

PREFACE

Biology is an introductory college text that covers the concepts and principles of biology from the structure and function of the cell to the organization of the biosphere. It draws upon the entire world of living things to bring out an evolutionary theme that is introduced from the start.

The writing style and clarity of the text make it appropriate for use by the liberal arts student but it is also comprehensive enough for the science major.

Biology demonstrates and in addition has the reader participate in the scientific process. Not only are notable contributors mentioned, significant experiments in the history of science are fully explained. Chapter 2, which discusses the scientific method, also illustrates this method by walking students through experiments in the current literature. As before, each part ends with a case study which encourages students to use scientific methodology in order to think critically. New to this edition are the Research Reports written by contemporary biologists who tell us how they go about doing their research and how their findings can be applied to human beings.

TEXT AND ILLUSTRATION COORDINATION

In this edition, you will find that all major topics begin at the top of a page and that each illustration is on the same or facing page with its text. Just glancing through the text verifies that the illustrations are on the same two page layout as their reference. This was achieved because the author was involved in deciding the layout of the book from the writing of the very first word! Coordination of text and illustration goes beyond simple placement, however. It also means making sure that the text and illustration together teach the concept under discussion. Contributors have helped improve the text and an excellent team of artists have assisted in creating the very best illustrations.

CHAPTERS NEW TO THIS EDITION

Evolution, which is the topic of Part III, includes two new chapters. The "Origin and History of Life" gives an overview of major evolutionary events since life evolved. "Human Evolution" is a chapter that includes the very latest information about recent discoveries.

Classification of plants and animals has been greatly influenced by cladistics, the most widely accepted school of systematics today. The various schools of systematics, including cladistics, are reviewed in the first of the diversity chapters. The diversity chapters received special attention and there is now a separate chapter for each of the kingdoms. New illustrations appear on nearly every page.

The part devoted to botany was expanded for this edition and recent research, especially concerning growth and development, is emphasized. These chapters have been carefully addressed. A new reading is devoted to the use of plants by human beings.

READINGS FOR THIS EDITION

The readings for this edition have been organized into several different types. We have already mentioned the "Research Reports," in which research biologists invite us to share in the excitement of their current findings. The "Of Human Interest" readings show how biology is applicable to the concerns of human beings. "A Closer Look" expands in an interesting way on the core information presented in the text. Some of these are about the research done by well-known biologists. Many chapters end with a section called "Biological Relationships" because students need to see how the various biological concepts are interrelated.

CLARITY IN WRITING AND NEW PEDAGOGY

Biology is as up to date as it possibly can be but is still retains its clarity and readability. The goal, as always, is to explain each concept without the use of jargon and in a way that is understandable to the beginning student.

Although the pedagogy in *Biology* has been praised by many, we have been able to make improvements. The micrographs are accompanied by a magnification bar that allows one to better judge the size of an organism. The use of these bars is explained in a reading entitled "The Microscopic Scale" found in chapter 5. Greek and Latin derivatives now accompany many boldfaced terms in order to give students a basis for learning and understanding scientific terminology. These are also included in the end-of-chapter glossary, which in this edition includes a full definition for each key term listed.

Even more significant, perhaps, are the new part introductions that review the central concepts of that part and how they relate to biology in general. At the start of each chapter, the chapter outline and learning objectives have been integrated so that learning objectives are listed under, and page referenced to, the major topics within that chapter. Students will appreciate that the heads for each chapter have been rewritten in an interesting way that highlights the significance of the material that follows. We continued to include the useful in-chapter summary statements that provide a synopsis of these same topics.

ORGANIZATION OF THE TEXT

The text has the following parts, which have been revised as discussed.

Introduction

An essay written by J. William Schopf, University of California—Los Angeles, which introduces the introductory chapter, shows how the unity and diversity of life is rooted in the evolutionary process. The chapter itself discusses the characteristics of life and at the same time introduces biological concepts that serve as an overview for the rest of the book.

Chapter 2, as mentioned, explains the scientific method and gives examples of both experimental and observational biological research.

Part I: The Cell

Cell structure and function and energy metabolism are presented in this part. Human applications are stressed throughout; for example, there is a reading about the new nutrition labels in the organic chemistry chapter. Cellular metabolism has been simplified, and there are many new illustrations to clarify cellular processes.

Part II: Genetic Basis of Life

This part is given a strong historical approach but practical aspects are not neglected. Students are given an opportunity to test their ability to do problems as they proceed. The cell cycle, human genetics, cancer coverage, and biotechnology have all been updated.

