

Development of bioenergetics

A. R. Crofts

A New Look at Mechanisms in Bioenergetics. By E. Racker. Pp. xiv+197. (Academic: New York, San Francisco and London, 1976.) \$9.50; £5.80.

PROFESSOR RACKER has ranged widely in his experience of research in bioenergetics, and this small book chronicles his activities in the field over the past ten years or so. The book takes the form of, and is based on, a series of lectures to students; it is aimed at the undergraduate or early post-graduate level rather than at established research workers. The chapters are prefaced by some admirably chosen quotations, and the text is interspersed with homilies and cautionary tales. The subject matter covered includes substrate level and electron transport-linked phosphorylation, ATP-driven ion pumps, resolution and reconstitution of the different complexes of enzymes which catalyse these activities, and details of the enzymology of these complexes.

Racker has played a major role in catalysing an acceptance of the chemiosmotic view of the mechanism of catalysing an acceptance of the chemiosmotic view of the mechanism of coupling between electron transport and phosphorylation. The book describes fully the very nice work carried out by Kagawa, Hinkle, Kandrach, Ragan and many other colleagues in collaboration with Racker, on the reconstitution of oxidative phosphorylation in liposome vesicles, using the purified enzyme complexes of the mitochondrial apparatus. This work had a strong biochemical appeal, which won over many of those in the field (and there were many) who had blanched at the large body of biophysical evidence previously available, that supported a similar view. The demonstrations that the mitochondrial ATPase, cytochrome oxidase and NADH₂ dehydrogenase could separately act as proton pumps when incorporated into liposome vesicles, and that when the ATPase was incorporated together with any of the electron transport complexes, the electron transport could drive phosphorylation, provided a powerful support for the argument for a chemiosmotic mechanism.

Most dramatic of all, however, was the demonstration, in work with Stoeckenius, that the purple membrane protein of *Halobacter* could be similarly reconstituted as a light-driven

proton pump, and that inclusion of the ATPase in the vesicles led to a preparation capable of photophosphorylation. In this case, a clear distinction was evident between the requirement for a device for pumping protons, and an electron transport system. The former was necessary, but not the latter, so that the obligatory coupling between electron transport and phosphorylation predicted by chemical and conformational hypotheses for the mechanism of coupling could be excluded. It is perhaps a minor criticism of this book that the controversy over the mechanism of coupling is framed in such a way as to highlight these biochemical contributions. This is only human; the book cannot be recommended as a completely balanced view of the development of the subject, but, rather, as a personal view.

The other criticism I have to make relates to the "lessons" which crop up here and there, especially at the beginning of the book. These are asides, included perhaps to entertain the reader, and for the most part they are sensible and amusing. Some of them, however, strike me as ham-fisted. For example, Racker is being both cynical and unjust

when he teaches with reference to Mitchell's preliminary paper on chemiosmotic coupling: "If you propose a brilliant, new hypothesis and avoid being specific, you probably will be ignored. If you want attention be sure to include a few features that are not essential for the main theme, but open to attack". Several other of the lessons also read like tips to a trainee con-man rather than distillations of wit and wisdom. The quotation above reflects more Racker's own late conversion to Mitchell's point of view than the considerable impact of this early paper; Racker (to his credit) draws attention to this tardiness of his in the preface.

These criticisms are, however, trivial, and I would not wish to discourage anyone from reading this book. It provides a lively and fresh insight into the subject, avoids obscurity and mystification, and provides a more than usually straightforward account of the development of an area of research, mistakes and all, in one of the most influential laboratories in the field. □

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Molecules in solution

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Biological Macromolecules and Polyelectrolytes in Solution. By Henryk Eisenberg. Pp. xviii+269. (Clarendon: Oxford; Oxford University: London, 1976.) £16.

Few developments in physical biochemistry over the past two decades have had greater impact than that initiated by Casassa and Eisenberg in the years 1960-64. In a notable series of papers, a theory was described which dramatically simplified the measurement of molecular weight in ternary systems. This was most timely: it coincided with a surge of interest in charged polymers and with the recognition of the subunit structure of many proteins, where measurements were often necessarily made in high concentrations of urea, etc. Such systems were now shown to be amenable to analysis by pseudo-ideal equations, with the twin provisos that the solutions were at dialysis equilibrium and, most characteristically, that the multiplying coefficients (for example, a specific density increment) were defined at constant chemical potentials of the permeating components. In this

way, all the effects of interaction (no matter how great) disappeared with the introduction of the appropriate coefficient.

The theory was very soon accepted, but, by the majority, perhaps, more on trust than by conviction, for the mathematics were undeniably tedious. The appearance of a volume by Professor Eisenberg devoted to a comprehensive account of macromolecules in solution is therefore an important occasion. The author has taken full advantage of the opportunities presented to him: a useful summary of the chief structural features of proteins and nucleic acids is followed directly by chapters on the fundamental thermodynamics of ternary solutions. Here the Casassa-Eisenberg concept is developed from first principles: this section contains a clear exposition of the meaning of the preferential interaction parameter, which should be read carefully by anyone tempted to refer loosely to 'solvation' or 'salt-binding'. The notation has been considerably simplified, and accordingly the essential concepts can now be grasped much more readily.

In the chapter devoted to partial volumes, density and refraction increments, the significance of the restriction of constant chemical potential is fully explained: a simple sketch brings home forcibly the meaning of each step. Here also we find the essential conclusions concerning the magnitude of the interaction coefficients: the practical demonstration that these do not