Book & Media Reviews

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Water: A Matrix of Life, 2nd Edition

by Felix Franks

The Royal Society of Chemistry: Cambridge, UK, 2000. 252 pp. Figs., tables. ISBN 0-85404-583-X. £18.95.

reviewed by Fred Tabbutt

Chemists who consider their science as the central science will find it easy to consider water as the central compound after reading Felix Franks's *Water: A Matrix of Life*. In fact, the author shows us that water's unique properties affect all of the sciences. In this second edition of a 1973 monograph, Franks reviews the many properties of water and the effects they have on life and the world as we know it. He presents a great number of surprising (at least for me) properties of water and clearly develops the physical, chemical, biological, and geological explanations to show the consequences of these properties. However, the book is more than an assortment of interesting and unique properties of water. It uses water as a vehicle to develop the thermodynamic, quantum mechanical, kinetic, and biochemical theories that form the backbone of the book. Furthermore, a recurring theme is what we do *not* understand about water. As is so often the case, the more you learn about water the more you recognize what you do not know.

The book begins with a global picture of water that treats the hydrologic cycle, global warming, and the development of life. One learns, for example, that the unusually large heat capacity of water makes possible the transfer of enormous amounts of thermal energy from the Gulf of Mexico to the Arctic Ocean by the Gulf Stream. In fact, all the coal burned worldwide in a year could only provide the energy received by the northern latitudes for 12 hours.

In the ensuing chapters the author starts with the isolated water molecule and progresses to the structure of water and its bulk properties. He explains the data that lead to our knowledge of the tetrahedral structure of bulk liquid water, the significance of which is revisited many times to explain some of the unique bulk properties. Later chapters cover aqueous solutions of "simple", ionic, and polar molecules and chemical reactions in aqueous solution; two chapters are about water and the chemistry and physics of life. The book concludes with chapters covering unstable water thermally (did you know that you can supercool water to −41 °C?) and in terms of heterogeneity (supersaturation), and two global chapters on availability, usage, economics, and politics.

One of the book's messages is that there are a lot of new things to know about water. Partly responsible for that are new techniques in X-ray and neutron diffraction, which have given researchers insight into the structure of liquid water and some of its solutions. New topics (for me) were the plastic behavior of water, residual entropy, excess functions to characterize it, the entropy/enthalpy compensation that water demonstrates, hydrophobic hydration, and aqueous glass technology—an emerging field in freeze-drying that enables one to chart a successful pathway from the thermodynamically stable form to the kinetically stable form of a labile molecule. I also found interesting some of the ways in which organisms use the properties of water to their advantage, from the implications of the tetrahedral structure for forming the building blocks of living matter, to the flowering plant *Lobelia telekii*, which grows on the slopes of Mt. Kenya where the daily temperature ranges from −10 to +10 °C. To survive the night temperatures, the plant produces a potent ice nucleating agent so that little supercooling occurs and the latent heat produced by the formation of ice tides the plant over until the morning. This contrasts with the device used by some Antarctic fish species in which ice formation is to be avoided, so they produce a peptide antifreeze to combat it.

While most of the figures and tables are from the 1973 edition, there are many new graphs and tables as well. Specific citations to the literature are not given in the text, but references to the literature from which the data are drawn are given for each chapter at the end of the book. Virtually all of the references are from the 1990s. The book is clearly written and free of errors.

This book would be a valuable resource in any departmental library. But I believe that it deserves a broader use than that. It would be an interesting text for an advanced class. For a senior-level, semester- or quarter-long class it would be a marvelous way to tie together and review topics covered in physical chemistry or biochemistry. Furthermore, with pertinent references for each chapter students have a good start for writing papers on the topics covered. It would be a selective review, since only those theories which are needed to understand the phenomenon being treated need be introduced. But the unexpected properties of water that are revealed would, in my opinion, be a strong stimulus for students' interest.

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