tories with *Lactobacillus bulgaricus 09*[6] have shown that L-dihydroörotic acid and DL-dihydroörotic acid prepared by the new procedure will support growth and that the activity of these substances as well as of orotic acid and ureidosuccinic acid are reversibly inhibited by D-dihydroörotic acid.

DEPARTMENT OF ORGANIC CHEMISTRY
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MERCK AND CO., INC.
WEST POINT, PA.
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JANICE T. GORDON
EDWARD L. ENGELHARDT

RECEIVED OCTOBER 26, 1953

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[6] L. D. Wright, C. A. Driscoll, C. S. Miller and H. R. Skeggs, *Proc. Soc. Exptl. Biol. Med.*, in press.

BOOK REVIEWS

Radiocarbon Dating. By WILLARD F. LIBBY, Professor of Chemistry, Institute of Nuclear Studies, University of Chicago. The University of Chicago Press, Chicago 37, Illinois. 1952. vii + 124 pp. 16 × 24 cm. Price, $3.50.

An undergraduate elective course gave this reviewer a side interest in geology and the seemingly unanswerable question: "How long has geology been a-making?" Five years later as a doctorate candidate in analytical chemistry he was exposed to a geochemical infection by contact with the late Alfred C. Lane, and helped to date several uranium-containing specimens. The uranium–thorium–lead method put reliable dates into the range of historical geology down to the most recent 100 million years; of this remaining recent void, the last 20,000 holds much of the interest, and now Professor Libby's group has made possible the radiocarbon dating of pre- and post-ice age materials. Hess' discovery of cosmic radiation in 1911 meant little to the nuclear chemist of those days, but the discovery of the neutron, its production by cosmic ray action in the atmosphere, and the reaction $N^{14} + n = H^1 + C^{14}$ all combined to give us radiocarbon dating, the C^{14} half-life of 5568 ± 30 years setting a practical limit of about 20,000 years, and with thanks to the long-gone plants which fixed the radioactive carbon dioxide and the animals which helped the plants to preserve it for use by Libby's testers.

In Chapter I the author presents the nuclear background, which is more complex than indicated above, and carefully cites and evaluates the many pertinent variables: the long-period constancy of cosmic radiation, the earth's radiocarbon inventory, its cycle of distribution and utilization, and the problem of reliable choice of reliable specimens. Chapter II continues the study, bringing up the question of the vertical and horizontal variations of neutron intensity, rate of exchange between atmospheric and fixed carbon dioxide (in ocean and land compounds), the mixing of the ocean reservoir, and the constancy of cosmic radiation during recent millennia. Chapter III deals with the method of arriving at the half-life value of carbon-14.

With the background theory and experiment covered, Chapter IV considers the preparation of the sample for measurement, with its problems of inorganic and organic combination, alteration of original substances by putrefaction, heat and possible exchange. Acceptable sample materials are charcoal, wood, grasses, peat, antlers and hairy materials, and shell. More or less thoughtfully planned and executed preparation is needed before any sample (in amount to yield 12 to 5 g. of final carbon) is ready for combustion to carbon dioxide, processing of the gas and reduction of the gas to carbon by hot magnesium. This carbon product requires further treatment to give the final carbon powder, which even yet contains some 10% of ash as magnesium oxide.

Chapter V describes the measurement of the radioactivity of the carbon, by an apparatus using a modified Geiger counter, and includes considerable discussion of apparatus and operational details which might have effects on the answers. For measurement the carbon powder is made into a mush which is spread thinly and evenly on the inside of the measuring cylinder; the water is dried out with pumping to the micron range, and an atmosphere of poorly adsorbed ethylene and argon is introduced. The cylinder is now ready for measurement. in an apparatus in which it is surrounded by a screen-wall of plain Geiger counters to reduce the activity background. The actual measuring run-time is 48 hours, with further time for background determinations.

Chapter VI lists materials measured and dates assigned for work done prior to late 1951, a total of 218 different samples. The specimens are from all parts of the globe, and represent relics of "literate" and illiterate recent and early man, of plant life related to pre- and post-glacial periods, of logs buried in the sands of time, and ancient vegetation gone to sodden peat in arctic and temperate climes. The ages found vary from a juvenile 712 ± 200 to the ancient "at least 21,000" years. The whole list is a wonderful help and factual spiritual lift to the time-counting archeologist, geologist and palynologist, as Frederick Johnson makes clear in Chapter VII. These last fifteen pages serve to interrelate the radiocarbon datings with previous chronology, showing how many perplexities are resolved, even though some remain and a few new ones are created. Just as uranium-lead ratios showed that thus measurable geologic time began some 2,000,000,000 years ago, that the Cambrian period went back 850,000,000 years and the youngest rocks with measurable ratios are maybe 100,000,000 years old, so now we know that Folsom man made arrow points 10,000 years past, the Mankato glacial period dates only 11,000 instead of 25,000 years back, it is 6500 years since Mt. Mazama blew its crown to dust to give us bottomless Crater Lake, and some nameless aborigines trapped fish 5700 years ago on Boylston Street, Boston.