Part III: Evolution

This new part presents evolutionary tenets and serves as a springboard for the diversity chapters that follow. New chapters are provided on the process of evolution, the history of life, and human evolution. Many new findings have been included.

Part IV: Diversity of Life

The diversity chapters have been placed in a new part which begins with a chapter on systematics and classification of organisms. Special care was taken to introduce and explain the cladistic school of systematics. Each kingdom is assigned its own chapter which has been written anew. Almost every illustration in this part has been reworked and redrawn.

Part V: Plant Structure and Function

Four chapters are devoted to flowering plant anatomy and physiology. The first chapter provides a foundation for the others that discuss nutrition and transport, growth and development, and reproduction. The chapters in this part were expanded, rewritten and updated. Many new and interesting topics, illustrating the vitality of this area of biology, have been added.

Part VI: Animal Structure and Function.

This part, which begins with a chapter on animal organization and homeostasis, contains separate chapters on the various animal systems. The comparative approach has been strengthened and as requested by adopters, there is additional material on the reproductive methods of various animals.

Part VII: Behavior and Ecology

A behavior chapter precedes those devoted to ecology because behavior pertains to the interactions of organisms within ecosystems. The behavior chapter was completely rewritten and it now has an experimental approach. The ecology chapters balance traditional ecology with environmental concerns. Some instructors may wish to begin the year's work with this part, which is certainly a workable alternative.

AIDS TO THE READER

Biology was written to provide students with the opportunity to enjoy, appreciate, and come to understand the concepts of biology and the scientific process. The following text features are especially designed to assist student learning.

I Part Introduction and Technology Correlation Lists

An introduction for each part highlights the central ideas of that part and specifically tells the student how the topics within each part contribute to biological knowledge.

At the beginning of each part are listings from *Explorations in Human Biology* and *Explorations in Cell Biology, Metabolism, and Genetics*, and from the *Life Science Animations* videotapes. The CD-ROM modules and the animations have been carefully correlated to figures in the chapters.

BIOLOGY AND TECHNOLOGY		
Many of the figures and concepts discussed in <i>Biology</i>, fifth edition, are further explored in technology products. The following is a list of figures in part II that contribute to technology products. A set of five videotapes contains over 50 animations of physiological processes integral to the study of biology. These videotapes, entitled <i>Life Science Animations (LSA)</i>, cover such topics as chemistry, genetics, and reproduction. A videotape series appears in appropriate figure legends to alert the reader to their availability.		
<i>Explorations in Human Biology</i> and <i>Explorations in Cell Biology, Metabolism, and Genetics</i> by George B. Johnson are interactive CD-ROMS with activities that can be used by an instructor or in the online placed in a lab or resource center for student use. This interactive software consists of modules that cover key topics discussed in a biology course. The CD-ROMS are available for use with Macintosh and IBM Windows computers. A CD-ROM series appears in appropriate figure legends to alert the reader of these activities.		
Corresponding Figures	Videotape Concepts	CD-ROM Modules
10.3 Cell cycle	10. Mitosis	Module: Regulate the Cell Cycle
10.4 Control of the cell cycle	11. Mitosis	Module: Regulate the Cell Cycle
10.5 Prokaryote	12. Mitosis	Module: Regulate the Cell Cycle
10.6 Mitochondrion	13. Mitosis	Module: Regulate the Cell Cycle
10.7 Apoptosis	14. Mitosis	Module: Regulate the Cell Cycle
10.8 Endoplasmic reticulum	15. Mitosis	Module: Regulate the Cell Cycle
10.9 Golgi apparatus	16. Mitosis and Cell Division in Plants	Module: Regulate the Cell Cycle
11.2 Overview of meiosis	17. Meiosis	Exploring Meiosis: Exploring Meiosis
11.3 Crossing-over occurs during meiosis I	18. Crossing Over	Exploring Meiosis: Exploring Meiosis
11.4 Chromatids of theoretical meiosis	19. Meiosis	Exploring Meiosis: Exploring Meiosis
11.5 Phases of meiosis	20. Meiosis	Exploring Meiosis: Exploring Meiosis
11.6 Types of karyotypes	21. Meiosis	Exploring Meiosis: Exploring Meiosis
11.7 Types of karyotypes	22. Meiosis	Exploring Meiosis: Exploring Meiosis

2 Learning Objectives

The Learning Objectives provide a framework for the content of each chapter. Note that the objectives are listed under the appropriate A-heads and are page referenced for student study.

