

CRC

HANDBOOK  
*of*  
BIOCHEMISTRY  
*and*  
MOLECULAR BIOLOGY  
3rd Edition

PHYSICAL and  
CHEMICAL DATA

Volume II  
Gerald D. Fasman



TAYLOR & FRANCIS  
PRESS



# **Handbook of Biochemistry and Molecular Biology**

**3rd Edition**

**Physical and Chemical Data  
Volume II**

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CRC PRESS, Inc.  
18901 Cranwood Parkway • Cleveland, Ohio 44128

**Library of Congress Cataloging in Publication Data (Revised)**

Main entry under title:

Handbook of biochemistry and molecular biology.

Previous editions published under title: Handbook of biochemistry.

Includes bibliographies and indexes.

CONTENTS: A. Proteins. 2. v.—B. Nucleic acids. 2. v.—C. Lipids, carbohydrates, steroids. — D. Physical and chemical data, miscellaneous.

1. Biological chemistry — Handbooks, manuals, etc.

2. Molecular biology — Handbooks, manuals, etc.

I. Fasman, Gerald D. II. Sober, Herbert Alexander, 1918— [DNLM: 1. Biochemistry — Tables.

2. Molecular biology — Tables. QU16 H235]

QH345.H347 1975 574.1'92 75-29514

ISBN 0-87819-512-2 (v.2)

This book presents data obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Every reasonable effort has been made to give reliable data and information but the editor and the publisher cannot assume responsibility for the validity of all materials or for the consequences of their use.

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International Standard Book Number (ISBN)

Former Complete Set 0-87819-503-3

Former Physical and Chemical Data, Miscellaneous 0-87819-512-2

Former ISBN Complete Set

Library of Congress Card No. 75-29514

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## PREFACE

The rapid pace at which new data is currently accumulated in science presents one of the significant problems of today — the problem of rapid retrieval of information. The fields of biochemistry and molecular biology are two areas in which the information explosion is manifest. Such data is of interest in the disciplines of medicine, modern biology, genetics, immunology, biophysics, etc., to name but a few related areas. It was this need which first prompted CRC Press, with Dr. Herbert A. Sober as Editor, to publish the first two editions of a modern *Handbook of Biochemistry*, which made available unique, in depth compilations of critically evaluated data to graduate students, post-doctoral fellows, and research workers in selected areas of biochemistry.

This third edition of the *Handbook* demonstrates the wealth of new information which has become available since 1970. The title has been changed to include molecular biology; as the fields of biochemistry and molecular biology exist today, it becomes more difficult to differentiate between them. As a result of this philosophy, this edition has been greatly expanded. Also, previous data has been revised and obsolete material has been eliminated. As before, however, all areas of interest have not been covered in this edition. Elementary data, readily available elsewhere, has not been included. We have attempted to stress the areas of today's principal research frontiers and consequently certain areas of important biochemical interest are relatively neglected, but hopefully not totally ignored.

This third edition is over double the size of the second edition. Tables used from the second edition without change are so marked, but their number is small. Most of the tables from the second edition have been extensively revised, and over half of the data is new material. In addition, a far more extensive index has been compiled to facilitate the use of the Handbook. To make more facile use of the Handbook because of the increased size, it has been divided into four sections. Each section will have one or more volumes. The four sections are titled:

**Proteins** — Amino Acids, Peptides, Polypeptides, and Proteins

**Nucleic Acids** — Purines, Pyrimidines, Nucleotides, Oligonucleotides, tRNA, DNA, RNA

**Lipids, Carbohydrates, Steroids**

**Physical and Chemical Data, Miscellaneous** — Ion Exchange, Chromatography, Buffers, Miscellaneous, e.g., Vitamins

By means of this division of the data, we can continuously update the *Handbook* by publishing new data as they become available.

