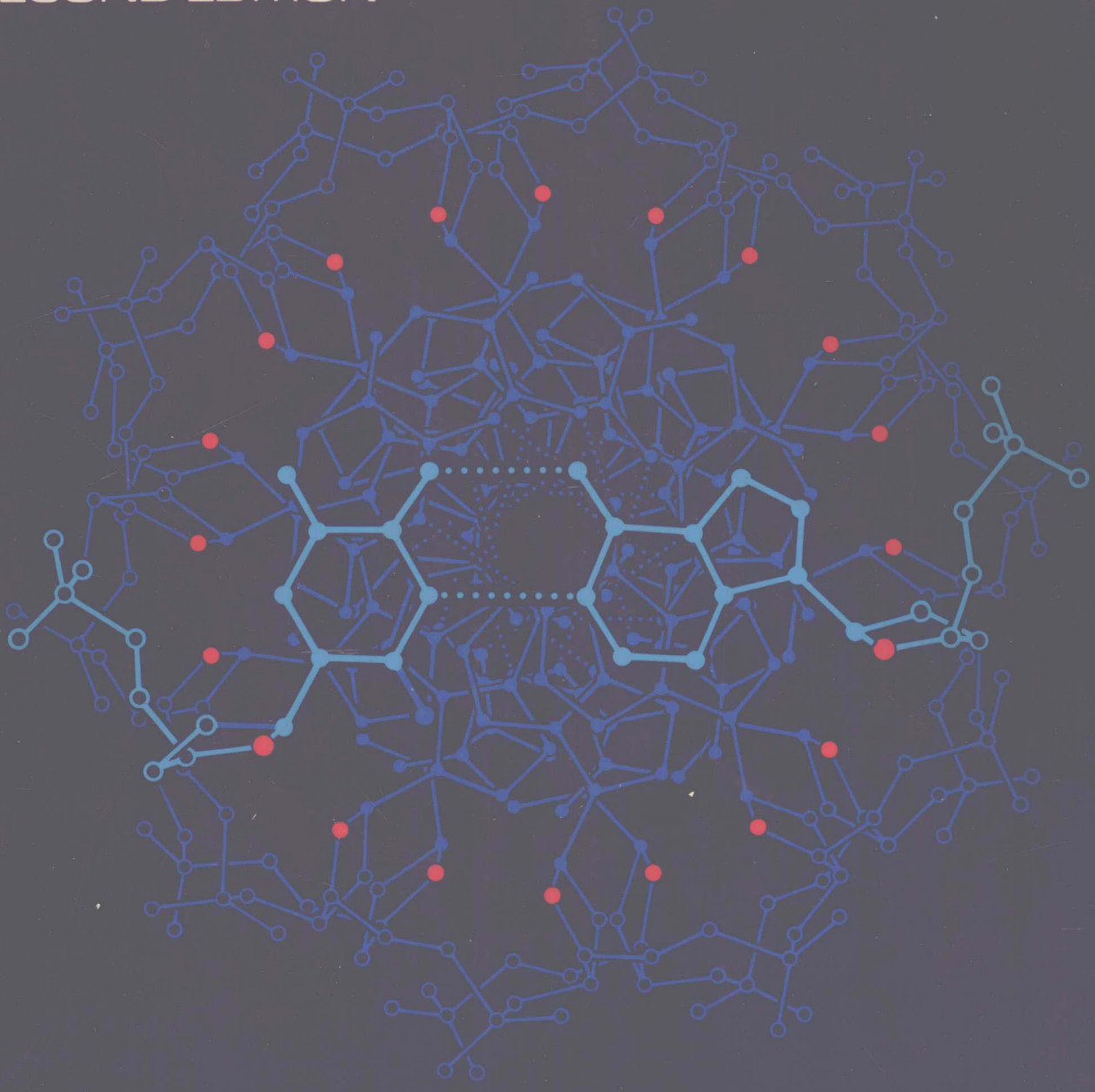
FRANK B. ARMSTRONG

BIOCHEMISTRY

SECOND EDITION



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FRANK B. ARMSTRONG

North Carolina State University

New York Oxford

OXFORD UNIVERSITY PRESS 1983

Library of Congress Cataloging in Publication Data

Armstrong, Frank Bradley.
Biochemistry.

