

Book Reviews

An Anniversary in Biochemistry

Current Aspects of Biochemical Energetics. Fritz Lipmann Dedicatory Volume. NATHAN O. KAPLAN and EUGENE P. KENNEDY, Eds. Academic Press, New York, 1966. 500 pp., illus. \$16.50.

This volume is dedicated to Fritz Lipmann and the "squiggle ($\sim$) P." Twenty-five years ago Lipmann published, in volume 1 of *Advances in Enzymology*, the remarkable paper "Metabolic Generation and Utilization of Phosphate Bond Energy," which laid the theoretical groundwork for all future development in the bioenergetics of life processes. With unusual simplicity Lipmann described how the "metabolic dynamo generates $\sim$ P-current. This is brushed off by the adenylic acid, which likewise functions as the wiring system, distributing the current. Creatine $\sim$ P, when present, serves as P-accumulator." The data presented were not new: adenosine triphosphate (ATP) had been known for almost 15 years, and the concept of coupling exergonic reactions with endergonic processes had been clearly stated by Kluver. What Lipmann did was to clarify the chemical nature and mechanism of generation of $\sim$ P and to demonstrate that the chemical coupling agent in cellular energy transformation was, indeed, the pyrophosphate bond energy of ATP. Lipmann predicted that $\sim$ P would prove to be essential for amino acid incorporation into protein. The nature of this initial reaction was suggested by studies concerned with fatty acid metabolism conducted in Lipmann's laboratory. Since then the same mechanism has been implicated for the activation of long-chain fatty acids, pantoic acid, benzoic acid, biotin, lipotic acid, and firefly luciferin.

The role of ATP in biosynthetic reactions is now well established, but the basic principles were there in the 1941 article. The function of ATP for chemical work, growth, motility and contraction, electrical activity, and, eventually, in the translation of the genetic code took on new meaning.

The present volume is an impressive assemblage of 34 contributions covering many aspects of the topics mentioned above and more. Many of the contributors have been closely associated with Lipmann or have been greatly influenced by his ideas. Kalckar, who also published an excellent review on phosphate bond energy in 1941 (*Chemical Reviews*), gives a brief, historical, and highly amusing presentation which sets the tone for the volume. It is not possible to mention all of the important contributions. By name they range from Kennedy and Kaplan (the editors) to Chantrenne, Stadtman, and Wald. A. Szent-Györgyi, Peters, Barker, Cori give the impression of the wide influence of Lipmann's concepts. Novelli, Hoagland, Engelhardt, Kiselev, Hotchkiss, and Gregory discuss the views now current regarding $\sim$ P, the code, and protein synthesis. There are others, but the two articles that impressed me most are the ones contributed by Van Niel and Krebs.

When Van Niel writes a "historical appreciation" he doesn't exactly start with the microorganisms from the Fig Tree Series over three billion years ago [E. S. Barghoorn and J. W. Schopf, *Science* **152**, 758 (1966)], but he comes close to it. From 1897 to 1967 one finds numerous contributions which help us understand Pasteur's statement that "fermentation is a correlative of yeast growth" and "the consequences of life in the absence of air." Van Niel leads us through these interesting developments, including the important contributions of Max Rubner and Kluver to the concepts of energetic coupling. The developments between 1930 and 1939 are presented in a logical sequence and give the background necessary to appreciate Lipmann's synthetic efforts. The preservation of bond energy and its utilization for mechanical and chemical work showed that there was a clear and logical relationship between metabolic activities and cell function. As Van Niel points out, "the accumulation of an impressive body of information . . . eloquently testifies to

the fundamental significance of Lipmann's concept of the metabolic generation and preservation of bond energy."

Krebs takes this occasion to discuss the "importance of theoretical concepts in biology and biochemistry today." His is an important article for the experimental scientists who often look askance at theorizing. In fact, many who review articles for some of our best-known journals insist that "only the facts" should be presented, discussions being limited to pointing out how these facts agree or disagree with "facts" presented by other authors. Krebs emphasizes the importance of trying to "derive unifying ideas, in terms of models and axioms, from the vast factual biochemical knowledge which is now accumulating." To those who object I suggest that they read Appendix 1 of Krebs's article concerning H. Kolbe's comments on Van't Hoff's theory of the tetrahedral structure of the carbon atom: "It is typical of the present times—uncritical and even anti-critical . . . that a virtually unknown chemist from a Veterinary College arrogates to himself making pronouncements on one of the ultimate problems in chemistry . . . which may never be solved and to supply a solution to this problem with a sureness and audacity, nay impudence, which can but amaze the genuine scientist." The present volume is clear testimony that Lipmann's article did not bring from the scientific community the same response that was evoked by Van't Hoff's contribution.

In the late 1930's and early in 1940 there were very few biochemistry departments in the United States that really were aware of the significant advances being made in phosphorus metabolism. Furthermore the knowledgeable ones were, for the most part, located in medical schools and had little impact on biology as a whole. Beadle and Tatum's "one gene—one enzyme" concept and Lipmann's article on phosphate bond energy altered all of this. Biologists soon became aware that powerful tools were being forged that would allow a precise analysis of some of the more fundamental processes associated with life.

Lipmann's contributions to all of these developments are summarized in part by the authors of the various papers in the volume. It is recommended reading for all students interested in the life sciences.

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