

*Anal.*¹¹ Calcd. for C₉H₁₂N₂O₆ (244.20): C, 44.26; H, 4.95; N, 11.47. Found: C, 44.54; H, 5.20; N, 11.71. λ_{\max} 262 m μ , ϵ_{\max} 7,900; λ_{\min} 232.5, ϵ_{\min} 2,090, OD²⁹⁰/OD²⁶⁰ 0.06 at pH 2. λ_{\max} 287, ϵ_{\max} 7,960; λ_{\min} 244.5, ϵ_{\min} 1,970; OD²⁹⁰/OD²⁶⁰ 2.13 at pH 12.¹²

The yield of pseudouridine C based on the sugar derivative (I) was 2%. The total yield of all four pseudouridine isomers was 3.5%.

This synthesis conclusively establishes the 5-D-ribosyluracil structure of natural pseudouridine, but the important question concerning the configuration of the anomeric carbon still remains unanswered. Hydrolysis experiments have indicated that the A isomers are produced, as expected, during acidic hydrolysis of the methoxyl groups. Since the benzoyl groups are removed from the sugar by a side reaction,¹³ the β -directing influence of the 2-

(11) Schwarzkopf Microanalytical Laboratory, Woodside, New York.

(12) These ϵ_{\max} values are in fair agreement with those reported by Yu and Allen,^{2a} but they are about 10% lower than those reported by Cohn.^{2b} The sample provided by Dr. Cohn and purified as described in ref. 9 gave values corresponding to those given above.

benzoyl group¹⁴ may be lost. From a consideration of the spectral data and by analogy with other nucleosides it seems likely that pseudouridine C is 5- β -D-ribofuranosyluracil and the B isomer is 5- α -D-ribofuranosyluracil. Attempts to settle this structural point and to improve the yield of pseudouridine by utilizing the less reactive cadmium reagent are in progress.

Acknowledgments.—We are indebted to Mr. Viktor Kurkov for technical assistance and to Mr. Peter Lengyel for preparing 1-O-acetyl-2,3,5-tri-O-benzoyl- β -D-ribose. This work was supported by grants from the National Science Foundation (No. 1602 C4) and the United States Public Health Service (No. RG-7262 C1).

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RECEIVED JUNE 30, 1961

(13) Presumably by reaction of the lithium derivative with the ester groups to form bis-(2,4-dimethoxy-5-pyrimidyl)-phenylmethanol.

(14) B. R. Baker, J. B. Joseph, R. E. Schaub and J. H. Williams, *J. Org. Chem.*, **19**, 1786 (1954).

BOOK REVIEWS

The Enzymes. Second Edition, Completely Revised. Volume 3. Prosthetic Groups and Cofactors (Part B). Edited by PAUL D. BOYER, Department of Physiological Chemistry, University of Minnesota, Minneapolis, Minnesota, HENRY LARDY, Institute for Enzyme Research, University of Wisconsin, Madison, Wisconsin, and KARL MYRBÄCK, Institute for Organic Chemistry and Biochemistry, University of Stockholm, Sweden. Academic Press Inc. 111 Fifth Avenue, New York 3, N.Y., 1960. xiv + 497 pp. 15.5 × 23 cm. Price, \$16.00.

The first edition of "The Enzymes" has proved to be a useful well of information; undoubtedly the second edition will turn out likewise. The information in these volumes is presented in a streamlined fashion which should provide painless reading with maximal absorption for the reader.

The biologist of today is presented with numerous volumes which are published for the dual purposes of keeping him abreast of diverse fields of interest, not necessarily his own, and to present an appraisal of the current status of these fields. In reading Volume 3 (Part B) of "The Enzymes," this reviewer had the impression that he was reading a super volume of an annual review work. One wonders if we really need or can afford such comprehensive treatises which in so many ways duplicate each other, duplicate the efforts of the varied annual summarizing publications and do away so completely with the personal aspects of scientific writing. It would seem that more effort could be devoted toward publishing memoirs or monographs, contributed by individuals who wish to sum up a point of view or provide a record of their investigations. Such publications need not be subject to the rigid time relations that are needed for multi-volume treatise publication and could benefit thereby.

Volume 3 (Part B) of "The Enzymes" contains eleven contributions of varying length; all contributions suffer from irritating editorial troubles. In this volume there is considerable unevenness among the eleven contributions, an unevenness that does not reflect the spirit of a revised edition of an advanced treatise on enzymology, the contributions to which should be authoritative treatments of each topic and remain so for some years.

