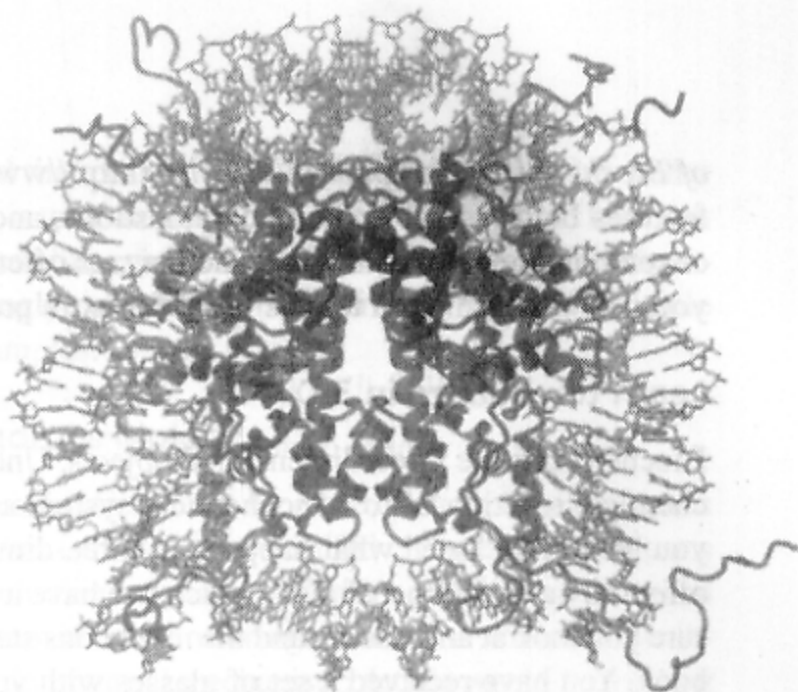




Preface

To the Student

Welcome to the study of the chemistry of life. As you venture into this exciting and dynamic discipline, you'll discover many new and wonderful things. You'll learn how some enzymes can catalyze chemical reactions at speeds close to theoretical limits—reactions that would otherwise occur only at imperceptibly low rates. You'll learn about the forces that maintain biomolecular structure and how even some of the weakest of those forces make life possible. You'll also learn how biochemistry has thousands of applications in day-to-day life—in medicine, drug design, nutrition, forensic science, agriculture, and manufacturing. In short, you'll begin a journey of discovery about how chemistry makes life both possible and better.

Before we begin, we would like to offer a few words of advice:

Don't just memorize facts; instead, understand principles

In this book, we have tried to identify the most important principles of biochemistry. Every year, a million or so research papers are published, perhaps half of them describing results of research in some area of biochemistry. Because the knowledge base of biochemistry is continuously expanding, we must grasp the underlying themes of this science. This textbook is designed to expand on the foundation you have acquired in your chemistry and biology courses and to provide you with a biochemical framework—the chemical principles of living cells—that will allow you to understand new phenomena as you meet them. As you progress in your studies, you will encounter many examples that flesh out the framework we describe in this book. These individual facts are useful in illuminating the basic principles.

Be prepared to learn a new vocabulary

An understanding of biochemical facts requires that you learn a biochemical vocabulary, which includes the chemical structures of a number of key molecules. These molecules are grouped into families based on their structures and functions; you should also learn how to distinguish among members of each family. As with any newly studied discipline, the more familiar you are with the vocabulary, the more easily you can learn and appreciate the discipline's literature.

Test your understanding

True mastery of biochemistry lies with learning how to apply your knowledge and how to solve problems. Each chapter concludes with a set of carefully crafted problems that test your understanding of core principles. Many of these problems are mini case studies that present the problem within the context of a real biochemical puzzle.

For more practice, including solving more traditional review exercises in biochemistry, we are pleased to refer you to *The Biochemistry Student Companion* by Allen Scism (see page vi). This book presents a variety of supplementary questions that you may find helpful. You will also find additional problems on the *Principles*

of *Biochemistry Companion Website* (<http://www.prenhall.com/horton>). This site features both regular and clinical questions, and the questions are categorized by chapter and level of difficulty. The quizzes offer hints and immediate feedback on your answers. This is a terrific place for extra practice.

Learn to visualize in 3-D

Biochemicals are three-dimensional objects. Understanding what happens in a biochemical reaction or to a biochemical system at the molecular level requires that you be able to “see” what happens in three-dimensions. Although textbook pages offer only a two-dimensional surface, we have a couple of suggestions. First, make sure you look at and understand the marvelous stereo pictures located throughout the book. You have received a set of glasses with your text; these make looking at the stereos much easier (although some of you will be able to view the stereo pictures in 3-D without the aid of the glasses). In addition, on both the website and on the Student CD *Exploring Molecular Structure* you will find many animations and interactive molecular models that you can manipulate in real-time on a computer. We strongly suggest you look at these movies and do the exercises that accompany them as well as participate in the molecular visualization tutorials.

