History of Biochemistry

Development of Biochemical Concepts from Ancient to Modern Times. HENRY M. LEICESTER. Harvard University Press, Cambridge, Mass., 1974. viii, 286 pp. $15. Harvard Monographs in the History of Science.

One consequence of the emergence of biochemistry (which includes what some prefer to call molecular biology) as a mature scientific discipline, as judged by the adherence of its practitioners to a set of concepts that guide their research and by its favored status in the competition for financial and institutional support, is the growing interest among historians of science in its past development. In this valuable book, Leicester, who has made important contributions to the historiography of chemistry (especially through two source books published in 1952 and 1968), has traced the history of attempts to explain biological processes in terms of material substances.

The text is divided into 20 relatively short chapters, the first seven of which (to p. 80) discuss the period before Paracelsus; according to Leicester, "with Paracelsus the modern science of biochemistry may be considered to have begun." In these early pages there are sketches of the biological and medical ideas of various classical and medieval writers, including Ko Hung and Hildegard of Bingen. The next four chapters (pp. 81–137) bring the story to the beginning of the 19th century, from Paracelsus to Lavoisier, via van Helmont, Sylvius, Stahl, Boerhaave, and Haller (among others). The final nine chapters (approximately 100 pages) trace the development of biochemistry during the 19th and 20th centuries until the 1930's. There is a lengthy list of references (up to about 1970) and indexes of proper names and subjects. It must be noted with regret that the number of misprints in this book seems excessively large.

Leicester clearly set himself the difficult task of compressing into a modest space a story whose complexities increase as it unfolds, especially after 1800. He has, I think, been more successful for the period before Lavoisier than for the subsequent development. I venture to note, however, that as in other accounts of the life-matter problem (for example, in Thomas S. Hall's outstanding *Ideas of Life and Matter* published in 1969), there is no reference to the influence of the skeptical philosophy of Pyrrho, as recorded by Sextus Empiricus, with its emphasis on suspension of speculation in studying natural phenomena (see Jean-Paul Dumont, *Le Scepticisme et le Phénomène*, Paris, 1972). If one accepts Leicester's definition of a biochemical concept as "any hypothesis of bodily function which involves specific substances," the question arises whether hypotheses involving such entities as spirit, phlegm, oil, salt, and earth qualify as biochemical concepts. Is there no historical difference between a hypothetical entity and a specific material substance? After all, as he notes on p. 127, when 18th-century physiologists "needed to fit some material substance into their general theory, they simply assumed that it must exist and have the desired properties." In contrasting this attitude to that of chemists, "who isolate and characterize the specific compounds they find in mixtures and then try to find a mechanism for their function in terms of the properties of the substances which have been found," Leicester appears to have oversimplified a more complicated interplay, in which empirical discovery derived from the practical arts, as well as Pyrrhonian skepticism, seems to have played a considerable historical role.

The latter part of the book, in which Leicester summarizes the development of biochemical concepts during the 19th and early 20th centuries, is regrettably brief. There are clear accounts of the discussion of several important problems, such as the nature of enzymes or the site of biological oxidations in the animal body, but the attempt to describe the complex development of concepts of intermediary metabolism in 11 pages, some of which are devoted to the history of protein chemistry, is less satisfactory. Notably, the concept of the colloidal state of living matter, so popular among biologists around 1900, is not treated adequately. Although the concepts of vitamins and hormones are rightly given separate chapters and it is stated that some of the B vitamins "were found as parts of various coenzyme molecules," the importance of this discovery is not discussed in relation to the emergence of new concepts of biological oxidations during the 1930's. Similarly, the story of the formulation of the Embden-Meyerhof scheme and its relation to the development of ideas about bioenergetics omits mention of the decisive experiments before World War II (especially those of Otto Warburg) on the coupling of oxidation to phosphorylation. The need for compression has led to occasional apparent contradictions, as on p. 211 where it is stated that "once the nitrogen [of amino acids] had been split off, no intermediates were known" but we are told two lines later that Garrod "had shown that in certain rare cases of 'inborn errors of metabolism' some intermediates in the oxidation of a few amino acids are excreted." The book concludes with a brief glimpse of the dramatic post-World War II recognition of the biological role of nucleic acids.

Leicester's book is to be welcomed as a useful brief introduction to the history of biochemistry. It may be hoped that readers will be stimulated by the excellent set of references to enlarge their view of the subject.

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The Pineal Gland

Pineal Chemistry. In Cellular and Physiological Mechanisms. W. B. QUAY. Thomas, Springfield, Ill., 1974. xvi, 430 pp., illus. $24.75. American Lecture Series, No. 894.

This book is probably the first to deal in a comprehensive way with the morphological, physiological, and biochemical aspects of the pineal gland. It presents a concise, thorough, and well-organized summary of the present state of pinealogy.

In the 17th century René Descartes proposed that the pineal organ housed the rational soul. Since then, this small and mysterious organ has attracted the attention of a large number of scientists of different disciplines. During the last two decades the number of publications on the pineal gland has increased almost exponentially, but, despite numerous experiments and speculations, its true function is yet to be elucidated. Quay's research has contributed a great deal toward clarifying the possible function of the pineal gland and melatonin, its putative hormone, and he is most qualified to be the author of such a comprehensive and up-to-date volume on this subject.