3

BASIC CHEMISTRY

Learning Objectives

Matter Is Composed of Elements

- Explain the difference between an element and an atom. 24–25
- Name and describe the subatomic particles of an atom, indicating which one accounts for the composition of elements. 25–26
- Describe and discuss the energy levels, electron orbits of an atom, including the orbits of the first two levels. 27–29
- Draw a simplified atomic structure of an atom with an atomic number less than 20. 29

Atoms Form Compounds and Molecules

- Draw (represent) two atomic structures for one and two element molecules, and distinguish between ionic and covalent reactions. 30–32
- Note which atom has been reduced and which has been oxidized in a particular reaction. 32

Water Is Essential to Life

- Describe the chemical properties of water, and explain how these properties affect their importance for living things. 33–36
- Define an acid and a base; describe the pH scale, and state the significance of buffers. 36–37



3 Internal Summary Statements

Internal summaries are highlighted and enlarged to illustrate the chapter's key concepts. These appear at the ends of major sections and help students focus their study efforts on the basics.

The chemical properties of atoms differ because the number and the arrangement of their electrons are different.

4 Illustrations and Tables

The illustrations and tables in *Biology* have been designed to help students learn basic biological concepts as well as the specific content of the chapters, and are consistent with multicultural educational goals. Often it is easier to understand a given process by studying a drawing, especially when it is carefully coordinated with the text, as is the case here. New to this edition are integrative illustrations where both a photograph and a drawing are combined. Several new illustrations include information formerly found in tables.

5 Customization Option

The pages are double-numbered for full-color customization. An instructor can order a customized textbook to suit their course needs.

6 Figures Referenced On-page

Textual references and figures are found on the same page spread in the fifth edition. That means a student never has to turn the page to see the referenced figure.

7 Figures Correlated to Technology

Figures are correlated to the *Explorations* CD-ROMs and the *Life Science Animations* videotapes. Two icons,  and , are placed by figures that can be further enhanced with the multimedia products.

8 Boxed Features

Each chapter contains one or more readings. *Research Reports* are written by contemporary scientists and tell us about a particular aspect of their field of study. *Of Human Interest* highlights topics of special interest and ties biological principals to student concerns. *A Closer Look* expands on the core information presented in each chapter.

RESEARCH REPORT

Life After Photosynthesis



Carbon dioxide (CO_2) from the atmosphere is the primary source for almost all of the organic carbon in the bodies of plants, animals, fungi, bacteria, and other organisms on earth. Plants fix CO_2 during photosynthesis, and other organisms get along by eating an absorbing plant material. It has long been known that the amount of CO_2 in the atmosphere influences how fast plants grow. This can occur. Generally, the more CO_2 available to a plant, the faster a photosynthesis. These observations are becoming more important because it is predicted that the concentration of CO_2 in the atmosphere, which is currently about 0.034%, will double within the coming century.

My research is concerned primarily with "life after photosynthesis," meaning the metabolism of plants after CO_2 is incorporated into organic molecules. Each metabolism is often referred to as secondary metabolism, which involves a long series of chemical reactions that lead to the production of various compounds.

One of the most interesting questions in the study of secondary metabolism is the amount of secondary metabolism in the enriched versus the unenriched world. Most metabolism in general increases when photosynthetic rate increases. This is because the more photosynthesis occurs, the more carbon is available for the synthesis of secondary metabolites.

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9 Chapter Summaries

The summary is a numbered list of statements that follow the organization of the chapter and helps students to identify the concepts and focus on important topics discussed in each chapter.

10 Chapter Questions

Three kinds of questions—study questions, objective questions, and critical thinking questions—appear at the close of each chapter. They allow students to test their ability to fulfill the study objectives. The study questions review the chapter, and their sequence follows that of the chapter. The critical thinking questions are based on biological concepts found in the chapter. They verify that knowledge of a biological concept allows one to reason about some particular aspect of biology. The objective questions allow students to test their ability to answer recall-based questions. The types of objective questions have been expanded in this edition to include questions that require the completing or labeling of diagrams. Answers to the objective questions and critical thinking questions appear in appendix D.

Writing across the curriculum recognizes that students need an opportunity to practice writing in all courses. When students write out the answers to the study questions, they are writing while studying biology. Writing out the answers to the critical thinking questions also fulfills writing across the curriculum requirements.