Book Reviews

Biology as the Reformulation of Old Questions

Ideas of Life and Matter. Studies in the History of General Physiology, 600 B.C.–1900 A.D. THOMAS S. HALL. Vol. 1, From Pre-Socratic Times to the Enlightenment. xii + 420 pp. Vol. 2, From the Enlightenment to the End of the Nineteenth Century. viii + 400 pp. University of Chicago Press, Chicago, 1969. $20.

Many general histories of biology have been written either as case studies of particular conceptions or as compendious, semiencyclopedic summaries of the principal biologists and all their key contributions to the development of the science. Authors of the first sort of history have frequently been sensitive to the changing meaning of scientific terms and to the influence of contemporary philosophical assumptions in these meaning shifts. Authors of the second sort, to make their way through the vast expanse of total history, have often built their narratives out of "whiggish" evaluations of biology's past heroes, and have thus assessed the work of prior biologists against current standards of scientific validity. In his *Ideas of Life and Matter* Thomas S. Hall has written a large, general book that borrows from each tradition within the history of biology but that attempts to transcend both.

Hall's book is a vast, two-volume work of approximately 800 pages and several hundred footnotes. It treats the contributions of more than 80 major biologists, relates some biographical data concerning each, recounts past theories, and often, though usually fairly subtly, comments on the correctness or incorrectness of ideas once propounded. Yet despite its size, scope, and format, *Ideas of Life and Matter* is, in largest part, more an extended essay on one set of closely related problems than an encyclopedic review of past biology. That set of problems, Hall explains in the introduction to volume 1 and the conclusion to volume 2, is what he tries to capture in his title. Hall claims that "the central problem of biology is summed up in the questions What is life? and What is it about certain things . . . that makes life possible in them?" This claim means, as Hall develops his theme more fully, that ever since the 6th century B.C. general physiology has been concerned with and, indeed, grew out of the attempted solution to this central pair of problems. The continuing need to solve this pair of problems is, Hall argues, a patent fact of our Western intellectual history, and it is also apparent that in attempting to solve these problems biologists have consistently tried to get at the larger questions by asking several related but smaller ones, for example, about the motion, nutrition, and generation of organisms. In proceeding this way biologists have followed an "interpretive strategy" inherited from the Greeks. Whether in the 4th century B.C., in A.D. 1680, or in the middle of the 19th century, biologists have, in one way or another, thought about the two central questions of living things, broken them down into smaller "classic questions," and, whether they realized it or not, tried to supply answers to these questions, large and small, by employing specific intellectual techniques also first developed in Greek antiquity. These interpretive techniques include such things as thinking of organisms in terms of certain recurrent analogies (for example flames and crystals), explaining the sensible phenomena in terms of inferred "cryptomena," and exploiting as they arise new cosmological, physical, and chemical ideas for the repeated renovation of biological theory. By using these analytical techniques, biologists have time and again come back to the two central, plaguing questions of their science with new solutions that always reflect in some way the times in which they were formulated. The dialectic between continuing questions and ever-new solutions (found, however, by employing old interpretive techniques in changing scientific circumstances) accounts, Hall suggests, for the historical unfolding of biology and its general theory of the organism.

The two volumes bracketed by the introductory and concluding essays flesh out Hall's thematic skeleton with abundant illustrative material. They also contain frequent reminders of the author's central concerns. Volume 1 begins with a detailed discussion of The Problem in Antiquity. Here, after a compressed but illuminating essay on the several possible formulations of the life-matter relationship, Hall surveys the biological theories of thinkers ranging from Thales and Heraclitus through Plato and Aristotle to Lucretius and Galen. The accounts are well integrated with larger themes and generally satisfying. The next major section of volume 1, Toward a New Biology, treats the life-matter problem and its derivatives in the 16th and early 17th century. Hall's emphasis is rightly divided between the continuation but renovation of ancient interpretive traditions by Paracelsus, Fernel, Harvey, and van Helmont and the radical break with tradition launched by Descartes's "microbiomechanics." A section on Life and Air continues the discussion through the 17th century and specifically illustrates the impact of Cartesianism. Many biotheorists (the term is Hall's) of the later 17th century picked up the ancient analogy of life to fire, but now, under the Cartesian mechanistic influence, they tried in various ways to conceptualize the heat essential to life in corpuscular terms. The principal representatives of this phase of the life-matter problem are, in Hall's treatment, Boyle, Hooke, Willis, Mayow, Lower, and Borelli. A relatively brief section on Animism and Mechanicism rounds out volume 1 with chapters on the theories of Stahl, Boerhaave, and Haller, three of the major biomedical writers (again the term is Hall's) of the earlier 18th century.

Volume 2 opens with an impressive discussion of Mechanicism and Vitalism, 1750–1800. Here Hall surveys the

theories of vital activity and material organization maintained by, among others, Buffon, La Mettrie, Bordeu, Blumenbach, and Hunter. The highlight of this section is the illuminating account of late 18th century vitalism that runs through several of the chapters. A long section devoted to Tissue, Cell, and Molecule follows. This part of the second volume is one of the most successful of Hall's book. He here blends incisive remarks about vitalistic explanations in general physiology with useful reviews of his central themes. Apt summaries of 19th-century views on protoplasm as a unique vital substance and cells as special vital units are also included, taking on heightened significance when interspersed with Hall's reminders of recurring classic questions and interpretive strategies. The work of Dujardin, Schwann, von Mohl, Schultze, and Huxley receives real illumination. Finally, Hall concludes his second volume with a discussion of The Physical Basis of Life, 1860–1900. The ideas of Haeckel, Nägeli, and Weismann directly relating to the life-matter problem are of principal interest here.