The book starts out with introductory chapters on development and anatomy. Then follow 11 chapters dealing with inorganic constituents, lipids, carbohydrates, amino acids, indoleamines, catecholamines, nucleotides and nucleic acids, enzymes, mitochondria and oxidative metabolism, soluble proteins and peptides, and miscellaneous other compounds and pigments. Each chapter has a brief summary, and the whole is summarized in a final chapter.

As a result of having been written by a single author—no longer a common practice in our scientific community—the book is not only well balanced but also enjoyable reading. It will be a guide to many investigators in this field and also an interesting reference book for general scientists. It deserves a warm recommendation.

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A Principle of Physics

The Discovery of the Conservation of Energy. YEHUDA ELKANA. Harvard University Press, Cambridge, Mass., 1974. x, 214 pp. $8.50.

The principle of the conservation of energy was a surprisingly late addition to the principles of classical mechanics. Elkana argues that neither the conservation principle nor the concept of energy itself was firmly fixed until 1847, when Helmholtz gave them precise meaning in his paper "Über die Erhaltung der Kraft." Until then the concept of energy was in a "state of flux," and one cannot talk unambiguously about "discoverers" of the conservation law. Furthermore this state of flux is characteristic of the creative stage of conceptualization in science. Once a concept is fixed by careful definition and mathematical formulation, it becomes a part of working science, and no longer serves the same creative function as before. A concept in a "state of flux" is valuable precisely because of its indefiniteness. The principle of the conservation of energy resulted from a general metaphysical presupposition that *something* in the physical world must be conserved through all physical changes. The long history of the principle was an attempt to determine precisely what that "something" might be.

The problem as Elkana poses it is an interesting one, but his own presentation is often confusing. In his introduction he outlines a sequence of historical events which he believes must also be the *logical* sequence of discovery. He follows the historical sequence with another list of factors that "constituted a solid basis for the enunciation of the conservation principle." Since this list is quite different from the "historical" or "logical" list, the reader is left to wonder how he should weld the two together.

The list of factors that constitute the basis of the conservation principle appears somewhat suspicious. It consists of the following four items: (i) an a priori belief in general conservation principles in nature, (ii) a realization that the Newtonian and Lagrangian formulations of mechanics must be correlated not only mathematically but also conceptually, (iii) a belief that the organic "forces" of animal heat and vital forces are reducible to the laws of inanimate nature, and (iv) the certainty that whatever is conserved in nature must be expressible in mathematical terms. If these are taken to be the necessary conditions for the discovery of the principle of the conservation of energy, then the author has preselected Helmholtz as the discoverer, for Helmholtz was the man with precisely these interests, attitudes, and skills. As might be expected, the author attempts to demonstrate the relative unimportance of two other factors that Thomas Kuhn emphasized in his paper "Energy conservation as simultaneous discovery" (*Critical Problems in the History of Science*, M. Clagett, Ed., University of Wisconsin Press, 1969, pp. 321–356), that is, the "availability of new conversion processes in the 19th century" and a "concern with engines."

After the statement of the problem, the book continues with chapters on mechanics, thermodynamics, and physiology, a chapter analyzing Helmholtz's paper, and chapters on the institutional setting and the philosophical background. Each of these chapters points toward Helmholtz as the man who finally succeeded in demonstrating the principle of the conservation of energy in its greatest generality. One curious problem appears in the chapter analyzing Helmholtz's paper. The author shows quite conclusively that Helmholtz did not distinguish between "force" and "energy" as we now understand those concepts. Sometimes *Kraft* meant one thing, sometimes another, and Helmholtz did not realize that there was any ambiguity in his use of the word. We are asked to believe that this was necessary as long as he was still struggling to analyze the concept. But if, as the author asserts, the concept of energy as we know it today emerges from that paper, one would expect Helmholtz to have resolved the ambiguity. We can still ask the question: "When were the concept of energy and the conservation principle firmly fixed?"

In addition to the ambiguity and confusion in the presentation of the argument, the book suffers from a large number of errors that seem to be the result of carelessness. In the chapter on mechanics, Lagrange's equations of motion are stated incorrectly. There follows a derivation of the equations taken from Dugas's *History of Mechanics*. The derivation contains at least eight errors. These errors may be from Dugas (I have only the French edition, which gives the derivation correctly), but they remain a puzzle for the reader to unscramble. The chapter also contains a long quotation from Cavendish in which a crucial diagram is missing, so that it is impossible to follow Cavendish's argument. In the chapter on heat and energy, the basic laws of thermodynamics are taken from a modern text, but they are not quoted correctly, and the reader will struggle to give some significance to the expression $dW = -dW$, where dW is the work done by an adiabatic system. The notes present further difficulties. Some quotations have no citation at all, and when a citation is provided, as often as not there is no page reference.

There is some useful information in this book about the history of the concept of energy and the principle of its conservation, but one must be prepared to work through a great deal of confusion in order to find it.

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Fluorocarbons

Fluorine in Organic Chemistry. R. D. CHAMBERS. Wiley-Interscience, New York, 1973. xviii, 392 pp., illus. $19.50. Interscience Monographs on Organic Chemistry.

Fluorine is a unique element, and highly fluorinated organic compounds are usually considered to belong to a separate field that has little relation to normal organic chemistry. Most earlier texts and reviews in this field have concentrated on collecting data illustrating the novel properties and chemistry of fluorocarbons. A major achievement of