Principles of Biochemistry

ALBERT L. LEHNINGER

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THE JOHNS HOPKINS UNIVERSITY

SCHOOL OF MEDICINE

WORTH PUBLISHERS, INC.

Principles of Biochemistry

Printed in the United States of America

Library of Congress Catalog Card No. 82-70015

ISBN: 0-87901-136-X

Third Printing, December 1984

Editors: Sally Anderson, June Fox

Production: Kenneth Ekkens

Illustrator: Shirley Baty

Picture Editor: Anne Feldman

Design: Malcolm Grear Designers

Typographer: Progressive Typographers, Inc.

Printing and Binding: Rand McNally and Company

Cover: Computer graphics representation of bovine trypsin inhibitor–trypsin complex (inhibitor surface in red, trypsin surface in green), courtesy of Robert Langridge

Worth Publishers, Inc.

444 Park Avenue South

New York, New York 10016

Preface

Principles of Biochemistry is intended primarily for students taking their first course in biochemistry. It is a new book, not simply an updating of my earlier books, *Biochemistry* (1970, 1975) and *Short Course in Biochemistry* (1973). In setting out to prepare new editions of those books, I grew increasingly uneasy about my objectives. The first edition of *Biochemistry*, published in 1970, was primarily for an undergraduate audience, for those taking their first, perhaps their only, course in biochemistry. The second edition in 1975 grew by more than 20 percent. A third edition, with a proportional effort to include new biochemical advances, would become a volume of 1,500 pages. Such a book could of course play an important role in biochemical education, but it would not properly serve the undergraduate audience for whom I had written *Biochemistry* in the first place. *Principles of Biochemistry* is, then, a return to my original objective; it is, in a manner of speaking, the 1982 rebirth of the first edition of *Biochemistry*.

Size was not the only consideration. The time has come when a single biochemistry textbook cannot be all things to all students. A comprehensive book that describes the full panoply of today's biochemistry at a level that would satisfy the needs of graduate students would surely be found intimidating by most undergraduates in their first encounter with the field. Textbooks have a tendency, moreover, to acquire more complex structure and become more densely written in successive editions, with the result that they often lose the very clarity of exposition and organization that made their first editions successful. A fresh start seemed called for.

I once felt that biochemistry should be primarily a graduate subject, to be approached only after a thorough grounding in chemistry and biology. Today I have quite a different view. Biochemistry should be taught much earlier, since it has become the *lingua franca* of the life sciences and greatly illuminates subsequent study in any area of biology. And not only biology: An early course in biochemistry for students of chemistry or

physics provides challenging glimpses of how living organisms solve some of the most fundamental chemical and physical problems.

Considered more broadly, an undergraduate course in biochemistry also has a place in educating young people for a future in which there will be ever-greater concern for the health and well-being of mankind. The extraordinary advances in biochemical genetics and genetic engineering, together with their social implications, are already matters of wide public interest. The growing world population, with its increasing demands for food, raw materials, and energy, can even now be seen to impinge on the delicate ecological balances within the biosphere. Increasingly, society must make important decisions involving conflicts between biological principles and political, industrial, or ethical concerns. It can therefore be argued that a knowledge of biochemistry is useful for all well-informed citizens, whatever their calling—quite apart from the special intellectual excitement it offers to those who wish to explore and understand the molecular interactions that take place in living organisms.

Principles of Biochemistry is made up of four parts: biomolecules, bioenergetics and metabolism, aspects of human biochemistry, and the fundamentals of molecular genetics; it is written in the same style and language I used in *Biochemistry*. Throughout the book I have tried to emphasize the framework and the molecular logic of biochemistry rather than encyclopedic detail, always with full explanations and descriptions of fundamental processes.

The book opens with chapters on cell structure and on some rudiments of organic chemistry relevant to biomolecules; thus it can be useful to those with a minimal background in biology and organic chemistry. After considering the properties of water, the structure and biological functions of proteins are described in depth. Hemoglobin is examined in detail to show how amino acid sequence and primary structure determine conformation, and how conformation can influence cell structure and function. Enzymes and the regulation of enzyme activity are then treated in depth, with repeated emphasis on conformation illustrated by a "gallery" of enzyme structures. Chapters on vitamins and coenzymes, on carbohydrates, and on lipids and membranes complete Part I.

