BOOKS: MOLECULAR BIOLOGY

Information Isn't Everything

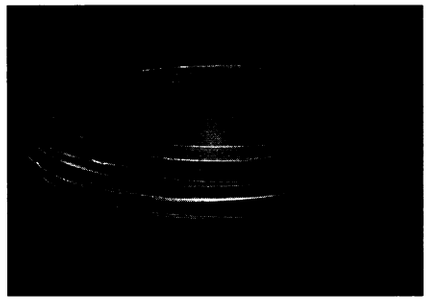
Louis J. DeFelice

Over 30 years ago, the research of Werner Loewenstein and his colleagues on cell junctions opened the field of intercellular communication. Since then, Loewenstein has contributed much to our understanding of biological information transfer. His new book, *The Touchstone of Life*, is in many ways highly original; it is also often disappointing. In it, he argues that "information flow, not energy per se, is the prime mover of life."

The Touchstone of Life Molecular Information, Cell Communication, and the Foundations of Life
by Werner R. Loewenstein
Oxford University Press, New York, 1999. 384 pp. $30. ISBN 0-19-511828-6.

The first section of the book leads us from the secular terrain of information theory to the mystical gates of the Garden of Eden. Loewenstein thus begins with no less a topic than the origin of life. He approaches this resoundingly biological theme from the standpoint of theoretical physics and then ties it to information with the ubiquitous entropy. Stepping back to look, literally and figuratively, at the big picture, Loewenstein considers the cosmic origin of information and the consolidation of information in physical objects on Earth. Sub-headings such as "The New Alchemy" and "The Proteus Stuff" will intrigue the erudite reader. Maxwell's demons, illusory creatures who can sort energy, are constant companions on this empyrean walk. They enter into virtually every argument and set the margins for Loewenstein's organizational fabric of biological molecules.

In Part Two, our expedition tramps to the interior of cells; we are still on the trail of information but now tracking errors in DNA molecules. Quantum chemistry, Loewenstein asserts, is no match for the grand design of the biological code, the "spooling of the golden thread" that can weave information into nets as well as yard goods. Readers familiar with Richard Powers's allegory, *The Gold Bug Variations*, will recognize themes in Loewenstein's metaphor of "the mountain and Mahomet," which the author uses to decorate the theory of how proteins read the genetic code.



"The Circus. Flowing in from the cosmos, information loops back onto itself to produce the circular information complex we call Life."

CREDIT: FIGURE 6.4/*THE TOUCHSTONE OF LIFE*

Fully halfway into the book, we arrive at the dominion where Loewenstein is monarch: "Information Flow Between Cells." But the topic of intercellular communication, easily Loewenstein's strong point, is unfortunately shrouded in obscurity. We begin to tire of similes and folk tales, and we yearn for more solid ground to stand upon. Cell membranes and cell-to-cell channels are topics that Loewenstein is rightfully identified with, yet the reader is stupefied by a plethora of demons and a profusion of analogies. Confusion is the likely result of the mislabeled "syncretic communication," which in Loewenstein's context refers to the union of like, not unlike, entities. I cannot think that "cellcosm" is a word worth coining, or that "Parlez vous Cellulaise?" is a subtitle that achieves the author's purpose. As a further frustration, Loewenstein is not only capable of but quite masterful at explaining science to the general reader; his skill is exemplified by the straightforward discussion under the upright title, "What is Cancer?"

Part Four is, happily, brief. We read that Epicurus was probably right in his pronouncement that all philosophy takes its origins from wondering. I wonder why Loewenstein falls into clichés about Occam's razor after so much hard work, or why Darwin barely appears in this summary—or, indeed, in the entire text. Is the machinery of Darwinism not the topic we are pondering? Such neglect is commonplace, as in Murray Gell-Man's pretentious book *The Quark and the Jaguar*. When physicists discourse on biological themes they may be forgiven for disregarding prominent theories of evolution, but when Loewenstein makes this blunder it is puzzling.

Loewenstein's book is not the place to learn physics, any more than Gell-Mann's book is the place to learn biology. Not that biology and physics are inexorably separate, only that neither author succeeds in the hoped-for synthesis, and neither tells us much about their actual topic, Darwinism. For possible mechanisms of Darwinian evolution, readers should look instead to the scholarly works of Ernst Mayr, such as his brilliant and comprehensive *Toward a New Philosophy of Biology*.

In fairness it should be said that this review is more about style than content, for *The Touchstone of Life* contains myriad facts, unexpected relations, and remarkable insights, albeit hidden in arcane embellishment. At the beginning of his tome Loewenstein touchingly acknowledges his colleagues and friends for what is by any measure a successful scientific and personal life. That was my favorite section of the book.

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BOOKS: BIOCHEMISTRY

Free Radicals in the 20th Century

Ian A. Cotgreave and Sten Orrenius

As a new millennium of scientific endeavor rapidly approaches, we are beginning to develop a more holistic vision of biochemical and genetic events in biological systems. This challenges us in terms of technical requirements for research, the interpretation of data, and predictions of the way forward. These quandaries are particularly apparent to researchers studying redox reactions and oxidative stress in biological systems.

Reactive Oxygen Species in Biological Systems
An Interdisciplinary Approach
Daniel L. Gilbert and Carol A. Colton, Eds.
Kluwer/Plenum, New York, 1999. 733 pp. $165, £97.50. ISBN 0-306-45756-3.

