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A Symposium on
THE USE OF ISOTOPES
in Biology and Medicine

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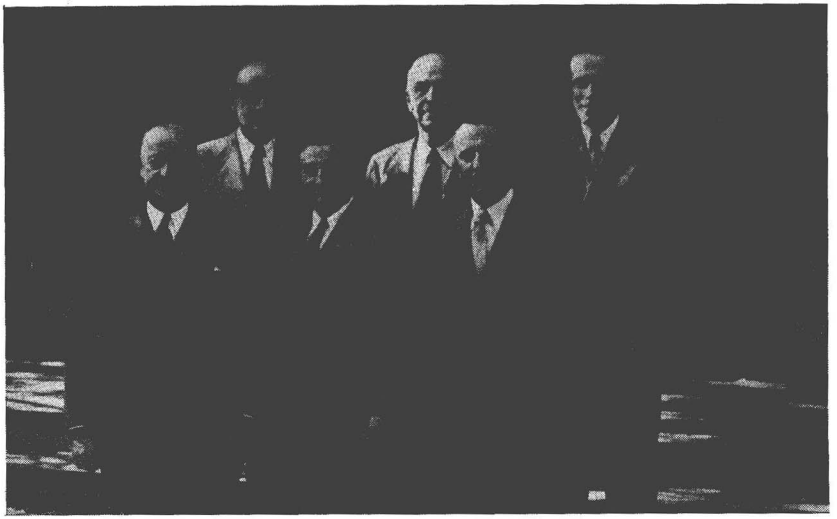
THE USE OF ISOTOPES IN BIOLOGY AND MEDICINE



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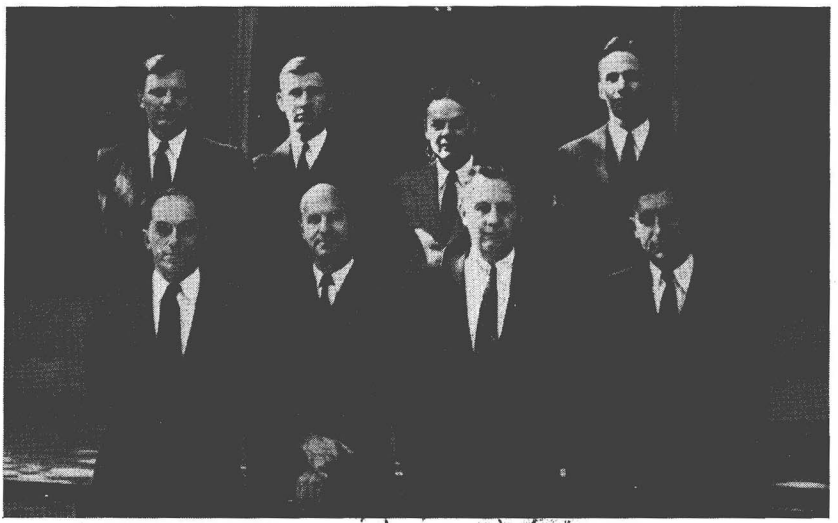

COMMITTEE ON ARRANGEMENTS

Front Row: Philip P. Cohen, Harold P. Rusch, Edgar S. Gordon, Robert H. Burris. Back Row: Harold F. Deutsch, E. C. Albright, Perry W. Wilson, John E. Willard

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Preface

It has been observed that man seems by nature incapable of launching any enterprise without an apology or an argument. Whether it be a new book or a revolution, it is accompanied, more often than not, by special pleading. A custom so time-honored as this should not, of course, be lightly disregarded, but surely the present volume would seem to be one that requires neither explanation nor defense. Ever since that December day five years ago when the nuclear chain reaction was started in the pile beneath the stands of a football field in Chicago, we have all been keenly aware that the world has changed. Whether we like it or not, we have, all of us, a stake in the developments and implications of atomic energy. The more ominous of these, symbolized by Hiroshima and Bikini, have been discussed at length in the press, over the radio, and from the lecture platform. The less spectacular, but more heartening, are primarily the interest of the specialist.

A desire to stimulate this interest among those qualified to contribute to future advances prompted the Wisconsin Alumni Research Foundation to support a conference at Madison during the week of September 10, 1947. At this meeting leading physicists, chemists, and biologists reviewed the developments in atomic physics that are especially applicable in the fields of biology and medicine. The major papers are published in this volume. Unfortunately it has been impossible to include also the stimulating group discussions that these lectures inspired throughout the conference——in corridors and lobby and on the terraces overlooking Lake Mendota.

The Committee on Arrangements thanks the Wisconsin Alumni Research Foundation for its generous support of the symposium and the Graduate School of the University, the conveners and chairmen, the participants, and others for their contributions to its success.

P. W. W.

THE COMMITTEE ON ARRANGEMENTS FOR THE SYMPOSIUM

Edgar S. Gordon, *Chairman*

E. C. Albright, *Accommodations*

Robert H. Burris, *Local Publicity*

Philip Cohen, *General Publicity*

Harold Deutsch, *Radio Publicity*

Harold Rusch, *Panel Discussions*

John E. Willard, *Exhibits*

Perry W. Wilson, *Publication*

Address of Welcome

WILLIAM A. MIDDLETON

University of Wisconsin

Ladies and gentleman, friends, in the absence of President Fred it is my privilege and pleasure to welcome you to this Symposium on the Use of Isotopes in Biology and Medicine. This intellectual feast has been provided by a grant from the Wisconsin Alumni Research Foundation. The wide range of subjects on the program, together with their manifold scientific implications, is an adequate brief for the desirability of such a presentation. Your full delectation of this repast will be ample reward for your host, the University of Wisconsin, and for the Committee that has labored so faithfully and effectively in its preparation.