It is only a little book but good things often come in small packages, and this one is good reading for all sorts of ordinary non-nuclear chemists.

DEPARTMENT OF CHEMISTRY
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Chemistry and Methods of Enzymes. Third Edition. By JAMES B. SUMNER, Professor of Biochemistry, Cornell University, and G. FRED SOMERS, Chairman, Dept. of Agricultural Chemistry and Associate Director, Agricultural Experiment Station, University of Delaware. Academic Press, Inc., 125 East 23rd Street, New York 10, N. Y. 1953. xvi + 462 pp. 16.5 × 23.5 cm. Price, $7.50.

In this, the 3rd edition, out 5 years after the 2nd, the authors have added new and dropped old material keeping the size of the book fairly unchanged. Since Sumner crystallized the first enzyme, urease, in 1926, a large number of enzymes from animal and plant tissues, from bacteria and molds have been crystallized and all proved to be proteins. In fact, the authors turn the sentence around and state that probably most proteins are enzymes. Enzyme chemistry has become a part of protein chemistry, in which determination of specific activity provides a particularly sensitive method for determination of purity and native state of the protein. The methods of purification still depend largely on art, with few generally applicable rules. Throughout the book one finds observations and remarks testifying to the long laboratory experience of the authors. This gives the book its individuality; the treatment of the subject matter is practical rather than theoretical or conceptual.

Part 1 deals with general properties, parts 2–6 with the following classes of enzymes; hydrolytic, oxidizing, transferases, desmolases, unclassified. The classes are subdivided and finally individual enzymes are described, giving historical data, occurrence, role, specificity, preparation, measurement of activity, activators, inhibitors, etc. There is an extensive bibliography after each chapter.

The unsystematic nomenclature of enzymes is apparent, though recently discoverers of new enzymes have mostly used the suffix -ase, appending it however not always to the substrate. The old names, such as trypsin, pepsin, etc., have historical justification. Renaming of an enzyme when it is found in other tissues or private systems of nomenclature, such as the use of the letters of the alphabet, add to already existing confusion.

There are a number of omissions and errors and some misprints. A few may be pointed out. On page 322 it is stated that it is likely that phosphorylases other than sucrose phosphorylase are also *trans*-glucosidases. This has been put to the test by Cohn and Cori and negative evidence has been obtained. Myokinase (page 342) has been found in liver and other tissues, where it was originally overlooked. The determination of the specific activity of muscle phosphorylase is misquoted (page 325).

In justification of the last chapter dealing with the role of enzymes in carbohydrate metabolism it is stated that an attempt has been made to show how enzymes act together.

Sumner's terse, short-sentenced style is unmistakable and very readable.

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The Bile Pigments. By C. H. GRAY, M.D., D.Sc., M.R.C.P., F.R.I.C., Professor of Chemical Pathology in the University of London. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1953. xv + 142 pp. 11 × 17 cm. Price, $1.75.

The author has stated that his objective is "to provide a readable, useful and brief account of the bile pigments, particularly in relation to man." He has succeeded admirably. To the chemist the book will provide background material from physiology and medicine to orient the chemical work. To the medical student it will provide a background in the chemistry of the pigments which is relatively broad in scope.

Minor criticisms may be made of the text. The use of the term "urobilin" instead of "the urobilins" may cause some confusion to the unwary, although the detailed discussion will straighten the situation out if the reader is persistent. On p. 117 the author's phraseology indicates that there is a problem connected with the anomalous rotatory dispersion of the hydrochloride of stercobilin, although this is probably not the problem to which he wished to direct attention. Similarly, he seems to imply the formation of optically active stercobilin from inactive stercobilinogen by the usual chemical methods. Such criticisms seem relatively unimportant, however, in the face of the skillful and authoritative service of compression and critical discussion which the author has performed.

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Constantes Sélectionnées. Atlas des Longueurs d'onde caractéristiques des Bandes d'émission et d'absorption des Molécules Diatomiques. Edited by B. ROSEN, Institut d'Astrophysique de l'Université de Liège. Hermann and Cie, 6 Rue de la Sorbonne, Paris V^e^, France. 1952. 389 pp. 21 × 27 cm. Price, 5600 fr.

