sample with high resolution, differentiating between

- **Key Techniques boxes in every chapter:** Twenty-six Key Techniques boxes are integrated throughout the text, demonstrating how cutting-edge technologies can be used to answer key questions in cell biology. See page xvii for a complete list.

Human Connections

ACE INHIBITORS: ENZYME ACTIVITY AS THE DIFFERENCE BETWEEN LIFE AND DEATH



Figure 5A-1 The Brazilian Pit Viper (*Bothrops jararaca*).

The Brazilian pit viper (*Bothrops jararaca*) (Figure 5A-1) scolds and strikes, injecting venom into a mouse. The venom releases a cocktail of peptides that widen the blood vessels in the mouse and cause a drastic drop in blood pressure. This

by the kidneys, it cleaves a specific peptide bond in an inactive protein known as angiotensinogen, releasing an N-terminal 10-amino acid peptide called angiotensin I.

Angiotensin I travels through the bloodstream to the pulmonary artery and lungs, where it is modified by the action of another enzyme, known as angiotensin-converting enzyme (ACE), which is abundant in the capillaries of the lungs. ACE cleaves two amino acids from the C-terminus of angiotensin I to convert angiotensin I to angiotensin II. Angiotensin II normally raises blood pressure if it has fallen too low by acting in the kidneys to return more sodium and water to the blood. Having more water in the blood increases blood volume, and because the vascular system is closed, this results in increased blood pressure. Angiotensin II is also a vasoconstrictor and will cause blood vessels to narrow, further increasing blood pressure.

Like many regulatory systems in the body, there is a regulatory pathway in place that has an opposite effect of angiotensin II. This system utilizes the peptide hormone bradykinin, which is a vasodilator. This causes blood vessels to relax and become wider, decreasing blood pressure. ACE is involved in regulating

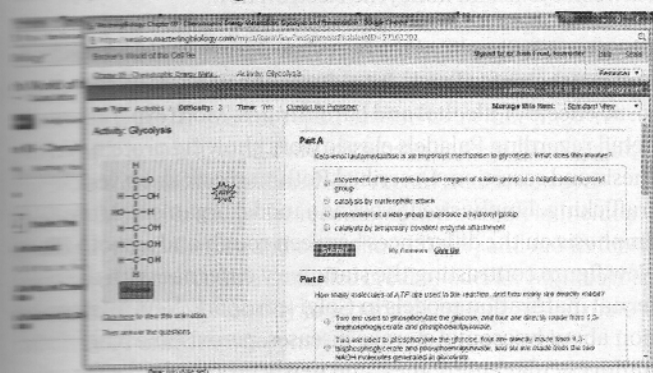
Human Connections boxes: Twenty-four Human Connections boxes emphasize the relevance of cell biology to human health and society, from the story of Henrietta Lacks and the HeLa cell line to the relevance of biochemical pathways to our diet, to the many cases in which cell biology helps us diagnose and treat human disease. See page xvii for a complete list.

Concept Check questions: Each main section of a chapter ends with a Concept Check question. These questions provide students with numerous opportunities to assess their understanding as they read. Answers to these questions are available at the back of the book.

Quantitative questions in every end-of-chapter Problem Set: New and existing quantitative questions are flagged at the end of each chapter to encourage students to work on developing their ability to perform calculations or to interpret quantitative information.

Content updates: Updated information highlighting the most recent advances in cell and molecular biology has been added throughout the book (see Content Highlights of the Ninth Edition below).

MasteringBiology®



MasteringBiology is an innovative online homework, tutorial, and assessment system that delivers self-paced tutorials with individualized coaching, hints, and feedback. The Mastering system helps instructors and students with customizable, easy-to-assign, and automatically graded assignments.

Integrated links in every chapter of the textbook point students to a variety of interactive online materials, including the following:

- More than 100 tutorials and activities that teach complex cell processes
- More than 100 molecular and microscopy videos, which provide vivid images of cellular processes
- 17 3-D Structure Tutorials that allow students to manipulate molecular structures, with assessment activities
- 240 Reading Quiz questions, which encourage students to read before class
- Many end-of-chapter questions and problems that are now assignable and automatically gradable
- Test Bank questions for every chapter
- The E-text, also available through MasteringBiology, which provides both access to the complete textbook and powerful interactive and customizable functions. In addition, a custom textbook option is available, allowing bundling of selected chapters chosen by the instructor to suit a particular course.
- A suite of Instructor Resources, including PowerPoint lecture outlines containing all the figures and photos and five to ten personal response system (PRS) clicker questions per chapter.
- Learning Catalytics is a “bring your own device” assessment and active classroom system that expands the possibilities for student engagement beyond standard clickers. Using Learning Catalytics, instructors can deliver a wide range of auto-gradable or open-ended questions that test content knowledge and build critical thinking skills.

Content Highlights of the Ninth Edition

Updated material and new information have been added throughout the book in both the text and art. Topics that have been altered, updated, or added include the following:

Chapter 1: A revised section on expression of genetic information in cells is presented much earlier in the textbook to integrate with other aspects of modern cell biology. New overview figure showing information expression in cells. New figures to introduce chromatography and electrophoresis. Described superresolution microscopy and photoactivatable GFP. Earlier introduction of immunoprecipitation, RNA sequencing, transcriptomics, DNA microarrays. New figure showing a DNA microarray. Revised figure showing importance of model organisms in cell biology research. Expanded discussion on the use of antibodies and immunofluorescence to identify cell components. Large new section describing experimental design, the null hypothesis, and experimental variables. Discussed use of mutants, reverse genetics, biochemical inhibitors in cell biology research.