The Editor wishes to thank the numerous contributors, Dr. Herbert A. Sober, who assisted the Editor generously, and the Advisory Board for their counsel and cooperation. Without their efforts this edition would not have been possible. Special acknowledgments are due to the editorial staff of CRC Press, Inc., particularly Ms. Susan Cubar Benovich, Ms. Sandy Pearlman, and Mrs. Gayle Tavens, for their perspicacity and invaluable assistance in the editing of the manuscript. The editor alone, however, is responsible for the scope and the organization of the tables.

We invite comments and criticisms regarding format and selection of subject matter, as well as specific suggestions for new data (and their sources) which might be included in subsequent editions. We hope that errors and omissions in the data that appear in the Handbook will be brought to the attention of the Editor and the publisher.

Gerald D. Fasman  
Editor  
August 1975

PREFACE TO PHYSICAL AND CHEMICAL DATA, MISCELLANEOUS:  
ION EXCHANGE, CHROMATOGRAPHY, BUFFERS,  
MISCELLANEOUS, E.G., VITAMINS, VOLUME II

This volume contains a subsection on chromatography and gel filtration including data on gas-liquid chromatography of amino acids, sephadex, and cellulose exchangers.

Data on absorption spectra, including material on amides, compounds of biological interest, and common ions are given. Information on the determination of protein concentration and data concerning calculations of optical rotatory dispersion data, and data on circular dichroism spectrophotometers are listed.

A subsection on fluorescence contains material on flavins, polyene probes, folic acid compounds, and vitamin B<sub>6</sub> compounds.

Data on bond angles and distances of common elements, the amino acid group, purines, and pyrimidines are listed.

Infrared and NMR spectral data on compounds of biological interest, data on vitamins, prostaglandins, and the physical chemical data on materials used in ultracentrifugation are listed.

This collection of data, for which the editor alone is responsible, is highly selective in nature. It is hoped that this volume will be of assistance to those working in the field of biochemistry and molecular biology.

Gerald D. Fasman  
Editor  
March 1976

## THE EDITOR

Gerald D. Fasman, Ph.D., is the Rosenfield Professor of Biochemistry, Graduate Department of Chemistry, Brandeis University, Waltham, Massachusetts.

Dr. Fasman graduated from the University of Alberta in 1948 with a B.S. Honors Degree in Chemistry, and he received his Ph.D. in Organic Chemistry in 1952 from the California Institute of Technology, Pasadena, California. Dr. Fasman did postdoctoral studies at Cambridge University, England, Eidg. Technische Hochschule, Zurich, Switzerland, and the Weizmann Institute of Science, Rehovoth, Israel. Prior to moving to Brandeis University, he spent several years at the Children's Cancer Research Foundation at the Harvard Medical School. He has been an Established Investigator of the American Heart Association, a National Science Foundation Senior Postdoctoral Fellow in Japan, and recently was a John Simon Guggenheim Fellow.

Dr. Fasman is a member of the American Chemical Society, a Fellow of the American Association for the Advancement of Science, Sigma Xi, The Biophysical Society, American Society of Biological Chemists, The Chemical Society (London), the New York Academy of Science, and a Fellow of the American Institute of Chemists. He has published 180 research papers.

The Editor and CRC Press, Inc. would like to dedicate this third edition to the memory of Eva K. and Herbert A. Sober. Their pioneering work on the development of the Handbook is acknowledged with sincere appreciation.

# TABLE OF CONTENTS

## NOMENCLATURE

Biochemical Nomenclature . . . . .	3
IUPAC Tentative Rules for the Nomenclature of Organic Chemistry Section E. Fundamental Stereochemistry . . . . .	20
The Citation of Bibliographic References in Biochemical Journals Recommendations (1971) . . . . .	58
Nomenclature of Labeled Compounds . . . . .	62
Definitive Rules for the Nomenclature of Carotenoids . . . . .	63