This atlas of spectra of diatomic molecules (part 5, "Tables of Constants and Numerical Data," published under the joint sponsorship of the International Union of Pure and Applied Chemistry and the International Union of Astronomy) forms a wave length index of 13000 band heads (or maxima) in the electronic spectra of 299 diatomic molecules. The atlas is intended to be used in conjunction with part 4 of the Tables (reviewed in THIS JOURNAL, **74**, 2950 (1952)), and contains corrections to part 4. New data accumulated between July, 1951, and the summer of 1952 are included.

The atlas is composed of four tables: Table I. A list of molecules which are considered in parts 4 and 5. Table II. Characteristic wave lengths. This table forms the body of the book and consists of 318 pages, begining at wave length 15050 Å. and going to 672 Å. Spectra of all molecules in part 4 are indexed by wave length in this way. Table II contains six columns: Column 1. Wave length in Å. direction of degradation; principal or characteristic bands in heavy type. Column 2. Formula of molecule whose wave length is given in Column 1. Column 3. Electronic transition (if known) to which the band belongs. Column 4. Vibrational quantum numbers concerned in the transition in column 3. Column 5. Wave lengths of other characteristic bands associated with the band in column 1. Column 6. References (usually to page number of part 4, which contains the bibliography). Table III. Separate wave length tables for some common diatomic molecules which occur frequently as impurities. While these wave lengths are duplicated in Table II, Table III is valuable for rapid identification of these molecules. Table IV. Table of the rotational lines of H_2 from 11222 to 854 Å., with identification of the transition.

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Inorganic Thermogravimetric Analysis. By CLEMENT DUVAL, with an Introduction by PIERRE CHEVENARD. Elsevier Publishing Co., Lovett Blvd., Houston, Texas. 1953. xv + 531 pp. 16 × 23.5 cm. Price, $11.00.

A preliminary section of the book comprising four chapters gives a review of the early development of thermobalances by Honda and associates of the Japanese group of investigators and by others. The Chevenard balance with filiar instead of knife edge suspension is described fully and its applications are outlined in general. The automatic features which have reached their fullest application at the hands of Duval and his colleagues are discussed in the concluding chapter of the section.

The second and principal part of the treatise has 62 chapters each dealing with a different element. An increasing order of atomic weights is the order of presentation. The various forms that have been proposed for the gravimetric determination of these elements have been studied and a total of 967 different forms are said to have been tested. The work as a whole gives a good orientation survey of the stability ranges of the various precipitates. There are some obvious errors that are apparently caused by failure to prepare the precipitates in a proper manner, and there are serious discrepancies between the stability ranges established by the earlier studies of the Japanese group and those found by the automatic procedures of Duval and his associates. It is well known that time–temperature curves may give misleading information as to salt hydrates and other thermal decompositions. For example, hydrates that seem to exist from studies on change in rate of weight loss cannot, in certain instances, be found in equilibrium studies.

Confirmatory observations are given that certain substances known to be capable of being dried only at room temperature in a vacuum desiccator are decomposed upon heating. The method appears to give a quick confirmation of many of the well-known general facts about heating precipitates and points out many cases where the analytical chemist has been too conservative. It is also revealed that certain substances such as cupferrates of iron or copper may be heated at proper temperature instead of the destructive ignition that has been practiced previously.

Interesting observations are given on the effect of heating on filtering devices and upon many other matters that have been too little studied in the past because of the tedious nature of the experimentation.

This book is a good type of research monograph because it will undoubtedly stimulate much future work. In addition to the work that is necessary to resolve controversial questions, the technique should be of service in various kinetic studies and in the quick testing of various inorganic materials that are used in synthetic work.

The typography of the book is good and the thermogravimetric graphs supplement the text with much detailed information that is useful. Some of the photographs that are given in the early chapters are less informative than adequate line drawings would be.

Author and reagent indices are given. The latter index has reagents that are useful in automatic thermogravimetric analysis marked with asterisks.

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N. H. Furman

Organic Crystals and Molecules. Theory of X-Ray Structure Analysis with Applications to Organic Chemistry. By J. Monteath Robertson, Gardiner Professor of Chemistry in the University of Glasgow. Cornell University Press, Ithaca, New York. 1953. xi + 340 pp. 16 × 23.5 cm. Price, $5.00.

Cornell University is to be congratulated on having appointed Professor Robertson as Baker Lecturer in Chemistry and on giving him the opportunity to present his lectures to a wider public in the book under review. Professor Robertson has contributed perhaps more than anyone else to the development of modern techniques for the precise determination of molecular configurations by X-ray analysis and in his lectures he summarizes his experience and his thoughts in this field.

