

INCORPORATION *IN VIVO* OF C<sup>14</sup> FROM LABELED METHANOL INTO THE METHYL GROUPS OF CHOLINE

Sir:

An investigation has been undertaken to test whether methyl groups supplied in the form of methanol can enter into transmethylation reactions of the body. An earlier test of whether methanol could support the growth of animals on a diet free of "biologically labile" methyl groups and containing homocystine was negative.<sup>1</sup> In the present experiment the more sensitive tracer technique, utilizing C<sup>14</sup>-labeled methanol, has been employed. The amount of radioactivity in the methyl groups of the choline isolated from the tissues of the rat after the administration of the labeled methanol was such as to indicate that methanol made available appreciable amounts of methyl groups which could be used in the transmethylation reactions of the body. The possible significance of this finding to the mechanism of transmethylation and even to the biological synthesis of "labile" methyl groups becomes of considerable importance and is being further investigated. In this connection the interesting observation of Binkley and Watson<sup>2</sup> may be pointed out, that methyl phosphate appears to be utilized in the formation of creatine from guanidoacetic acid by rat liver homogenates.

A total of 9 ml. of a 2.4% aqueous solution of C<sup>14</sup>-labeled methanol with an activity of  $5.33 \times 10^6$  counts per minute per ml. was injected subcutaneously in 1-ml. portions twice daily into a 161-g. rat over a five-day period. During this time the animal was kept in an open-circuit metabolism apparatus for the collection of the expired carbon dioxide. For fifteen days prior to injection and for the duration of the experiment the rat was allowed free access to a diet of the following composition (in g.): sucrose 54.85, vitamin-free casein 20, DL-methionine 0.15, fat (Covo) 19, Osborne and Mendel salt mixture 4,

(1) du Vigneaud, Chandler, Moyer and Keppel, *J. Biol. Chem.*, **131**, 57 (1939).

(2) Binkley and Watson, *ibid.*, **180**, 971 (1949).

corn oil (Mazola) 1, containing 4.0 mg. of  $\alpha$ -tocopherol acetate, 0.1 mg. of 2-methyl-1,4-naphthoquinone, 750 I. U. of vitamin A and 125 I. U. of vitamin D; water-soluble vitamins, administered *per os* twice daily, in the following amounts (mg. per day): thiamine hydrochloride, riboflavin, pyridoxine hydrochloride, nicotinic acid and *p*-aminobenzoic acid, 0.08 mg. each; calcium *d*-pantothenate 0.4, inositol 0.8, folic acid 0.02 and biotin 0.0008; 2 micrograms of vitamin B<sub>12</sub> every other day.

During the five-day period a radioactivity of  $22 \times 10^6$  counts per minute, out of the total injected radioactivity of  $48 \times 10^6$  counts per minute, appeared in the expired carbon dioxide. The animal was then sacrificed; choline was isolated from the carcass as the chloroplatinate (*Anal. Calcd. for C<sub>10</sub>H<sub>28</sub>N<sub>2</sub>O<sub>2</sub>·PtCl<sub>6</sub>: Pt, 31.68. Found: Pt, 31.14*), and creatine as the creatinine potassium picrate (purity determined by the Jaffe reaction, 100%). The choline was then degraded to trimethylamine, which was isolated as the chloroplatinate and recrystallized from water-ethanol (*Anal. Calcd. for C<sub>6</sub>H<sub>20</sub>N<sub>2</sub>·PtCl<sub>6</sub>: Pt, 36.96. Found: Pt, 37.06*). The specific activities of these compounds, determined after combustion and isolation of the carbon dioxide as barium carbonate, are given in the table, in terms of counts per minute per millimole of compound.

Compound	Specific activity
C <sup>14</sup> -Labeled methanol injected	ca. $7 \times 10^6$
Choline chloroplatinate	$7.18 \times 10^6$
Trimethylamine chloroplatinate	$6.45 \times 10^6$
Creatinine potassium picrate	$1.11 \times 10^6$

No exchange of methyl groups was found to occur between choline and C<sup>14</sup>-labeled methanol, allowed to stand together for several days.

This work has been confirmed with another animal. Complete details of these experiments and related ones will be forthcoming shortly.

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RECEIVED JANUARY 18, 1950

## NEW BOOKS

**Ion Exchange, Theory and Application.** Edited by FREDERICK C. NACHOD, Sterling-Winthrop Research Institute, Rensselaer, New York. Academic Press, Inc., Publishers, 125 East 23d Street, New York, N. Y. 1949. xxii + 411 pp. Illustrated. 16.5 × 24 cm. Price, \$8.50.

Since the publication of methods for manufacturing synthetic ion exchange resins by Adams and Holmes, the ion exchange process has spread from a few applications to many applications in almost all fields of chemistry and related fields. The large volume of published literature in this field is so diversified in nature and contained in so many journals that it has been extremely difficult for anyone

interested in the field to survey it. This volume is very timely and will be of great value to those desiring to apply ion exchange techniques to specific problems in a large variety of fields of study, as well as a reference book for courses in chemistry and chemical engineering.

