Iron in Biological Systems

The Biological Chemistry of Iron. A Look at the Metabolism of Iron and Its Subsequent Uses in Living Organisms. Proceedings of an institute, Edmonton, Canada, Aug. 1981. H. Brian Dunford, David Dolphin, Kenneth N. Raymond, and Larry Sieker, Eds. Reidel, Boston, 1982 (distributor, Kluwer Boston, Hingham, Mass.). xiv, 518 pp., illus. $59.50. NATO Advanced Study Institutes Series C, vol. 89.

This proceedings volume combines useful background information with a coherent selection of current topics in the biochemistry of iron. The organizers limited the coverage to manageable proportions by focusing on a few subjects of special activity and interest. They excluded hemoglobin and myoglobin in favor of lesser-known systems. An interdisciplinary approach to biological structure and function is emphasized throughout. The biological evidence is compared with studies of synthetic models, various spectroscopic tools are utilized, new x-ray crystallographic data are presented, and even a quantum chemical calculation is included.

In a delightful keynote lecture, "Iron: an element well-fitted for its task?," Hill presents the general theme and frame of reference for the institute. Two more introductory papers further elaborate on the physicochemical background. Iron uptake, storage, and transport are discussed next. A fascinating chemistry and physiology have evolved to meet the needs of all organisms for a store of soluble iron in a hostile environment of low iron solubility. Six papers are devoted to these topics, in particular to the storage protein ferritin found in most forms of life, to the vertebrate transport protein transferrin, and to the microbial siderophores. After a brief digression on nuclear magnetic resonance data of *c*-type cytochromes, specifically the four-heme cytochrome c_3, some recent results are presented on the chemistry and crystal structure of hemerythrin, whose non-heme, binuclear spin-coupled iron complex reversibly binds dioxygen. A very informative section on iron-sulfur proteins follows, which brings the reader up to date on 3Fe-3S proteins, hydrogenases, and nitrogenases. The enormous complexity of the last two systems still defies definition, but exciting discoveries are reported on subgroups and smaller iron-sulfur proteins. Heme model studies are discussed next, beginning with an illustration of the subtle relation between structure and magnetic properties of ferric hemes and ending with a detailed survey of hydroporphyrin chemistry.

The last and largest section of the proceedings deals with heme enzymes, specifically peroxidase, cytochrome P450, catalase, and cytochrome *c* oxidase. As the name indicates, these enzymes contain the heme just mentioned as a prosthetic group in their active center. Moreover, they utilize O_2 and H_2O_2 as a substrate to perform various functions. The comparison of the different enzymes is very illuminating, for it shows the role of the protein in the control of the reactivity. Progress is evident on many fronts. A remarkable structural model of catalase is described, details of the heme environment are pinpointed by NMR, resonance Raman, and ENDOR data, and analogies in reaction mechanisms between cytochrome P450 and peroxidases are explored. What look like pieces of a puzzle at first sight become meaningful in the larger context of the book, and slowly but steadily a coherent picture emerges. To provide this overview in a volume crammed with the latest facts is a significant achievement.

Peter G. Debrunner
Department of Physics,
University of Illinois,
Urbana 61801

Beringia as a Habitat

Paleoecology of Beringia. David M. Hopkins, John V. Matthews, Jr., Charles E. Schweger, and Steven B. Young, Eds. Academic Press, New York, 1982. xiv, 490 pp., illus. $37.

The Bering Strait, separating northeastern Asia from northwestern North America, is not only very narrow but also very shallow. A dry land bridge would link the two continents if sea level fell only 46 meters. In fact, it often fell far more during Pleistocene glacials, when water was withdrawn from the world ocean by the great continental ice sheets. During the "Last Glacial" maximum, only 18,000 years ago, sea level fell at least 120 meters, and the "land bridge" was a vast plain, extending 1000 kilometers from north to south. This now submerged plain and the adjacent parts of Asia and North America are known to specialists as Beringia.

It was almost certainly through Beringia that people first moved from the Old World to the New, and the nature and timing of the event have long fascinated archeologists. But ancient Beringia is interesting for other reasons as well, including the "productivity paradox" that is the central focus of this book. The essence of this paradox is that "glacial" Beringia supported an apparently rich and diverse ungulate fauna on an apparently meager vegetational base. Plant fossils indicate a sparse and unproductive "steppe-tundra," while animal fossils imply herds of woolly mammoth, horse, bison, and other ungulates, in addition to the caribou/reindeer that totally dominated Beringia in postglacial times.

In attempting to resolve this paradox, the book includes views of ancient Beringia by paleobotanists, paleozoologists, geologists, climatologists, ecologists, and archeologists, drawn from both North America and the Soviet Union. Most of the contributions were originally presented at a Wenner-Gren Foundation conference in 1979, but they were substantially revised for publication. There are also some fresh, post-conference papers, including a thoughtful overview by the organizer-editors.

Although the Beringian land bridge emerged many times during the Pleistocene, nearly all the contributions concentrate on the "Last Glacial," from which the majority of well-dated evidence has come. The Last Glacial was a complex interval, comprising (i) a cold beginning from a locally uncertain time until 80,000 to 60,000 years ago; (ii) a variably cold but generally milder middle from then until 30,000 years ago; and (iii) a cold end from 30,000 until 14,000 years ago. The productivity paradox is particularly striking for the last of these periods, when the land bridge was most extensive and vegetationally least productive. Beringian climate during this interval was not only very cold, but also so dry that the bridge was not glaciated, although large glaciers existed in adjacent uplands on either side. The bridge was breached by rising sea level around 14,000 years ago, following the rather abrupt and then progressive climatic amelioration that led to essentially modern conditions about 8500 years ago.

The contributors did not resolve the productivity paradox, but most would probably agree that the diversity of large ungulates in glacial Beringia need not imply a particularly rich environment. Instead, in combination with paleobotanical and geologic evidence, it suggests a relatively diverse environment with scattered productivity "hot spots" in valley bottoms and other sheltered microenvironments. It is in fact unknown and probably unknowable just how abundant the large ungulates were, but it seems unlikely that they were as numerous as ungulates in some comparably diverse