BOOKS: PHYSIOLOGY

How Molecules Make Organisms Work

Pat Willmer

Many comparative physiologists who keep a bibliographic database find that the "Ho…" and "So…" sections are among the longest, reflecting the huge impact that Peter Hochachka and George Somero have had on the field over the last 30 years. Whole-organism physiology is to some the linchpin of biology, the hub into which cell and developmental biology feed and from which behavior and ecology radiate. But, perhaps more than anyone else, these authors have made us focus our efforts and analyses "downward" in our attempts to understand what is going on. In the two previous versions of *Biochemical Adaptation*, readers were led down, primarily to the cell and the enzyme. I should confess that as a graduate student, the first version (*1*) influenced me to become an environmental physiologist rather than the more cellular person I had anticipated evolving into; somehow, knowing about enzymes didn't quite do it for me. Nearly two decades have elapsed since the previous edition (*2*), and Hochachka and Somero now present a real tour de force. Because of the revolution in technological analyses, they can take us deeper, toward the molecule and the controlling gene. They are able to inject such enthusiasm that these depths are genuinely intriguing; at the same time, they integrate our understanding back upward to the actual organism coping with its changing environmental settings.

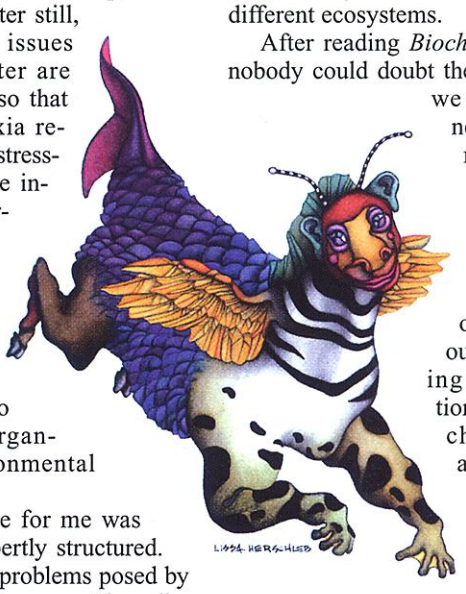
Whatever your current expertise and focus, this book should succeed in taking you through a comparative analysis of the most vital physiological processes. It is also likely to cheer you up. Students and scientists with backgrounds in fields other than physiology will benefit especially from the short summaries that pepper each section. Research physiologists and biochemists will often find the details eye-opening, bringing to mind new approaches to their problems or new applications for their techniques. And though it is admittedly alarming to be shown how far the field has come recently (all the key references seem to post-date 1995), the book reveals so many fresh possibilities that it manages not to be off-putting. The result is a masterpiece: exciting, invigorating, and challenging.

Biochemical Adaptation
Mechanism and Process in Physiological Evolution
by Peter W. Hochachka and George N. Somero
Oxford University Press, New York, 2002. 478 pp. $80, £62.50. ISBN 0-19-511702-6. Paper, $40, £29.50. ISBN 0-19-511703-4.

The short introductory chapter, in itself exemplary, should become required reading for biology students. It is as good a summary of modern thinking on dissecting adaptation and exploring comparative issues to detect underlying unity as I have seen. Read it if you need to be persuaded why anyone should bother to understand biochemical and physiological adaptation. On first glance, the rest of the book seems rather curiously composed, with four of the six subject-related chapters concentrating on metabolism and issues relating to oxygen supply (a major focus of Hochachka's research). Fortunately, the remaining two chapters, which discuss water relations and thermal relations, occupy more than half the book. Better still, the links between the issues covered in each chapter are beautifully drawn out, so that we can see how hypoxia responses link to osmotic stresses and how water-solute interactions influence thermal biology. Thus the balance of topics is in practice pretty good, and the authors achieve their stated aim of providing an integrative approach to understanding how organisms cope with environmental stresses.

A particular pleasure for me was that each chapter is expertly structured. The authors explain the problems posed by various environmental stressors. They dissect each into its key components (not just its implications for cell stability, but for membranes, channel proteins, cytoskeletal macromolecules, and nucleic acids as well). And they identify the features that a regulatory system requires to adapt to the stressor. The authors then select and integrate literature on archaeans, bacteria, plants, and animals to present the available information on how such regulation is achieved. For some systems, we know enough to see similarities across all these kingdoms; for others, there are inevitable discontinuities in available data—with studies on *Escherichia coli* and on the mammalian kidney, but not much in between. But even for these less-studied cases, Hochachka and Somero lay the groundwork of principles and possibilities so well that they can propose an underlying pattern. Their theme of revealing both the unity and diversity of cellular adaptation systems admirably survives the gaps in our knowledge.

Every chapter has its highlights. The chapter on cellular metabolism includes, almost as an aside, a thoughtful debunking of recent fractal explanations of the relation between body size and metabolic rate (the allometric 0.75 "rule"). The three chapters concerned with oxygen supply reveal how common molecular tricks can explain hypoxic adaptations of mud-dwelling worms, of high-flying geese, of deep-diving mammals, and of Himalayan sherpas. The account of water-solute adaptations shows us convergent evolution of the use of similar osmolytes across all kingdoms of living organisms and neatly explains why this should be so. The chapter on temperature makes the leap from protein thermosensitivity to predicting the effects of global warming on species in different ecosystems.



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After reading *Biochemical Adaptation*, nobody could doubt the huge added value we are getting from new analytical techniques in biology such as genomic chips, novel imaging systems, and remote microsensors. The level of sophistication of our answers is changing beyond recognition, but so too is the character of those answers. Hochachka and Somero offer not only descriptions of how organisms work, but the dazzling prospect of at least beginning to answer the tantalizing questions of why they work just that way and no other. We should hope that our Ho… and So… bibliographies continue to grow for another ten years and, in due course, lead to a fourth edition of this excellent book.

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References
1. P. W. Hochachka, G. N. Somero, *Strategies of Biochemical Adaptation* (Saunders, Philadelphia, PA, 1973).
2. _____, *Biochemical Adaptation* (Princeton Univ. Press, Princeton, NJ, 1984).