Finally, please let us know of any errors or omissions you encounter as you use this text. With your help, we will continue to evolve this work into an even more useful tool. Our email addresses are at the end of this Preface. Good luck, and enjoy!

To the instructor

We welcome to this new edition all our loyal users and those instructors who are, for the first time, teaching one-term courses in biochemistry to chemistry majors, perhaps to meet the new American Chemical Society Committee on Professional Training guidelines. We hope you will find this the ideal book for your course. If you have any questions or comments for us, please send us email.

A book for your students

At some point, students cease to be intimidated by the need to skip around in a book. In our experience, that transition lies somewhere after they have begun a course like yours. We have organized this book as we would organize our courses. And while we doubt that everyone will want to cover everything within these pages, we have tried to include only those topics we felt would likely be covered in a one-semester, one-quarter, two-quarter, or general introductory course.

We have also taken care to make the text as modular as possible. Each larger topic we cover resides in its own section. Reaction mechanisms, where possible, are separated from the main thread of the text and can be passed over by those who prefer not to cover this level of detail. The text is extensively cross-referenced to make it easier for you to reorganize the chapters and for students to see the interrelationships among various topics and to drill down to deeper levels of understanding.

We built the book explicitly for the beginning student taking a first course in this burgeoning subject. Parts One and Two lay a solid foundation of chemical knowledge that will help students understand, rather than merely memorize, the dynamics of metabolic and genetic processes. These sections assume knowledge generally gained in prerequisite courses in general and organic chemistry, including a rudimentary knowledge of the organic chemistry of carboxylic acids, amines, alcohols, and aldehydes. Even so, key functional groups and chemical properties of each type of biomolecule are carefully explained as their structures and functions are presented.

A focus on principles

There are, in essence, two kinds of biochemistry textbooks: those for reference and those for teaching. It is difficult for one book to be both, as it is those same thickets

of detail sought by the professional that ensnare the struggling novice on his or her first trip through the bush. This text is unapologetically a text for teaching. It has been designed to foster student understanding and is not an encyclopedia of biochemistry. This book focuses unwaveringly on teaching basic principles, each principle supported by carefully chosen examples.

A focus on chemistry with rigorous biology

When we first wrote this text, we decided to take the time to explain in chemical terms the principles we underscore. To that end, we offer detailed chemical explanations of most of the chemistry herein, including mechanisms (which tell students *how* and *why* things happen). This is important because offering careful and complete mechanisms discourages rote memorization (partial mechanistic details would be just that much more for students to try to remember). While this approach may make the course more of a struggle for the empiricists among your students, it does mean they leave with a deep understanding of the chemistry behind biology. After all, there is much one can say about biochemistry, but the greatest legacy of this course should be the ability of your students to manage and use new information about things we don't discuss in these pages.

While we emphasize chemistry, we also stress the *bio* in *biochemistry*. We point out that biochemical systems evolve and that the reactions that occur in some species are variations on a larger theme. In this edition, we increase our emphasis on the similarities of prokaryotic and eukaryotic systems, while we continue to avoid making generalizations about all organisms based on reactions that occur in a few.

A focus on the visual

Biochemistry is a three-dimensional science. Our inclusion of the latest computer-generated mono and stereo images is intended to clarify the shape and function of biomolecules and to leave students with an appreciation for the relationship between the two. Most of the macromolecular images in this edition are new, skillfully prepared by Jonathan Parrish of the University of Alberta. We have included a free stereo viewer with each copy of the text.

For those students with access to a computer, we offer a number of other opportunities. Accompanying most pictures of macromolecules are Protein Data Bank (PDB) reference numbers for the coordinates from which the images were derived. This allows students to explore the structures further on their own. In addition, we have a gallery of prepared PDB files that students can view using Chime or any other molecular viewer; these are posted on the text's Companion Website (<http://www.prenhall.com/horton>). We offer a CD for students, called *Exploring Molecular Structure*, that includes animations of key dynamic processes as well as visualization tutorials using Chime. Finally, we offer instructors a CD that contains the gallery of animations, all the PDB files, as well as most of the art from the textbook in .jpg format. This makes the preparation of in-class electronic presentations (e.g., using PowerPoint) much easier. Please see the listing of supplements on page xi.

The organization

In this text we strive to present the story of biochemistry in a clear, coherent, well-integrated manner, building at each stage the background needed for the next stage. This book is arranged in four parts, each building on those that come before.

Part One forms an introduction to all that follows. Chapter 1 gives a brief survey (perhaps review) of cellular structure and the four classes of biomolecules—proteins, carbohydrates, lipids, and nucleotides—which are covered extensively in Part Two. In this chapter, and throughout the book, we sustain a consistent pattern of presentation, from basic chemistry to biochemical function. We first show the chemistry of monomeric units and then explore the properties and functions of the biopolymers and aggregates formed from those monomers—amino acids to proteins,

monosaccharides to polysaccharides and glycoconjugates, lipids to membranes, and nucleotides to nucleic acids.

Part Two includes three chapters on enzyme properties, enzyme mechanisms, and coenzymes (Chapters 5, 6, and 7). We encourage a firm grasp of these critical subjects as well as signal transduction, which is introduced in Chapter 9, since they are prerequisite to later appreciation of the role of enzymes in metabolic pathways.