## CHROMATOGRAPHY AND GEL FILTRATION

Gas-liquid Chromatography of Amino Acids . . . . .	93
Effect of Variables on Column Pressure, Elution Volume, Peak Width, Height and Separation (Resolution) in the Ion Exchange Chromatography of Amino Acids on Sulfonated Styrene-divinylbenzene Copolymer Resins . . . . .	112
The Ion Exchange Chromatography of Urine Amino Acids: Resolution of The Ninhydrin Positive Constituents by Different Chromatographic Procedures . . . . .	114
Amino Acids of a Single Wet Thumbprint . . . . .	121
Elution Behavior of Naturally Occurring Ninhydrin-positive Compounds during Ion Exchange Chromatography . . . . .	122
Ratios Calculated from Absorption at 440 and 570 $m\mu$ of the Ninhydrin Reaction Product Color Constants of Some Amino Acids and Related Compounds . . . . .	123
Chromatographic Position of 185 Ninhydrin Reactive Substances . . . . .	125
Rapid Short Column Chromatography of Amino Acids Related to Metabolic Diseases . . . . .	128
Gel Filtration Media . . . . .	130
Cellulosic Ion Exchangers . . . . .	136

## ABSORPTION DATA

Absorption Data of Amides . . . . .	141
Ultraviolet Spectra of Compounds of Biological Interest . . . . .	144
Transmission Limits of Ions . . . . .	196
Spectrophotometric Determination of Protein Concentration in the Short-wavelength Ultraviolet . . . . .	197
Numerical Constants for Moffitt Equation for $b_0$ Calculations . . . . .	198
Modern Design of Circular Dichroism Spectrophotometers . . . . .	201

## FLUORESCENCE

Luminescence of Flavins . . . . .	205
Fluorescent Polyene Probes . . . . .	211
Fluorescent Parameters of Folic Acid Compounds of Biological Interest . . . . .	214
Fluorescence Properties of Vitamin B <sub>6</sub> Compounds . . . . .	215
Common Detergents Used in Biochemical Research . . . . .	216

## BOND ANGLES AND DISTANCES

Covalent and Van der Waals' Radii of Common Elements . . . . .	221
Bond Angles and Distances . . . . .	222
Bond Angles and Distances for Purines and Pyrimidines . . . . .	224
Infrared Correlation Chart No. 1. . . . .	228
Infrared Correlation Chart No. 2. . . . .	231
Infrared Correlation Chart No. 3. . . . .	232
Infrared Correlation Chart No. 4. . . . .	233

Far Infrared Vibrational Frequency Correlation Chart . . . . .	235
Chart of Characteristic Frequencies between $\sim 700\text{--}300\text{ cm}^{-1}$ . . . . .	237
Characteristic NMR Spectral Position for Hydrogen in Organic Structures . . . . .	247
Food and Nutrition Board, National Academy of Sciences – National Research Council	
Recommended Daily Dietary Allowances, Revised 1974 . . . . .	248
Satisfactory Levels and Intakes of Nutrients that meet Nutritional Requirements . . . . .	250
Pyridoxine, Pyridoxal, and Pyridoxamine Derivatives . . . . .	252
Tetrapyrrole Tables . . . . .	268
Properties for Ascorbic Acid and Ascorbate-2-sulfate . . . . .	281
Biological Characteristics for Ascorbic Acid . . . . .	283
Vitamins . . . . .	284
Prostaglandins . . . . .	312
Weights of Cells and Cell Constituents . . . . .	424
Particle Diameter . . . . .	425
Chemical and Physical Properties of Various Commercial Plastics . . . . .	426
Chemical Resistance and Other Properties of Centerpiece Materials Used in the Beckman Model-E	
Analytical Ultracentrifuge . . . . .	428
Chemical Compatibility of Millipore Filters, O-Rings, and Filter Holders . . . . .	431
Centrifugal Force Chart for Rotors Most Commonly Used in Density Gradient Centrifugation . . . . .	433
Chemical Resistance of Plastics Used in the Manufacture of Ultracentrifuge Tubes . . . . .	434

INDEX . . . . .	437
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## ***Nomenclature***

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## BIOCHEMICAL NOMENCLATURE

This synopsis of the recommendations of the IUPAC-IUB Commission on Biochemical Nomenclature (CBN) was prepared by Waldo E. Cohn, Director, NAS-NRC Office of Biochemical Nomenclature (OBN, located at Biology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830), from whom reprints of the CBN publications listed below and on which the synopsis is based are available.

