Cellular energy metabolism and its regulation

by D. E. Atkinson
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Professor Atkinson is widely acknowledged in the biochemical world as an exponent of provocative ideas. He is perhaps most widely known for his introduction of the adenylate energy charge concept as a more realistic means of assessing the energy balance in cells than the use of the ATP/ADP ratio. However, his contributions extend well beyond that to include for example consideration of cellular solvent capacity and its implication for cellular organisation and analysis of the kinetic behaviour of regulatory enzymes. Professor Atkinson makes it clear that his style is unchanged. Thus '. . .it may be well to warn timid and consensus-seeking readers that they may wish to stop here: some of the ideas proposed in this book have not received the imprimatur of universal acceptance'. And 'Majority opinion has not historically been an infallible guide to validity in science. . .'. To these sentiments, one can only say 'right on' – we should all be more willing to challenge current dogmas in the interest of ascertaining how secure are the foundations of such ideas, and with the risk that we may in the end have to accept that the dogma is indeed well-founded.

Under the general heading of regulation of cellular energy metabolism, this book covers most of the areas to which Professor Atkinson has contributed and, in doing so, draws on and in several areas expands his previous review articles on these topics. The result is an approach to the topic which one might characterise as physiological enzymology, i.e., consideration of the properties of enzymes as related to the cellular environment in which they function, which is all too rare. As we feel our way towards understanding of detailed cellular organisation it is becoming increasingly apparent that radical re-thinking is required in the way we relate data obtained on isolated enzymes in dilute solution to observations made on systems in which physiological organisation is more or less intact. Thus, as is pointed out here, it will be necessary to take account of metabolite binding in these systems in which for many metabolites the enzyme concentration may be in the same range or even exceed that of its substrates and effectors. Indeed, as Professor Atkinson points out, the whole question of substrate (or enzyme) concentration may take on quite a different meaning if the cellular system is as highly organised as some workers believe it to be.

Professor Atkinson also devotes a whole chapter to discussion of the role of the adenylate system in metabolic coupling and provides a clear chemically-based analysis and explanation of these concepts. In an appendix, he discusses at length the much-maligned and misused characterisation of ATP, ADP and related species as 'high energy' compounds, and also takes up the Banks/Vernon thesis that since the chemical potential of ATP remains constant the molecule cannot serve as a universal source of cellular energy. Whether followers of this latter view will be satisfied by the analysis presented is uncertain, but at least Professor Atkinson attempts to demonstrate the areas in which he feels this challenge to current dogma is itself invalid.

This is then a fascinating book which should be read by all students of metabolism and metabolic regulation, and in particular by final year undergraduates and post-graduates. It is essential to realise that much of the material is controversial. In many areas one feels Professor Atkinson would expect to find contrary views, for it is clear that he intends his analysis as one man's view of the role of the adenylate system in metabolism and metabolic control, rather than as the final work on the subject. I hope the book will be made widely available and will be widely read.

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