As should be obvious from the foregoing summary, *Ideas of Life and Matter* is a major contribution to the history of biology. It is organized around large, interesting, and important themes, and it is filled out with ample supporting evidence presented in a scholarly manner. One develops the sense when reading this book that Hall has both a clear vision of what the history of biology should be about and erudition to match his vision. And yet Hall's two volumes add up to something less than the perfect book, for *Ideas of Life and Matter* is marred by two disquieting faults. First, it is simply too vast. Hall's erudition occasionally gets in his way, sometimes hindering rather than helping the development of his central thesis. To make his points most effectively, one feels in retrospect, Hall would have done better to limit his illustrative material to certain episodes while substantially ignoring or very succinctly summarizing others. The sections on the Pro-Socratics, Descartes, the 18th-century vitalists, and the mid-19th-century microscopists struggling with cells, sarcode, and protoplasm would have been perfectly appropriate and not at all tedious elaborations of the ideas sketched in the introductory and concluding essays. These sections, by and large, read better than the others, and this probably results from the fact that the life-matter problem was obviously and insistently central to these writers whereas it was not necessarily so to others. By adding large amounts of additional material on other authors or periods Hall greatly inflates his study, at times almost bringing it unwittingly close to the encyclopedic summary he wishes to avoid. The second fault with *Ideas of Life and Matter* is closely related to the first: it is repetitive. Hall all too frequently reviews his main interpretive ideas in the body of his text, now and then managing to exasperate rather than further enlighten his reader. Indeed, the problem is sometimes acute, because Hall seems to be most repetitive exactly where his text is most swollen with extraneous or near-extraneous matter. Why, for example, do we need to know about Epicurus's views on atomic indeterminacy (volume 1, pp. 133–134), Hooke's mechanical inventions (volume 1, p. 296), or Priestley's contributions to phlogiston theory (volume 2, pp. 150–53)? It is exactly at these and similar points that one sometimes finds it hard to resist the thought that Hall returns to still another review of his central themes just when his narrative has actually wandered from them. Essays of 800 pages are not necessarily twice as good as those of 400.

Despite its imperfections, *Ideas of Life and Matter* is a good, solid, and extremely valuable book. Its basic themes, however often repeated, deserve to be thought over by biologists and historians of science for a good while. For should not biologists wonder whether they are not still caught in the net of ancient questions and analytical techniques, and ought not historians ponder whether biology, as Hall sometimes straightforwardly insists, really grew directly out of grapplings with the life-matter problem? Hall's ideas on these subjects are important, and his enthusiasm for their continuing consideration or, if need be, perfection is infectious. The book itself will quite probably become a standard textbook or work of reference on the history of biology, and it ought to be respected as such even if it was not exactly so intended.

In short, like his previous *Source Book in Animal Biology*, Hall's *Ideas of Life and Matter* can and should be turned to with confidence, interest, and admiration.

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Biological Radiation

Luminescence of Biopolymers and Cells. GRIGORII M. BARENBOIM, ALEKSANDR N. DOMANSKII, and KONSTANTIN K. TUROVEROV. Translated from the Russian edition (Leningrad, 1966). F. Chen, Transl. Ed. Plenum, New York, 1969. viii + 232 pp., illus. $12.50.

This book should be useful to anyone taking up or already somewhat experienced in the theoretical or practical study of luminescence in biological systems. Despite its modest length, and the by no means exhaustive treatment, the major aspects of the subject are clearly presented. Moreover, the book is reasonably well up to date. A statement that "the original Russian text . . . has been thoroughly revised by the authors for the present edition" notwithstanding, the bibliography contains only one reference to literature other than Russian later than 1966, the year the original text was published. Even so, one of the impressive features of the book, and certainly one of the most useful, is its coverage of the large amount of research, with a resulting multitude of technical publications, many of which have not been readily available in the West, that has taken place in this field in Russia during the past few years.

An introduction of 17 pages undertakes, with considerable success, to provide "a summary of the fundamentals of molecular luminescence," including brief reference to the energies of molecules, transitions between molecular energy levels, fluorescence, anti-Stokes fluorescence, "Vavilov's law" (constant quantum yield of fluorescence over broad ranges of wavelengths), the "Shpol'skii effect," the effects of the solvent on electronic spectra of molecules, polarized fluorescence, optical transitions between singlet and triplet states, the transfer of electronic excitation energy or sensitized luminescence, and luminescence quenching.

The introduction is followed by six chapters, the first four of which deal with "Photoluminescence of aromatic amino acids, synthetic polypeptides, proteins, and cells," "Luminescence of purines, pyrimidines, and nucleic acids," "Radioluminescence of biopolymers and their components," and "Chemiluminescence of cells and organisms." The last two chapters, which deal exclusively with methods and instrumentation, constitute a valuable source of information and ideas for detecting and