The synopsis is divided into three sections: Abbreviations, symbols, and trivial names. Each section contains material drawn from the documents (A1 to C1, inclusive) listed below, which deal with the subjects named.

Additions consonant with the CBN Recommendations have been made by OBN throughout the synopsis.

### RULES AND RECOMMENDATIONS AFFECTING BIOCHEMICAL NOMENCLATURE AND PLACES OF PUBLICATION (AS OF FEBRUARY 1975)

- I. IUPAC-IUB Commission on Biochemical Nomenclature
  - A1. Abbreviations and Symbols [General; Section 5 replaced by A6]
  - A2. Abbreviated Designation of Amino-acid Derivatives and Peptides (1965) [Revised 1971; Expands Section 2 of A1]
  - A3. Synthetic Modifications of Natural Peptides (1966) [Revised 1972]
  - A4. Synthetic Polypeptides (Polymerized Amino Acids) (1967) [Revised 1971]
  - A5. A One-letter Notation for Amino-acid Sequences (1968)
  - A6. Nucleic Acids, Polynucleotides, and their Constituents (1970)
  - B1. (Nomenclature of Vitamins, Coenzymes, and Related Compounds)
    - a. Miscellaneous [A, B's, C, D's, tocals, niacins; see B2 and B3]
    - b. Quinones with Isoprenoid Side-chains: E, K, Q [Revised 1973]
    - c. Folic Acid and Related Compounds
    - d. Corrinoids: B-12's [Revised 1973]
  - B2. Vitamins B-6 and Related Compounds [Revised 1973]
  - B3. Tocopherols (1973)
  - C1. Nomenclature of Lipids (1967) [Amended 1970; see also II, 2]
  - C2. Nomenclature of  $\alpha$ -Amino Acids (1974) [See also II, 5]
  - D1. Conformation of Polypeptide Chains (1970) [See also III, 2]
  - E1. Enzyme Nomenclature (1972)<sup>a</sup> [Elsevier (in paperback); Replaces 1965 edition.]
  - E2. Multiple Forms of Enzymes (1971) [Chapter 3 of E1]
  - E3. Nomenclature of Iron-sulfur Proteins (1973) [Chapter 6.5 of E1]
  - E4. Nomenclature of Peptide Hormones (1974)
- II. Documents Jointly Authored by CBN and CNOC [See III]
  1. Nomenclature of Cyclitols (1968) [Revised 1973]
  2. Nomenclature of Steroids (1968) [Amended 1971; Revised 1972]
  3. Nomenclature of Carbohydrates-I (1969)
  4. Nomenclature of Carotenoids (1972) [Revised 1975]
  5. Nomenclature of  $\alpha$ -Amino Acids (1974) [Listed under I, C2 in the following table]
- III. IUPAC Commission on the Nomenclature of Organic Chemistry (CNOC)
  1. Section A (Hydrocarbons), Section B (Heterocyclics): *J. Am. Chem. Soc.*, 82, 5545;<sup>a</sup> Section C (Groups containing N, Hal, S, Se/Te): *Pure Appl. Chem.*, 11, Nos. 1-2<sup>a</sup> [A, B, and C Revised 1969;<sup>a</sup> Butterworth's, London (1971)]
  2. Section E (Stereochemistry):<sup>b</sup> *J. Org. Chem.*, 35, 2489 (1970); *Biochim. Biophys. Acta*, 208, 1 (1970); *Eur. J. Biochem.*, 18, 151 (1970) [See also I, D1]

<sup>a</sup>No reprints available from OBN; order from publisher.

<sup>b</sup>Reprints available from OBN (in addition to all in IA to ID and II).