Bibliography: p.
Includes index.
1. Biological chemistry. I. Title.
QP514.2.A73 1983 574.19'2 81-18922
ISBN 0-19-503109-1 AACR2

Outside front cover: Top view of B DNA depicting one complete turn of the helix (ten base pairs). See P. 233.
Illustration © by Irving Geis.
Inside front cover: The von Liebig Laboratory in Giessen, Germany.
(The Bettmann Archive, Inc.)
Cover design by Charles and Ruth Kaplan.

Printing (last digit): 9 8 7 6 5 4 3 2 1

Printed in the United States of America

PREFACE

The writing of the second edition of *Biochemistry* was influenced significantly by the constructive critiques and suggestions provided by colleagues, students, reviewers, and users of the first edition. With regard to the changes incorporated into the second edition, two new chapters, Lipid Biosynthesis (Chapter 19) and Recombinant DNA Research (Chapter 26), were added, and presentations in many of the other chapters were revised and/or expanded. Some of these changes include a discussion of glycogen synthesis (Chapter 11), the catalytic mechanism of ribonuclease A (Chapter 13), the glyoxylate cycle (Chapter 16), restriction mapping and the newer systems for DNA sequencing (Chapter 21), the mitochondrial genetic code and attenuation (Chapter 22), intracellular transport of proteins (Chapter 23), recent research findings on prostaglandins (Chapter 24), and the mode of action of vitamins A, D, and K (Chapter 25). Particular attention was also given to an expansion of the presentation on nitrogen metabolism (Chapter 20) by including nitrogen fixation, nitrate reduction, and the synthesis and catabolism of all 11 nonessential amino acids. Also, the discussion on purine metabolism is now complemented by one on pyrimidine metabolism.

The expanded second edition may now contain more material than can be conveniently presented in a one-semester, introductory course in biochemistry. If such is the case, it is hoped that individual instructors will select those topics from the book that best suit their treatment of the discipline in meeting the educational needs of their classes.

In preparing the new edition, I was again fortunate to have the assistance of colleagues who provided critical reviews of individual chapters. For their valuable contributions, my sincere appreciation

is extended to Wendy F. Boss, William E. Donaldson, H. Robert Horton, Daniel W. Israel, William A. Jackson, Bryan H. Johnson, William L. Miller, David W. Niesel, Joanne M. Ravel, and Samuel B. Tove. The useful critiques furnished by the reviewers selected by Oxford University Press are also appreciated. I recognize with gratitude the help provided by Jeanne B. Koger in proofreading the galleys and by Irene Nunes, who carefully and thoroughly copy-edited the manuscript. The impeccable typing of Anne Richardson, who prepared the manuscript, is also gratefully acknowledged. I express a special thanks to my editor, Michael R. Cook, whose dedicated efforts assured a smooth transition from the first to the second edition. Finally, I extend my appreciation and love to my family; their contributions of patience, support, and encouragement made the task of revising the text much easier.

Raleigh, North Carolina F.B.A.

PREFACE TO FIRST EDITION

Biochemistry is for an introductory course designed to accommodate undergraduates from widely varying curricula. For an instructor, the current broad interest in such offerings in biochemistry poses the challenge of teaching a course that meets the educational needs of majors from preprofessional programs, biological sciences, agricultural sciences, chemisty, engineering, and science education curricula. Such a generalized course has been taught by Frank B. Armstrong at North Carolina State University since 1968 and by Thomas Peter Bennett at the Rockefeller University. It was this mutual interest in teaching introductory biochemistry that prompted us to engage in the collaborative effort that made *Biochemistry* a reality.

