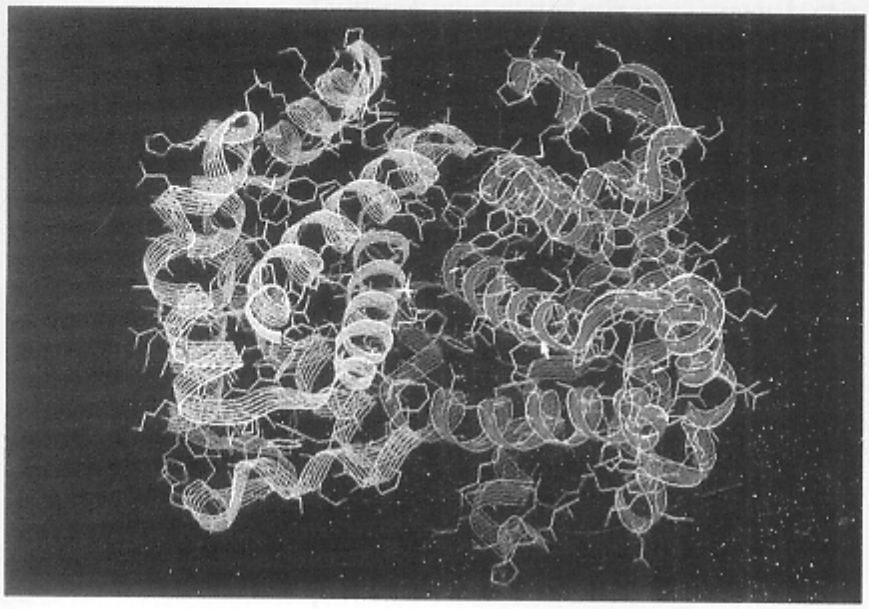
PREFACE



α-helixes of hemoglobin.

This text is intended for students in any field of science or engineering who want a one-semester introduction to biochemistry but who do not intend to be biochemistry majors. My main goal in writing this book is to make biochemistry as clear and interesting as possible and to familiarize all science students with the major aspects of biochemistry. There are many reasons why students in the pure and applied sciences should be acquainted with biochemistry. For students of biology, chemistry, physics, geology, and nutrition, biochemistry impacts greatly on the content and approach of their fields, especially in the areas of medicine and the pharmaceutical industry. For engineers, studying biochemistry is especially important for those who hope to enter a career in biomedical engineering.

Students who will use this text are at an intermediate level in their studies. A beginning biology course, general chemistry, and at least one semester of organic chemistry are assumed in preparation.

SPECIAL FEATURES

• Visual Impact

One of the most distinctive features of this text is its visual impact. Its extensive full-color art program includes artwork by the well-known biochemical illustrator, Irving Geis, and by professional artists, John and Bette Woolsey. The illustrations convey meaning so powerfully that many have become, or are certain to become, standard presentations in the field.

- **Chapter Overviews**

  Written by Irving Geis, the introductory paragraphs serve as overviews for each chapter. These chapter-opening paragraphs tie together the material from previous chapters with the topics to be discussed. They serve as building blocks for new ideas.

- **Interviews**

  Each of the five parts opens with an interview with a research biochemist, one a Nobel laureate. These outstanding scientists talk about both their research interests and teaching biochemistry. The interviews include a brief look at both their professional and personal lives and are included to encourage students to look closely at a career in science.

- **Boxes**

  Boxes on special topics, such as lactose intolerance, sickle cell anemia, and artificial sweeteners, highlight points of particular interest to students.

- **Interchapters**

  Two flexible interchapters explain the experimental methods for determining protein structure and the anabolism of nitrogen-containing compounds. These interchapters follow Chapters 9 and 18.

- **Summaries**

  Each chapter closes with a summary, a broad selection of exercises, and an annotated bibliography of up-to-date references.

- **Glossary and Answers**

  The book ends with an answer section, a glossary of important terms and concepts, and a detailed index.