Jaenicke and Lynen provide a lengthy and thorough discussion on almost all aspects of coenzyme A. Of particular

interest to biochemists will be the compilation, into a very useful table, of all known enzyme reactions that require either coenzyme A or one of its derivatives. Botanically inclined readers will be interested to know that royal jelly is a plant (Table, 2 p. 14). On the whole, this is a masterly review and one which more than adequately summarizes Lynen's investigations and thoughts on coenzyme A. The chapter was originally written in German, was admirably translated by Dr. Helmut Beinert, but somehow a discrepancy between the numbered equations, figures and tables and their corresponding numbers in the text did appear in the final printed version.

Most aspects of the chemistry and enzymology of the pyridine coenzymes are discussed by N. O. Kaplan. This discussion summarizes, and usefully so, recent investigations on the chemical and physical properties of DPN and TPN. Possible reaction mechanisms of DPN and TPN, as studied with these coenzymes or with one of their derivatives, are also discussed. The chapter points out again the complexities introduced by the discovery of different isomeric forms of the pyridine coenzymes. This reviewer found the discussion of the enzymatic destruction of DPN most helpful, but was disappointed that plants weren't included in the section on the distribution of pyridine nucleotides.

E. M. Kosower presents a series of interesting considerations on what is known about charge transfer complexing. Even though little is known about such reactions in biological systems, Kosower does consider the evidence and theories for such reactions in pyridinium systems and possible applications of these theories to reactions of pyridine nucleotides. This chapter is a solid discussion of things that are either partially known or need to be investigated.

L. J. Reed contributes a chapter on lipoic acid. The chapter comprises a comprehensive review of the chemistry and biological role, in terms of reaction mechanisms, of lipoic acid.

"Metal and Enzyme Interactions: correlation of composition, function, and structure" is the title of a very ambitious chapter contributed by B. L. Vallee. The main emphasis of this chapter is on the non-heme metal-coenzymes and consequently centers on Vallee's own contributions. After a brief introductory discussion of metal containing

enzymes, metal enzyme complexes and metal-complexing agents, Vallee considers in some detail the role of zinc in several enzymes, including alcohol dehydrogenase. This is a rather complete summary of the author's contributions to this field, but perhaps one which is somewhat too selective as regards over-all contributions.

K. G. Paul contributes a chapter on heme compounds in enzyme catalysis. This chapter deviates in many ways from the usual treatment of heme compounds; it is well written and makes interesting reading if only because of the dry humor that occasionally crops up. The author's discussion of technical advances in the study of heme compounds is perhaps rather superficial but on the whole this is a rewarding chapter to read.

The chemistry and selected aspects of the biological roles of vitamins K and E are the subjects of two chapters, contributed by H. Dam and E. Søndergaard (vitamin K) and P. D. Boyer (vitamin E). Both of these chapters concentrate mainly on discussing existing evidence concerning the biological role of vitamins K and E, a role that unfortunately remains elusive.

In a charming essay, Wald and Hubbard discuss the enzymatic aspects of the visual process, the material for the chapter coming mainly from the author's own investigations. The reader is disappointed in that he does not find out how enzymes act as amplifiers, a choice tidbit that is promised in the chapter's introductory comments.

The last two chapters of the book comprise a brief and concise review of the role of ascorbic acid in mammalian systems (J. J. Burns and G. Aslwell) and a short exposition on enzymatic equilibria and thermodynamics (M. J. Johnson). The latter contributions seem out of place in this volume since one would like to think that "the average biochemist who has become interested in enzymic equilibria" would have progressed further in his knowledge of these matters than this chapter will lead him.

This reviewer enjoyed reading Volume 3 (Part B) of "The Enzymes," but with the reservations expressed in the opening comments of this review.

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Biochemie und Klinik. Monographien in Zwangloser Folge.

Edited by DR. G. WEITZEL, O. Prof. für Physiologische Chemie, Direktor des Physiol.-Chem. Instituts der Universität Tübingen, and DR. N. ZÖLLNER, Priv.-Doz. für Innere Medizin, Wiss. Assistent der Mediz., Poliklinik der Universität München. Nicht-glykolytische Stoffwechselwege der Glucose. By PROF. DR. S. HOLLMANN, Göttingen. Georg Thieme Verlag, Herdweg 63, Stuttgart-N, Germany. 1961. x + 220 pp. 15.5 × 23.0 cm. Price, DM. 39.—.