Part II deals with bioenergetics and cell metabolism—the "meat and potatoes" of biochemistry. A thorough grounding in cell bioenergetics is followed by detailed discussions of glycolysis, the citric acid cycle, electron transport, and oxidative phosphorylation. Chapters on the catabolism of fatty acids and amino acids follow, succeeded by chapters on biosynthetic pathways and photosynthesis. Regulation of metabolic pathways is discussed in detail.

Part III is devoted to human biochemistry. It includes chapters on organ relationships in metabolism, endocrine regulation, and human nutrition. To me, nutrition is not simply a

matter of knowing that a given vitamin serves as part of a given coenzyme. The science of nutrition is one of biochemistry's greatest contributions to human welfare, and I believe it deserves a more holistic treatment than it usually receives.

In Part IV I have provided an especially full treatment of the "cutting edges" of molecular genetics; these chapters take into account the rapid pace of new developments (through 1981), including the techniques of DNA cloning.

Throughout the book there are many interest-provoking items of related information, some historical in nature, many dealing with medicine and human health, still others touching on zoology and animal physiology, agriculture and food, environmental issues, and world nutritional problems. Occasionally, there are brief sections covering more difficult, quantitative, or interesting but optional information. This material may not be covered in all courses, so it is boxed for easy identification. Examples include the derivation of the Henderson-Hasselbalch equation, the *RS* system, how to tell a person's age through amino acid chemistry, and the sequencing of DNA.

There are almost 850 illustrations, tables, charts, and photographs in the book. Each chapter has a summary as well as a useful list of readings and references. There is a comprehensive glossary of over 400 biochemical terms at the end of the book.

Particularly noteworthy are the problems at the end of each chapter, over 350 altogether, most of them written by Paul van Eikeren of Harvey Mudd College. The problems are not merely numerical; they focus on biochemical reasoning and require thoughtful analysis. All of them, together with their answers in an appendix, have been thoroughly reviewed by experienced teachers of undergraduate biochemistry.

In presenting this new book, I again welcome suggestions and criticisms from teachers and students alike.

Acknowledgments

I am very grateful to those who have helped me prepare this book. First, I must thank Paul van Eikeren for writing most of the problems in the book and the answers in the appendix. Carl Shonk of Central Michigan State University went over each problem and its solution with a fine-toothed comb and made many valuable suggestions to enhance their didactic value. I want also to thank Barbara Sollner-Webb of Johns Hopkins School of Medicine for providing the problems for the chapters on genetic biochemistry.

The entire text, both in drafts and final version, was reviewed in detail by Edward Harris of Texas A & M University, James Hageman of New Mexico State University, and Carl Shonk. Specific sections of the manuscript were also closely scrutinized by Norman Sansing, University of Georgia; James Bamburg, Colorado State University; Michael Dahmus, University of California, Davis; and Paul Englund and Barbara Sollner-Webb of the Johns Hopkins School of Medicine. Keith

Roberts of the John Innes Institute provided useful suggestions for illustrations in the early chapters. Geoffrey Martin carefully checked the accuracy of all the equations and structural formulas in the book, and Linda Hansford proofread the entire book and prepared the index. I must, however, take sole responsibility for errors of fact or emphasis.

I am especially grateful to Peggy Jane Ford, who not only typed the manuscript, several times over, but also marshaled my time and attention to the competing demands of teaching, research, administration, and book writing. I also wish to thank June Fox and particularly Sally Anderson of Worth Publishers, who edited and guided the book through production. Indeed, I wish to thank the entire staff of Worth Publishers for their understanding, encouragement, and practical help. An author could not ask for better cooperation in seeing his brainchild into print.

Finally, I must acknowledge with deep appreciation the indispensable aid and encouragement of my wife, who not only tolerated the occupational agonies that beset the long-distance writer, but also served as my keenest critic of style and language.

ALBERT L. LEHNINGER

Sparks, Maryland
January 1982

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