Part I, comprising roughly half the book, starts with the historical development of classical crystallography and gives a very compact and readable account of this basic material. There then follows a development of the theory of X-ray analytical methods which is neat and up-to-date and thought provoking.

In Part II he illustrates the application of X-ray methods to "the analysis of some organic molecular structures." Professor Robertson apologizes for the fact that he pays most attention to examples taken from the work of his own laboratory. From the reviewer's point of view, this adds to rather than detracts from the importance of the book. It enables the author to present most clearly the development of the subject as he has helped to make it grow. His comments are, however, not confined to his own work and his discussions of the work of others are most illuminating. As might be expected by those who have read Professor Robertson's papers, the presentation is extremely clear and explicit. The reviewer enjoyed particularly the chapters on bond length measurements in ring hydrocarbons and on molecular arrangement and hydrogen-bonded structures.

Technically, the book is well produced and seems to contain extremely few misprints. The many line diagrams are very well drawn and are apt illustrations of the text. The half-tone illustrations seem to be rather poorly printed in the copies which the reviewer has seen.

This book should certainly be read by all working crystallographers and would serve as an excellent textbook for a course in the subject. It can also be recommended as worthwhile reading for any chemist who wishes to understand more about the applications of the methods of crystallography to the determination of the structure of organic molecules.

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A. L. Patterson

Crystal Structures. By Ralph W. G. Wyckoff, Laboratory of Physical Biology, National Institute of Arthritis and Metabolic Diseases, Bethesda, Maryland. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1953. Section III, 660 pp. 19.5 × 25 cm. Price, $14.50. Supplement II, 148 pp. 19.5 × 25 cm. Price, $4.00.

With the increasingly rapid accumulation of knowledge concerning the arrangements of atoms in crystals, it becomes more and more important to have available some reference work to which one may turn to find out whether the structure of a certain substance or class of substances has been determined, and, if so, what the significant conclusions are, where the details can be located, etc.

There are at present two (still incomplete) compilations attempting to fill this need. One is the "Strukturbericht," with its successor, "Structure Reports," now being issued annually under the auspices of the International Union of Crystallography. The other is the set of loose-leaf volumes, entitled, "Crystal Structures," being published under the authorship of Dr. Wyckoff. Both are extremely valuable. Both deal primarily with the results of crystal structure analysis, Wyckoff's work being strictly limited to this. The "Structure Reports" also include the results of electron diffraction studies on gas molecules and of X-ray diffraction studies of alloys; for many substances, they also give brief descriptions of the method of analysis, correlative optical data, etc.

Opinions differ with regard to the relative advantages of a set of annual volumes and a single loose-leaf compendium, periodically brought up-to-date by insertion of replacement and supplementary pages, also with regard to methods of arrangement and classification of the material. (See the review[1] of Wyckoff's Vol. II.) There is no one *best* solution to these problems and much can be said in favor of the system adopted by Dr. Wyckoff.

The present additions consist of supplementary pages to the previously issued chapter on "The Structures of Aliphatic Compounds," plus new chapters on "The Structure of Benzene Derivatives" and "The Crystal Structures of Alicyclic and Heterocyclic Compounds, and of Carbohydrates." These three chapters constitute an authoritative, practically complete description of published structure analysis results (by X-ray diffraction methods) on organic compounds. Data are included for about 1250 such substances, in many cases with excellent drawings, showing the arrangement of the atoms in the molecule and the arrangement of molecules in the crystal, with interatomic distances, interbond angles and the crystallographic parameters.

This monumental reference work is sure to prove of inestimable value to organic, physical, inorganic and biological chemists as a source of information on the structures of the chemical substances with which they deal. Considering the immense amount of careful, critical work involved in the collection, evaluation, classification and publication of the material, the price is very reasonable.

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(1) J. Donohue, This Journal, **74**, 5554 (1952).

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Maurice L. Huggins

Inorganic Chemistry. By E. de Barry Barnett, D.Sc. (Lond.), F.R.I.C., Formerly Head of the Chemistry Department, Sir John Cass Technical Institute, E. C. 3, and C. L. Wilson, M.Sc. (Q.U.B.), Ph.D. (Glas.), F.R.I.C., Reader in Analytical Chemistry, The Queen's University of Belfast. Longmans, Green and Co., 55 Fifth Avenue, New York 3, N. Y. 1953. xiv + 512 pp. 17 × 25.5 cm. Price, $7.00.