ORGANIZATION

Because biochemistry is a multidisciplinary science, the first task in presenting it to students of widely different backgrounds is to put it in context. Part I provides the necessary background and connects biochemistry to the other sciences. Part II focuses on biomolecules, while Part III discusses biochemical reactions. Metabolism is covered in Part IV. The final part of the book is devoted to the flow of genetic information.

In Part I, The Position of Biochemistry in the Sciences, three chapters relate biochemistry to other fields of science. Chapter 1 deals with the connections of biochemistry to physics, astronomy, and geology, mostly in the context of the origins of life. Chapter 2 discusses the more readily apparent linkage of biochemistry with biology, especially with respect to the distinction between prokaryotes and eukaryotes, as well as the role of organelles in eukaryotic cells. Chapter 3 builds on material familiar from

general chemistry, such as buffers and the solvent properties of water, but emphasizes the biochemical point of view toward such material.

Part II, The Molecular Nature of Cellular Components, focuses on the comparison and contrast that arises from the juxtaposition of organic chemistry and biochemistry. An introduction to the section explicitly addresses the differences in emphasis and approach between the two disciplines. Chapters 5, 6, and 7 deal with amino acids and peptides, carbohydrates, and lipids. Students may have some familiarity with the first two topics from organic chemistry, but detailed discussions of lipid structure are likely to be new.

In Part III, the dynamic aspects of biochemical reactions, rather than the structure of biomolecules, become the center of attention. Thermodynamic concepts learned in general chemistry are applied specifically to biochemical topics such as coupled reactions and hydrophobic interactions. Chapters 9 and 10 cover the structure and action of proteins, one emphasizing structure and the other the behavior of proteins as enzymes. Finally, there is a discussion of the dynamics of membrane structure in Chapter 11.

In Part IV, metabolism is discussed. In Chapter 12, the connection is made between metabolism and electron transfer (oxidation-reduction) reactions. Coenzymes are introduced in this chapter and are discussed in later chapters in the context of the reactions in which they play a role. Glycolysis and the citric acid cycle are treated in Chapters 13 and 14, followed by the electron transport chain (Chapter 15) and oxidative phosphorylation. A discussion of photosynthesis rounds out the discussion of carbohydrate metabolism (Chapter 17). The catabolic and anabolic aspects of lipid metabolism are dealt with in a single chapter (Chapter 16). The metabolism of nitrogen-containing compounds such as amino acids, porphyrins, and nucleobases is covered in Chapter 18. Chapter 19 summarizes metabolism and gives an integrated look at metabolism, including a treatment of hormones and second messengers. A brief discussion of nutrition, specifically showing the relationship of nutritional requirements to metabolic pathways, is also included in this chapter.

The final section, Chapters 20–22 (Part V), deals with molecular biology. The structure of nucleic acids (Chapter 21) is presented in detail as a preparation for discussing the replication of DNA, the translation of the genetic message in RNA (Chapter 21), and the ultimate translation of that message in the synthesis of proteins (Chapter 22).

This text attempts to give an overview of important topics of interest to biochemists and to show how the remarkable recent progress of biochemistry impinges on other scientists. The length is intended to allow instructors to choose favorite topics but not to be so long as to be overwhelming for the limited amount of time available in one semester.

ALTERNATIVE TEACHING OPTIONS

The order in which individual chapters are covered can be changed to suit the needs of specific groups of students. With students who have a strong background in organic chemistry it should be possible to omit Chapter 4

and the early sections of Chapters 5 and 6. It is possible to delay coverage of the material on thermodynamics until the start of the metabolism section or to move thermodynamics to the beginning of the course. Some instructors may prefer to cover molecular biology before intermediary metabolism, and these sections are flexible enough to be moved.