Your presence bespeaks a serious interest in the remarkable developments in the area of atomic energy. The very word *atom* has been shorn of its connotation of indivisibility. Nuclear fission is *fait accompli*. Even the lay imagination has been captured by this revolutionary discovery. More important is its impact upon scientific thought and endeavor. Throughout the civilized world research workers are applying this new tool to a host of problems in biology and medicine, among related and diversified subjects. Beyond a peradventure, time and the judgment of history will relegate the application of this newly discovered force in the violence of warfare to a position of subsidiary importance as compared with its contribution to the sum of human knowledge. By this same token the Symposium in Madison may become more significant than the extravaganza at Bikini.

Two groups of our lineal forbears are watching this newer growth with particular interest and absorption. The first of these curious-minded students of nature sought the philosopher's stone. By its virtue the baser metals were presumed to be transmuted to gold. Precious stones might be derived

from ordinary rock. Medically this thesis envisioned "potable gold" (*aurum potabile*) as the elixir of life. This panacea promised the cure of all diseases and the indefinite extension of life. So flagrant were its excesses that the Church issued two famous bulls (1317 and 1326) forbidding the practice of alchemy. Certainly Roger Bacon, Paracelsus, John Dee, Leonhard Thurnheysser zum Thurn (the original "gold bricker" who plated tin with gold), the Rosicrucians, and a host of fellow alchemists are viewing the wonders of the modern transmutation of metals with envious eyes.

Our more acceptable forefathers (scientifically speaking) are gathered about Robert Boyle in the Invisible College convening at Gresham College, as was their wont before the foundation of the Royal Society (1660). To their meetings were submitted all questions that excited the intellectual curiosity of these natural philosophers. Of this remarkable number Robert Hooke, warped of mind and crooked of body, is notable as secretary and gadgeteer extraordinary. He devised Boyle's air-pump, with which certain fundamental experiments on respiration were performed. Through him international scientific correspondence was maintained on an extended, if tardy, plane. One of the participants in this interchange was Anton van Leeuwenhoek. With his own hands this self-trained scientist ground the lenses for more than 247 simple microscopes. His contribution opened the broad vista of microscopy to innumerable seekers for the truth. The tradition of intellectual curiosity took root in the United States through the foundation of the American Philosophical Society (1743). The most eminent of American natural scientists, Joseph Leidy, thrived in its atmosphere. In a day before narrow specialization his interests ranged from parasitology to paleontology. His authoritative work on *Fresh Water Rhizopods of North America* was completed with a fifty-dollar microscope at the cost of two hundred and twenty-two dollars to the Geological Society. If science requires a further lesson in humility, the brilliant contributions of the Curies laboring in the shed of the School of Physics in Rue Lhomond, Paris, should suffice. From the Elysium of departed scientists all these kindred spirits will be listening to our deliberations with rapt attention.

The scientific horizon has been extended. New techniques require new and complicated apparatus. Much of this material is expensive and invites the monetary participation of private and governmental agencies. Science is a jealous mistress. You cannot buy brains and ideas. You may merely implement them. In the subsidy of research the munificent benefactors should be spiritual partners as well as material contributors. The modern urge to capitalize upon research by practical returns has tempered the zest for abstract fundamental study for truth itself. In taking our youth to the "Delectable Mountains" let us not forsake the guides Knowledge, Experience, Watchful and Sincere.

In this season of our scientific triumph let us also reflect upon our responsibilities. The United States Atomic Energy Commission has demonstrated commendable insight and vision in rendering isotopes available for scientific research not only in this country but also in the world at large. John Hay won everlasting distinction as a statesman by his attitude toward China after the Boxer Rebellion (1900). The Fulbright Bill is heartening evidence that the "open door policy" still applies in education and science. By its provisions the United States of America gives notice of its material support of Pasteur's philosophy, "Science has no country."

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THE USE OF ISOTOPES IN BIOLOGY AND MEDICINE

Addresses Delivered at an Institute Held at the University of Wisconsin from September 10 to September 13, 1947

Isotopes in Biochemistry: Historical Background

HANS T. CLARKE

Columbia University

The use of isotopes as tracers in biological systems is now approaching its twenty-fifth anniversary. In 1923 George Hevesy published an article (1) entitled "The Absorption and Translocation of Lead by Plants: A Contribution to the Application of the Method of Radioactive Indicators in the Investigation of the Change of Substances in Plants." At that time the only radioactive elements available were those of natural occurrence; Hevesy's experiments were carried out with thorium B (Pb^{212}; half-life 10.6 hours), the nitrate of this isotopic lead being suitably diluted with the nitrate of ordinary lead (the principal constituent of which is the stable isotope of mass 208). The roots of bean plants were placed in solutions of the lead nitrate thus labeled and the uptake of lead by various portions of the organism was estimated by radioactivity determinations on the ash. By far the highest concentration of lead was found in the root, which in twenty-four hours took up more than half the lead from 200 cc. of a $N/10^6$ solution of lead nitrate. Under the same conditions the root absorbed two hundred times as much lead from a N/10 solution. Hevesy further showed that the assimilated lead was readily displaced by exposure to a fresh solution of lead nitrate, from which he concluded that the element did not combine with carbon in the plant but remained in ionizable form.

This pioneer experiment established the pattern for the type of research discussed in this Symposium, but further developments had to await the availability of isotopes of elements more closely related to general biochemistry. The first of these was deuterium, discovered in 1932 by Urey and his colleagues, who soon developed practical methods for the production of highly concentrated heavy water.

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