Like several of the more recent books intended to meet the need for texts intermediate between general chemistries and exhaustive treatises, the text under review begins with chapters devoted to theoretical aspects of the subject. The first of these chapters consists of an historical introduction dealing with the older atomic theory and the periodic law, the second deals briefly with the older (chemical) methods of determining atomic weights and even more briefly with modern (physical) methods. There follow chapters on radioactivity, on artificial atomic distintegration and on isotopes, their separation and their uses. The last chapter of the introductory portion of the book deals with the stereochemistry of covalent molecules, with elementary crystal structure and, very briefly, with the phenomenon of resonance, and is especially well done.

Although this portion of the text is highly condensed, it is clearly and interestingly written. Its excellence makes more surprising what seems to the reviewer the omission of subject matter fundamentally important to a thorough understanding of modern inorganic chemistry. Thus there is no discussion of modern interpretations of acid-base systems, no treatment of oxidation potentials, of electronegativity (in the Pauling sense) or of "magneto chemistry." Except for an occasional mention of coördination complexes in the descriptive part of the book, the discussion of this topic is limited to the few pages devoted to the stereochemistry of covalent compounds; the chemical reactions of complex compounds, the factors affecting their stability, and their uses are not described at all.

Systematic inorganic chemistry begins with a very brief discussion, supplemented in later chapters by details for specific cases, of general methods for the isolation of the metallic elements, and with a chapter on the inert gases and hydrogen. The discussion of these topics is quite satisfactory, even though there is no mention of the unusual behavior of helium at low temperatures nor of tritium or of atomic hydrogen. The next one hundred and sixty pages are devoted to the metallic elements and their simple, well known compounds, arranged according to the groups of the periodic system.

This portion of the text suffers most pronouncedly from the effects of the omissions already mentioned, and from a failure to apply to inorganic chemistry those theoretical concepts which are included in a general way in the introductory chapters. As a result,.the section devoted to the metallic elements takes on the character of an old-fashioned inorganic chemistry, in which the occurrence, the extraction or preparation and properties of the metals and of their most common compounds (*i.e.*, their oxides, hydroxides, carbonates, sulfates, halides, etc.) are presented in purely descriptive, monotonous fashion. Admittedly this monotony cannot be entirely avoided. But it seems to the reviewer that this difficulty could have been somewhat overcome by condensing much of the descriptive matter, *e.g.*, that dealing with physical properties, the formulas of hydrates, the colors of compounds, into tables. Such a procedure might have further relieved the monotony by leaving space for discussions of compounds in which the metals exhibit abnormal valencies, of hetero and isopoly acids, and of coördination complexes, especially those of the transition elements. Use of oxidation potentials would have coördinated subject matter presented piecemeal, and inclusion of such modern experimental procedures as chromatographic separation and liquid–liquid extraction (barely mentioned in the text) might have added variety and interest to the presentation.

It is, however, unjust to make these criticisms without calling attention to the preface in which the authors state that it is their intention "to provide a text-book suitable for students reading for a university degree or similar professional qualifications." They further state that "It is assumed that the reader has a knowledge of inorganic chemistry covered by the usual 'intermediate course'. . . . It has therefore been possible to omit much elementary matter. . . . A knowledge of physical chemistry, elementary but above the usual 'intermediate' standard, has also been assumed." The reviewer is not familiar with British requirements for degrees and the like, nor with the content of British intermediate courses. His criticisms may therefore be based on a misunderstanding of what is needed to meet the author's objectives. He nevertheless feels that, although the treatment of the metallic elements may prepare students to meet certain specific requirements, its almost completely descriptive character and its almost complete limitation to the commonly encountered, simple compounds will not arouse in the reader an interest in inorganic chemistry.

Far more satisfactory, in the reviewer's opinion, are the chapters on the non-metallic elements (including boron and silicon). This aspect of inorganic chemistry lends itself more readily to discussions of the steps involved in the reactions described, and the authors here have taken full advantage of the opportunity. In these chapters also the presentation is not limited to the most commonly encountered compounds of the elements in question, but covers the field as broadly as could be expected of anything other than a comprehensive treatise. The presentation could perhaps have been improved by discussing the behavior of some of the compounds as generalized acids or bases (in the G. N. Lewis sense) but that comment may be too greatly based on the reviewer's predilection. Since the interpretation of some of the more complex reactions is still unsettled, the almost complete lack of references to the original literature rather than to monographs, somewhat limits its usefulness for the student planning to pursue inorganic chemistry further.

The text is clearly and concisely written. It is remarkably free from typographical and other errors. It contains much descriptive material and should prove useful as a compact, convenient, reference work.

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BOOKS RECEIVED

October 10, 1953–November 10, 1953

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