The purpose of these monographs is to review critically certain subjects of biochemistry which have become important for clinical medicine. Recent developments in biochemistry have made it abundantly clear that the key to an understanding of disease processes is often to be found in metabolic abnormalities. In particular, the so-called inborn errors of metabolism have become explicable in terms of a genetic loss of a single enzymatic function. With the unravelling, in the last 20 years, of the principal metabolic pathways, the content of biochemistry has increased enormously, some say as much as 300%, and it then becomes very difficult for the non-specialist to gain a working knowledge of a new and rapidly developing field. If he turns to the large handbooks, he will often find them out of date. These monographs, by being more limited in scope, are supposed to bridge the gap between biochemistry and clinic. They are to inform the clinician of important developments which may be applicable in medicine, and they are to give the biochemist a deeper insight into clinical problems.

The present volume fulfills this purpose to a considerable degree, since it may be read with profit by representatives of either discipline. An up to date bibliography of more than a thousand references covers the existing literature up to 1960 and gives an idea of the amount of work which has been done in recent years on "non-glycolytic" pathways of glucose metabolism.

In the glycolytic pathway the carbon chain of glucose undergoes oxidation at positions 3 and 4 and yields pyruvic acid as the principal intermediate product. This pathway is mainly concerned with the production of metabolic energy. There are now two other oxidative pathways known to occur in the mammalian organism which serve more specialized purposes. One is oxidation at carbon 1 which leads to the pentose phosphate cycle and the other oxidation at carbon 6 which leads to the glucuronic acid-xylulose cycle. In both cycles the pentoses which are formed by decarboxylation can be converted back to hexoses by a series of reactions involving isomerization and group transfer. Attempts have been made to measure quantitatively the extent of these reactions in various tissues, largely by means of isotopically labeled glucose. Other topics dealt with in this monograph are the synthesis and degradation of L-ascorbic acid, the synthesis of amino sugars, the function of uridine-linked sugar derivatives, and the metabolism of L-fucose and L-rhamnose. The metabolism of these substances in microorganisms is also considered. A special chapter is devoted to the separation, identification and determination of sugars and their derivatives.

The material in this monograph is well organized and is illustrated by numerous schemes of metabolic sequences in the form of chemical formulas. Quantitative aspects of metabolism are emphasized and the tabular material is well chosen. The author shows an excellent knowledge of the field and has produced a clearly written and well balanced critical survey which can be read with profit by biochemists as well as clinicians.

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Biochemistry of Steroids. By ERICH HEFTMANN and ERICH MOSETTIG, Steroid Section, Laboratory of Chemistry, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y. 1960. xi + 231 pp. 16 × 23.5 cm. Price, \$5.75 (college), \$6.90 (trade).

According to the editor's introduction, this volume is the first complete book to be written on the biochemistry of steroids and supplements Fieser and Fieser's chemical treatment, "Steroids." However, the two works are quite different, both in form and utility. Whereas Fieser and Fieser is a comprehensive treatise of greatest usefulness to the expert in steroid chemistry, Heftmann and Mosettig is, as stated by the authors, a brief introductory book to fill the need for concise information about the biochemical aspects of steroids for organic chemists in the pharmaceutical industry and for students and research workers in the various fields of biochemistry, physiology, endocrinology, pharmacology and medicine.

The authors have accomplished a formidable task in correlating and condensing a vast amount of information into a compact and readable form. The book's ten chapters are arranged in a sequence following as much as possible the biogenetic relationships between the classes of steroids. The first chapter concerns cholesterol and contains an excellent summary of the current knowledge about cholesterol biosynthesis. Next are discussed the other sterols, vitamin D, the steroid sapogenins and alkaloids, the cardiac glycosides and the bile acids. In each case consideration is given to the structure and occurrence of important compounds, biogenetic information when available, physiological and economic importance and methods of analytical determination. The final part of the book deals with the steroid hormones, progestational, corticoid, androgenic and estrogenic, with a consideration of the biosynthesis, metabolism, physiological actions and methods of analysis for each class. Especially valuable is a description of the modified physiological properties of the newer synthetic analogs of the natural steroid hormones.

Trivial nomenclature is used for the most part which makes for easy reading, and where systematic steroid nomenclature is required the older conventions are employed. This practice facilitates correlation with Fieser and Fieser, but, unfortunately, it tends to prolong the time before steroid chemists and biologists uniformly employ the