The topics covered in the text were selected after seeking the advice of a number of instructors from various campuses who teach courses in biochemistry. A majority of the material, therefore, represents a basic core of instruction that all those consulted considered necessary for an introductory course and that we have found desirable in our own teaching. In the interest of brevity, the text is written in a simple, direct style. Where appropriate, the text is accented with historical notes, definitions, or information pertaining to the relevant aspects of the material being presented; medical anomalies, for example, are tied to inborn errors of metabolism.

Chapters 1 through 5 are introductory in nature and recognize the various backgrounds of students taking their first course in biochemistry. This section includes a brief history of biochemistry, emphasizing the development of molecular biology; a review of the elements needed for life and of biogeochemical cycles; a discussion of water and buffers; chemical topics that are important to the subsequent text; and an overview of cell biology.

Amino acids and proteins are two of the classes of biomolecules discussed in the book's second section, Chapters 6-13. A presentation of the molecular aspects of the structure and biological function of proteins, with emphasis on myoglobin, hemoglobin, and enzymes, precedes a description of other principal types of biomolecules, i.e., carbohydrates, lipids, nucleic acids, and B-vitamins.

The molecular basis of bioenergetics serves as a prelude to the third section (Chapters 14-20), which includes the production of chemical energy by living systems and interrelated topics on intermediary metabolism. The synthesis of ATP is the underlying theme of the chapters on glycolysis, tricarboxylic acid cycle, electron transport, oxidative phosphorylation, and photosynthesis. Carbon metabolism, emphasized in the presentation of the recovery of energy from sugars, is complemented by a discussion of the metabolism of nitrogen-containing biomolecules. This section concludes with a presentation of the molecular aspects of human nutrition.

The last section, Chapters 21-24, returns to some of the key accomplishments attained by molecular studies of biological phenomena. Chapter 21 on hormones includes the impressive strides that have been made toward understanding the molecular basis of hormone action. Chapters 22-24 are devoted to the classes of macromolecules of the Central Dogma, stressing molecular studies on DNA, RNA, and protein synthesis, respectively. A discussion of the coding capacity of the bacteriophage ϕX174 was selected for the book's closing, since the results of these studies succinctly exemplify the revolutionary impact that molecular biology continues to have on the study of biology.

The authors gratefully acknowledge those who aided in the preparation of *Biochemistry.* The following provided constructive critiques of many of the chapters and contributions of information and materials: Drs. Mary Bonneville, Janice Glenn, Thomas Conway, H. Robert Horton, Evan E. Jones, Joseph S. Kahn, Ian S. Longmuir, A. Russell Main, John F. Roberts, and Harold F. Swaisgood. The reviews and information provided by Mr. Hugh Craft are also acknowledged, and a special acknowledgment goes to Mr. Richard R. Randall, who served as an in-house editor for the manuscript. Thanks are given to the graduate students of the Department of Biochemistry at North Carolina State University for their careful help in proofreading the galleys. Appreciation is also expressed for the critical persistence and guidance of Mr. Robert

J. Tilley and his associates at Oxford University Press and for the thoughtful critiques provided by the reviewers selected by the publisher. The excellent typing of Mrs. Anne Richardson, who prepared the copies of the manuscript, is sincerely appreciated. We save for last our thanks to our families, who endured many months with authors-in-residence and who, in spite of this imposition, provided us with continuous support and encouragement.

FRANK BRADLEY ARMSTRONG
Raleigh, North Carolina

THOMAS PETER BENNETT
Philadelphia, Pennsylvania

December, 1978

But the task of the biochemist is, after all, the study of the physicochemical processes associated with the manifestations of what we call life—not the life of some particular animal or group of animals, but life in its most general sense.

ERNEST BALDWIN, 1937
Preface to *An Introduction to Comparative Biochemistry*

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