In addition to a very short introduction, the subject matter of this volume is divided into sixteen chapters: Ion Exchange Equilibria, The Kinetics of Fixed-Bed Ion Exchange, Fundamental Properties of Ion Exchange Resins, Ion Exchange Equipment Design, Ion Exchange in Water Treatment, Multistage Systems in Ion Exchange, Desalting Sea Water, Applications of Ion Exchange to the Separation of Inorganic Cations, Ion Exchange as a Tool in Analytical Chemistry, Metal Concentration and Recov-

ery by Ion Exchange, Catalytic Application of Exchangers, The Use of Ion Exchange Adsorbents in Biochemical and Physiological Studies, The Separation of Amino Acids by Ion Exchange Chromatography, Sugar Refining and By-Product Recovery, Ion Exchange Recovery of Alkaloids and Miscellaneous Applications of Ion Exchange.

As stated by the Editor in the Introduction: "Ion Exchange has been known for almost a hundred years, but the manifold applications as well as the complexity of the theoretical aspects are only a few decades old." Therefore, it is difficult for a single individual to prepare a comprehensive treatment of the large number of subjects covered in this book. This difficulty has been resolved by selecting a number of authors who have made significant contributions and are familiar with the literature in the phases of the subject discussed in the various chapters.

In the first edition of a volume with so many contributors, it is difficult to avoid a great deal of repetition. This difficulty is more pronounced in the chapters dealing with theory and general discussions than in those concerned with specific applications, although even in the latter cases, there has been a tendency for the authors to repeat material already covered adequately in previous chapters. It is to be hoped that much of this repetition can be eliminated in a later edition.

The order of the topics appeared to be good with the exception that the one concerned with Fundamental Properties of Ion Exchange Resins should have appeared as the first chapter, in the opinion of the reviewer. This would seem to be a reasonable revision from a consideration of the subjects, and even more so when one considers the contents of the respective chapters and the authors' methods of presentation. Also, it would be an improvement in style if the outlines for the various chapters were more uniform. This variation is particularly noticeable in the table of contents which lists the topics designated with Roman numerals by the authors. Thus, the table of contents gives no indication of the relative importance or lengths of the various chapters; in fact, some of the shorter chapters have been given the largest amount of space in the table of contents.

It is difficult to evaluate a volume with a number of contributing authors without considering each chapter individually. This is not possible in a short review. In a rapidly advancing field, such as ion exchange, it is of particular importance that the authors supply a critical commentary of the literature rather than simply giving a summary with a bibliography. Most of the authors have done this quite satisfactorily. A few chapters appear to have been prepared rather hurriedly and are not adequate treatments of the topics. In the opinion of the reviewer, the outstanding chapters were three, eight, ten, twelve, fourteen, fifteen and sixteen.

A number of miscellaneous applications of ion exchange were discussed in the last chapter. Several of these are probably of equal importance to other applications which were discussed separately in earlier chapters. With the rapid advances which are taking place in the field, they will warrant separate chapters in future editions.

On the whole, the book should prove very useful in a large number of fields. There were a few inevitable typographical errors, but the number was small as compared to many first editions.

EDWARD R. TOMPKINS

## BOOKS RECEIVED

December 10, 1949-January 10, 1950

- M. BORN AND H. S. GREEN. "A General Kinetic Theory of Liquids." Cambridge University Press (American Branch), 51 Madison Avenue, New York 10, N. Y. 1950. 98 pp. \$2.25.
- A. GUTHRIE AND R. K. WAKERLING (edited by). "The Characteristics of Electrical Discharges in Magnetic Fields." National Nuclear Energy Series. Div. I, Vol. 5. McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York 18, N. Y. 1949. 376 pp. \$3.50.
- A. GUTHRIE AND R. K. WAKERLING (edited by). "Vacuum Equipment and Techniques." National Nuclear Energy Series. Div. I, Vol. 1. McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York 18, N. Y. 1949. 264 pp. \$2.50.
- C. S. HAMILTON (edited by). "Organic Syntheses, Vol. 29." John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1949. 119 pp. \$2.50.
- R. N. HAWARD. "The Strength of Plastics and Glass." Interscience Publishers, Inc., 215 Fourth Avenue, New York 3, N. Y. (Cleaver-Hume Press, Ltd., London.) 1949. 245 pp. \$5.50.
- D. NACHMANSOHN. "Metabolism and Function." Elsevier Publishing Company, Inc., 215 Fourth Avenue, New York 3, N. Y. 1950. 348 pp. \$6.00.
- A. N. PURI. "Soils: Their Physics and Chemistry." Reinhold Publishing Corporation, 330 W. 42nd Street, New York, N. Y. 1949. 550 pp. \$7.00.
- GLENN T. SEABORG, JOSEPH J. KATZ, AND WINSTON M. MANNING (edited by). "The Transuranium Elements. Research Papers. Parts I and II." National Nuclear Energy Series. Div. IV, Vol. 14b. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. 1949. 859 pp. (Part I). 872 pp. (Part II). \$15.00 (Two parts not sold separately).
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- W. THEILHEIMER. "Synthetische Methoden der organischen Chemie." Repertorium 2. S. Karger, Holbeinstrasse 22, Basel, Switzerland. 1948. 309 pp. S. fr. 35. English translation from Interscience Publishers, Inc., 215 Fourth Ave., New York 3, N. Y. \$7.50. (Revised and corrected notice.)
- ARNOLD WEISSBERGER (edited by). "Physical Methods of Organic Chemistry. Part II." Technique of Organic Chemistry. Volume I. Interscience Publishers, Inc., 215 Fourth Avenue, New York 3, N. Y. 1949. 1023 pp. \$12.50.
- RALPH W. G. WYCKOFF. "Electron Microscopy. Technique and Applications." Interscience Publishers, 215 Fourth Avenue, New York 3, N. Y. 1949. 248 pp. \$5.00.