SUPPLEMENTS

The text is accompanied by the following supplements:

- CAMPBELL'S COMPANION AND PROBLEMS BOOK by William M. Scovell (Bowling Green State University) accompanies and complements the text, with the objective of helping students gain a more comprehensive understanding of biochemistry.
  1. Each chapter begins with an introductory paragraph outlining the major topics discussed in the text.
  2. Each chapter contains Learning Objectives to help focus attention on important concepts.
  3. The heart of the book is the additional problems with detailed explanations and answers. These are intended to develop a fuller understanding of general concepts, and in some cases, focus on important details of a structure, reaction, mechanism, metabolic cycle, or pathway. In addition, some problems go beyond the text material to provide a glimpse of rapidly evolving areas.
  4. A section is included which reviews many of the more important organic reactions underlying the anabolic and catabolic reactions in biochemistry. This section provides a foundation for clearly realizing that biochemistry is simply "chemistry in living systems."
  5. A number of important topics, which are currently experiencing rapid if not explosive development, are "SPOTLIGHTED" to point out their role and impact on today's burgeoning understanding of the molecular basis of biology.
- INSTRUCTOR'S MANUAL by Mary Campbell. Includes chapter summaries, lecture outlines, answers to all exercises, and a bank of 25 multiple-choice questions for each chapter.
- OVERHEAD TRANSPARENCIES. One hundred full-color figures from the text.
- COMPUTERIZED TEST BANK. Compatible with IBM and Macintosh computers, it contains 25 multiple-choice questions for each chapter.

ACKNOWLEDGMENTS

The help of many others made this book possible. A grant from the Dreyfus Foundation made possible the experimental introductory course that was the genesis of many of the ideas for this text. My colleagues Edwin Weaver and Francis DeToma gave much of their time and energy in

initiating that course. Many others at Mount Holyoke were generous with their support, encouragement, and good ideas, especially Anna Harrison, George Hall, Lilian Hsu, Sheila Browne, Susan Hixson, Janice Smith, Jeffrey Knight, Sue Ellen Frederick Gruber, Peter Gruber, Carolyn Quarles, and Sue Rusiecki. I am deeply indebted to my colleagues at the University of Arizona, where I did much of the writing while on sabbatical. Particular thanks go to Professor Leslie Forster, in whose lab I worked both on this text and on protein fluorescence.

Many biochemistry students have used and commented on early versions of this text, with outstanding contributions by Heidi Behforouz and Clelia Biamonti at Mount Holyoke and Douglas Murrow and Stephanie Williams at the University of Arizona. The thought of my own mentors has been an inspiration to me: Walter Moore and Henry Mahler, whose untimely death was such a loss to us all, at Indiana University and Paul O. P. Ts'o at The Johns Hopkins University.

I would like to acknowledge my colleagues who contributed their ideas and critiques of my manuscript:

Robert Armstrong, Michigan State University

Bruce Banks, University of North Carolina-Greensboro

Charles H. Brueske, Mt. Union College

Clyde Denis, University of New Hampshire

Lester R. Drewes, University of Minnesota-Duluth

John R. Edwards, Villanova University

C. Dan Foote, Eastern Illinois University

Charles Grisham, University of Virginia

Richard Hewitson, Eureka College

Charles F. Hosler, Jr. University of Wisconsin-LaCrosse

Albert Light, Purdue University

Sabeeha Merchant, University of California, Los Angeles

Patrick W. Mobley, California State Polytechnic University-Pomona

Lawrence J. Tirri, University of Nevada, Las Vegas

Chen-Pei D. Tu, The Pennsylvania State University

Barbara D. Wells, University of Wisconsin-Milwaukee

The efforts of Richard Morel, Tom Thompson, Jeff Holtmeier, and Kathy Walker at Harcourt Brace Jovanovich contributed greatly to the development of the manuscript. John Vondeling, publisher, Janet Nuciforo, Sandi Kiselica, and Margaret Mary Anderson at Saunders College Publishing took over the herculean task of turning manuscript into a book. Carol Bleistine directed the art and design efforts that have had such magnificent results. I feel privileged that Irving Geis has contributed not only some of his classic illustrations but the introductory overviews to each chapter. John and Bette Woolsey created the illustrations and turned crude sketches into works of art. Computer ray trace space-filling molecu-

lar models, which set a new standard of excellence for computer art, were produced by Leonard Lessin, F.B.P.A., in conjunction with Hans Dijkman, Ph.D., and Waldo Feng. I extend my most sincere gratitude to those listed here and to all others to whom I owe the opportunity to do this book. Finally, I thank my family, whose moral support has meant so much to me in the course of my work.

Mary K. Campbell
November 1990