Part Three features eight chapters that focus on metabolic pathways. In Chapter 10, we introduce the intricate molecular symphonies of metabolism by considering how pathways are energized, interrelated, and regulated. Next comes glycolysis (Chapter 11), which we describe in detail. At this stage, we establish a format that recurs in subsequent metabolic chapters—first describing the basic pathway in chemical and enzymatic terms, then demonstrating the bioenergetic requirements and sources of energy, and concluding with an account of regulatory mechanisms. Note that the early introduction of signal transduction (Chapter 9) allows integration of regulation into each chapter of metabolism and allows discussion of flux through reciprocal pathways. Part Three includes a comprehensive chapter on photosynthesis (Chapter 15), a process whose early steps we relate to oxidative phosphorylation and whose later steps we relate to other pathways of carbohydrate metabolism.

Part Four concludes the book with four chapters on the flow of biological information. Our main emphasis throughout this series of chapters is on the basic processes that govern pathways of information flow. We take pains to incorporate within our story of genes and gene expression the principles of biochemistry taught in preceding chapters. The final chapter (Chapter 23) is a substantial and contemporary presentation of techniques used in recombinant DNA technology.

New features in this edition

We are grateful for all the input we received on the first two editions of this text. Changes you'll notice in this third edition include the following:

- integration of the material on nucleotide structure and function into various chapters in the book.
- 30% more problems at the end of every chapter, with detailed solutions to all problems in an appendix at the end of the book.
- more extensive marginal cross-referencing to enhance the connection of concepts and the integration of material, to permit instructors to cover the material in a different order, and to improve the efficiency of students' studying.
- the addition of special topic, clinical application, and deeper-look boxes to most chapters.
- the addition of MediaLabs to encourage the learning of biochemistry using the internet. You will find these labs help you assign collaborative activities, help you keep up with this ever-changing science, and help you impart to students the dynamic nature of biochemistry.
- addition of a complete glossary of biochemical terms.
- update of all Selected Readings at the end of each chapter.

Since publication of the second edition, major advances have been made in a number of areas. For this edition, we made many changes to each section of the text to reflect these advances. For example, we added many, many new protein structures, each with Protein Data Bank cross-references; expanded the discussion of protein structure (with more examples); expanded the discussion of known multifunctional enzymes; increased the emphasis on molecular evolution; enhanced the discussion of the mechanism of energy conservation as ATP; incorporated the results of the various genome initiatives; added new information on transcription and trans-

lation, including new information on the structures of the ribosome and RNA polymerase; and added a discussion of the molecular description of programmed cell death (apoptosis).

Supplements

To aid you in the classroom, we offer several tools:

Biochemistry Digital Image Gallery (Macintosh and Windows: ISBN 0-13-026678-7)

Designed for instructors, this CD includes most images from the textbook (.jpg format), all animations on the student CD (QuickTime format), a gallery of PDB files that can be viewed using Chime, and all simulations from the student CD. It also includes a set of pre-built, editable PowerPoint slides organized by chapter and section. Using this CD makes preparing electronic lecture presentations a snap.

Overhead Transparencies (ISBN 0-13-026681-7)

A set of 140 full-color overhead transparencies featuring images from the text is available to qualified adopting instructors.

Test Item File (ISBN 0-13-026674-4)

A collection of over 2300 short-answer and multiple-choice test questions organized by chapter and section is also available to instructors. These questions were written by William Coleman of the University of Hartford and Donna Gosnell of Valdosta State University and are specifically designed to accompany this edition of the text.

TestManager (Windows ISBN 0-13-026677-9; Macintosh ISBN 0-13-026676-0)

This is an electronic version of the test bank accompanied by an easy-to-use software application that allows easy selection, creation, editing, and deletion of questions, easy administration of quizzes, easy quiz printing, and even makes it possible to offer quizzes over a local area network.

Course Management using WebCT, BlackBoard, or CourseCompass

If you use or would like to use on-line course management, please contact your local Prentice Hall representative or email us at chemistry_service@prenhall.com. We offer robust, tested, pre-built courses that accompany this edition of the text in WebCT, BlackBoard, and CourseCompass.

For your students, we offer the following supplements:

The Biochemistry Student Companion by Allen Scism of Central Missouri State University (ISBN 0-13-026670-1). This student workbook features many additional study questions for each chapter as well as useful study and data tables.

The Horton: *Principles of Biochemistry Companion Website* (www.prenhall.com/horton) by David Daleke of Indiana University and Andrew Ellington of the University of Texas–Austin. This companion website features a variety of unique online resources of interest to biochemistry students, including updated web links, a three-tiered problem-solving center (where students get instant feedback on their quiz answers), links to relevant websites, and biomolecule visualization tutorials.

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Finally, we close with an invitation for feedback. Despite our best efforts (and a terrific track record in the previous editions), there are bound to be mistakes in a work this size. We are committed to making this the best biochemistry text available; please know that all comments are welcome.

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