Book Review

# *Bioenergetics 2* by David G. Nicholls and Stuart J. Ferguson

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Reviewed by Peter L. Pedersen, Johns Hopkins University Medical School

In the ten years since the publication of the first edition of *Bioenergetics*, the focus of research in the bioenergetic field has changed dramatically. General acceptance of the principles of Mitchell's chemiosmotic theory coupled with the advances in molecular biological and biophysical techniques have allowed researchers to move ahead, and to make advances in understanding the structure and function of the bioenergetic protein machinery. David Nicholls and Stuart Ferguson have recognized the changes in the field and, with *Bioenergetics 2*, have focused on the current structure/function advances while maintaining a clear explanation of the basic bioenergetic principles and the chemiosmotic theory. The nine chapters of *Bioenergetics 2* can be divided essentially into two parts, with the first four chapters dealing with the chemiosmotic theory, and the later chapters with the structural and functional aspects of the proteins of the respiratory chain and the F-type ATPases.

The first four chapters provide a clear and concise description of the chemiosmotic theory. This description is both qualitative and quantitative, giving plenty of simple examples to help the reader to understand better the discussion. Mitochondrial, bacterial, and chloroplast systems are included in the discussion. The actions of different types of uncouplers, as well as the methods used to measure the proton motive force and its components are clearly described. The many examples and figures help to further the reader's understanding of the proton motive force and the relative contributions of $\Delta\Psi$ and $\Delta$pH. This qualitative discussion is reinforced with mathematical proof, but is not so heavy on the equations as to lose the less mathematically inclined reader. The basic principles of thermodynamics as they apply to the chemiosmotic theory have been introduced in a clear manner, while avoiding lengthy mathematical derivations. The authors have also done an excellent job of pointing out the postulates and assumptions of the theory and then walking the reader through the experimental evidence and data that back up these assumptions. At the end of chapter 4, several controversial issues are discussed, including various controversies relating to the proton pump mechanism, the proton circuit, alkaliphilic bacteria, and stoichiometries (P/O ratios, etc.).

The second half of the book is perhaps where it makes its mark, going a step beyond previous works in the bioenergetic field, by discussing the current views and understandings of the structural and molecular aspects of the bioenergetic proteins. Chapter 5 deals with the respiratory chain, providing a closer look at complexes I–IV. Here the authors describe the redox carriers and polypeptide chains that hold them, and introduce the current views as to how passage of electrons down the chain leads to proton pumping. The oxidases and reductases of various bacteria are also discussed.

It is in the discussion of the photosynthetic reaction center and bacteriorhodopsin (chapter 6) where structure and function truly come together. Beautiful color photos of the x-ray structure of the photosynthetic reaction center and bacteriorhodopsin allow the authors to bring together both the spectroscopic and biochemical data along with the structural data to provide the reader with a clear understanding of how these proteins might function. This chapter helps the reader to open up the "black box" of electron transport, and get a sense of how proton pumping may be accomplished on a molecular level.

Chapter 7 discusses the $F_0F_1$ ATP synthase. The discussion is clear, but somewhat concise. Insight is provided into the gross structure of the ATPase, as well as a brief discussion of the nucleotide binding sites. The mechanism of ATP hydrolysis is also discussed, along with one current view of coupling of proton movement with ATP synthesis. This chapter is perhaps the weakest in the book, not quite giving the detail of structure/function relationships that can be found in the current literature. Finally, chapters 8 and 9 deal with other important mitochondrial and bacterial transporters, as well as with several other transporters. These chapters help to point the reader toward a better understanding of how bioenergetic principles relate to other membrane systems not involved in ATP synthesis, such as ion distribution across vacuolar and plasma membranes, and how the chemiosmotic theory can be applied throughout nature.

This book will be useful as a text for both undergraduate and graduate courses in bioenergetics as well as a supplement to regular biochemistry texts. Perhaps one of the most important aspects of the book is its references to current reviews, providing the reader with a starting place in the literature for further information. *Bioenergetics 2* provides an excellent introduction to the principles and current research in the field of bioenergetics and, therefore, is highly recommended for anyone, from student to professor, entering the field.