Interest in this area is growing extremely rapidly. A cursory perusal of Medline found 177 citations containing the words "reactive oxygen species" or "oxidative stress" over the interval 1976 to 1984. For 1991 through

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1995, the corresponding figure increased to 3972; 5756 citations have appeared from 1996 to the present. Reactive oxygen species, which include free radicals, peroxides, singlet oxygen, ozone, and nitrogen monoxide and dioxide free radicals, are the focus of much current research. Given these developments, a volume dealing with these topics, particularly from a multidisciplinary approach, is timely. The plethora of work in the field, however, places great expectations on the new volume edited by Daniel Gilbert and Carol Colton, *Reactive Oxygen Species in Biological Systems*.

Any treatise of this kind should fulfill three criteria: (i) Contributors should present up-to-date factual material that accurately reflects present areas of interest, to directly assist efforts in both research and teaching. (ii) The underlying philosophy of the volume should be evident in the organization of the material, to readily convey the "larger picture" in an holistic manner. (iii) The contents should captivate the reader's interest and provide a sense that "something new" has arrived.

The chapters are well stocked with relevant facts and figures. For instance, a chapter dealing with steady state concentrations of reactive oxygen species in mitochondria presents accessible tables of data that are highly useful for both pedagogic and research purposes. Additionally, the references throughout the book cover work up to and including 1997, an acceptable cutoff in view of the breadth of coverage.

Although interdisciplinary in approach, the volume is somewhat less successful at presenting an integrated view of the field. It follows established approaches in contents and organization. Individual contributions generally follow the principle of biological complementarity, increasing in complexity from the molecular level to the level of the intact organism.

The volume's introductory section includes a thorough treatise on the biological chemistry of reactive oxygen species, which is essential material for any text on this subject. The next section discusses necessary biochemical and molecular features of the generation of reactive oxygen species in biological systems. Among the topics covered are the biochemistry of cellular antioxidants, the consequences of reactive oxygen metabolites, and the generation of oxidative stress. For this last topic, the focus is on signal transduction and the regulation of gene expression. There is some overlap and unnecessary duplication of coverage of these topics among the various chapters, an indication of a lack of integration within the book.

Reactive nitrogen species are not formally covered by the book's title, although they are of considerable current interest. A good deal of effort is expended on describing their chemistry and the biochemistry of their production. Another interesting and rather unusual component of the book is the section on environmental pro- and antioxidants. The chapters specifically refer to inhaled oxidants, such as ozone, and to dietary antioxidants. They clearly illustrate the need for an interdisciplinary approach—one that combines information from a variety of disciplines including chemistry, biochemistry, clinical science, and epidemiology—to understanding the effects of exogenous oxidants and antioxidants on human physiology. The section on intracellular pro- and antioxidants appears somewhat disjointed; it might have been better to integrate this material into previous sections dealing with their basic biochemistry. Additionally, endogenous antioxidants have recently been covered more extensively elsewhere (*1*).

Dangerous radical. The discoverers of dephlogisticated air, Priestly (the target of this political caricature) and Scheele, and of oxidation, Lavoisier, were also the first to report oxygen toxicity.

The production of reactive oxygen and nitrogen species in various cell types is more than adequately covered in the volume's penultimate section, which includes unusual chapters on the role of reactive oxidants in plant cell metabolism and in mammalian fertilization. Two chapters emphasize neuronal aspects of the generation of reactive oxygen metabolites and the reactive species' effects on nerve cell function. The final section uses selected, mainly neurological, conditions to detail the role of oxidative stress in a variety of pathophysiological states and aging, topics covered in most volumes on the field. It includes an interesting chapter on the role of protein oxidation in cellular and tissue aging. This is a long-studied area of biochemistry that is currently finding increased application in research on a variety of fundamental disease processes.

The authors certainly use a fresh approach by opening the volume with a delightful historical appraisal of the field of redox reactions in biological systems. Gilbert's account points out the major landmarks in our understanding, from the findings of Boyle, Priestly, and Scheele. This unusual and eye-catching departure from other texts will be very useful in teaching. The editors' concluding overview of reactive oxygen species will also be useful, although it is largely a recapitulation of the major issues raised in the book rather than a synthesis.

The book does not provide sufficient coverage of several extremely relevant topics. Little attention is paid to analytical approaches for the assay of highly reactive species, methodologies of fundamental interest to most researchers in this field. In this area, considerable efforts will be required to develop sensitive, non-invasive techniques for studying reactive species in intact biological systems. In the area of biochemistry, an appraisal of the means by which reactive species modify protein structure and function could have more effectively illustrated the links between alterations of intracellular redox states and the regulation of integrated physiological processes. Other important topics that, unfortunately, are largely avoided include the role of oxidants and oxidative stress in cell cycle regulation, mitogenesis, and apoptosis.

Reactive Oxygen Species in Biological Systems: An Interdisciplinary Approach provides a relatively up to date, factual account of most current areas of research. Thus it will clearly provide a useful tool for teaching and research. The volume's contents and organization, however, are largely similar to those of other books in the field, and fall short of integrating the chemical, biochemical, biological, and pathobiological topics into an innovative, holistic vision.

References

1. H. Sies, Ed. *Antioxidants in Disease Mechanisms and Therapy* (Academic Press, San Diego, CA, 1997); L. Packer and E. Cadenas, Eds. *Handbook of Synthetic Antioxidants* (Dekker, New York, 1997).