SCIENCE

Phosphorus Metabolism

Only now, a full twenty years since the discovery of the energy-rich phosphate bond, has the key role of phosphorus in metabolism become widely appreciated among biologists. Ten years ago, in already classic reviews, Lipmann and Kalckar stretched the nature of the phosphate cycle and the widespread generation and utilization of energy-rich phosphate bonds in organisms. However, award of the Nobel prize (1947) to C. F. and Gerty Cori for their work on the role of phosphorus in the reversible transformation of glucose to glycogen was required to quicken and extend the general interest of biologists. The subject even begins to appear in new college textbooks of general biology, although by no means in all.

Landmarks along the way began with the discovery of hexose phosphorylation (Harden and Young, 1905). Then came creatine phosphate (Fiske and Subbarow, 1929) and the work of Lohmann and Meyerhof on phosphate energy in muscle contraction (1934), the calculation that *all* the energy from the utilization of sugar goes into the energy-rich phosphate bond (Lundsgaard, 1931), and the isolation of three phosphorus-containing coenzyme systems—adenosine triphosphate (ATP), diphosphopyridine nucleotide (DPN), and diphosphothiamine. These coenzymes, especially, revealed the crucial role played by phosphorus in the transfer and release of energy through phosphorylation, oxidation-reduction, and decarboxylation. The symbols ATP and DPN are fast becoming as widely known as the symbols of chemical elements or genes.

It is particularly appropriate that this anniversary of discovery has been celebrated by a symposium on the metabolic functions of the phosphate esters. The gathering was attended by many of the leaders in the developments of the past two decades. There were about 120 participants, with The McCollum-Pratt Institute of The Johns Hopkins University, Baltimore, as host. The dates: June 18–21.

The subject is so vast that discussion was limited to the functions of phosphate in carbohydrate and protein metabolism. (The remainder will be considered in a second symposium.) The program was organized in an original and singularly effective way. Each session had as moderator a notable pioneer or leader in the field: the Coris, Green, Gunsalus, Heppel, Johnson, Lipmann, Najjar, Neuberg, Ochoa, Racker. Each major topic was first comprehensively reviewed and then followed by short reports of current work by selected participants. General discussion, led by the moderator, ensued. It is impossible to summarize the proceedings in brief space. Suffice it to say that the topic of carbohydrate metabolism, including new alternate pathways, was reviewed by Hassid, Horecker, and Leloir. The latter came from Argentina to report on newly discovered coenzymes, in particular uridine-diphosphoglucose (UDPG). The metabolism of 2-carbon compounds, especially "active acetate" (acetyl-CoA), was reviewed by Barker; and Hunter and Lehninger discussed oxidative phosphorylation and electron transport. The P-containing coenzymes, particularly the structure and function of coenzyme A, received much attention (Kornberg and others). Schmidt provided a greatly needed review of the metabolism of pyrophosphates, metaphosphates, and polyphosphates. The influence of ions on phosphorylation (Lardy) and the thermodynamics of phosphate bonds (Oesper) were examined. Finally, a most interesting session dealt with the utilization of phosphate-bond energy in organisms. Muscular contraction (Mommaerts), electrical activity (Nachmansohn), bioluminescence (McElroy), peptide bond synthesis (Cohen), urea formation (Ratner), and carbon-dioxide fixation (Utter) were considered and afforded glimpses of expanding frontiers.

Like last year's symposium on Copper Metabolism, which was published by Johns Hopkins University Press, this one will appear in book form. A separate summary will be issued shortly.

Bentley Glass

Department of Biology
The Johns Hopkins University

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

All correspondence should be sent to SCIENCE, 1515 Massachusetts Ave., N.W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.

Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates on request.