who are at best secondarily interested in biological phenomena. There are a few of a new breed of students of biomechanics trained in both biology and fluid mechanics. I believe these will make the major advances in biofluid mechanics.

Vogel's style is conversational, and together with his puns and sometimes obscure classical allusions it may be irritating to some readers. Yet the overall approach is successful. It is simply not possible to read the book without itching to adjourn to the laboratory to try out ideas that come to mind under Vogel's stimulation. Whether he likes it or not, Vogel is an evangelist.

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Biomineralization

Silicon and Siliceous Structures in Biological Systems. Papers from a meeting, Richmond, Va., Dec. 1978. TRACY L. SIMPSON and BENJAMIN E. VOLCANI, Eds. Springer-Verlag, New York, 1981. xvi, 588 pp., illus. $98.90.

Silica deposits, in the form of amorphous to poorly crystalline opal, are widely distributed in the biological world. The involvement of silica in biomineralization has been documented in both animal and plant protists and in higher animals and plants. Because of this wide phylogenetic distribution, the literature on siliceous organisms is scattered. Simpson and Volcani have done a great service in attempting to bring together in this volume a sampling of recent assessments of most of the known occurrences of biogenic silica.

There are chapters dealing with silicified algal groups, especially the diatoms and chrysophytes, and with protozoans, especially the radiolarians, choanoflagellates, and rhizopod amebas. Among the higher organisms there are chapters devoted to silica in higher plants and in the sponges, including the coralline sponges. Most of the authors have concerned themselves with the fine structure and deposition of silica, but a few deal with physiological aspects, especially the effects of germanium as a metabolic analog for silicon. Except for the occurrence of opal known in mollusks (patellacean gastropods), the biological coverage is reasonably complete.

Papers authored by the two editors and their collaborators account for about one-third of the book. A chapter on cell wall formation in diatoms is noteworthy because it describes a variety of unpublished results from Volcani's laboratory, such data being otherwise generally unavailable. Only the paper by Riedel and Sanfilippo on radiolarian evolution seems out of place. It is an interesting account of radiolarian morphogenesis through time, but its relationship with silica is clearly subordinate. It is a paper for paleontologists, especially those concerned with the nature of evolutionary change as discerned from the fossil record. It should have been published elsewhere (and I hope that it will be).

Although there are very few typographical errors, there are a disturbing number of substantive errors and sources of confusion. The most frequent error and source of potential confusion concerns the use of the term "silicon." Where "silica" would better have been used silicon is variously described as dissolved, soluble, polymerized, or amorphous. Silicon granules, flakes, and capsules are discussed. Silicon is even referred to as an anion in one place and silica as an element in another. Quartz is parenthetically listed as obsidian flakes and blue glass, neither being correct. An introductory chapter on the chemistry of silica and the mineralogy of siliceous deposits would have been a very useful addition to the book.

Phytoflagellates are discussed under the heading of algal groups by several authors, but appear under Protozoa in another case, serving to confuse anyone attempting to sort out a phylogenetic history of silica deposition. The unfortunate impression is created in the introduction that the coralline sponges are newly discovered, when in fact they have been known since the turn of the century. It is suggested that diatoms must have developed the ability to capture silicic acid from very dilute solutions because concentrations in natural water are so low. Most geochemists would reverse this argument to state that natural water concentrations are low because diatoms (and other organisms) so effectively sequester silica.

The status of research on the process of silica biomineralization may be compared with that of research on calcification. Siliceous structures lack the complication imposed by the crystallography of the carbonate and phosphate minerals, but the morphological complexities are similar. Volcani concludes that "the mechanism of silicification is largely *terra incognita* about which there are far more questions and speculations than answers." A similar statement applies to calcification. Thus, this book should be of interest to anyone investigating biomineralization and may provide some insights to those concerned with calcareous structures in biological systems. For anyone interested in silica deposition or siliceous organisms it is a useful compendium, but one that needs careful reading in one or two chapters to avoid the errors.

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Muscle Structure

The Structural Basis of Muscular Contraction. JOHN SQUIRE. Plenum, New York, 1981. xviii, 698 pp., illus. $65.

Since the 1972 Cold Spring Harbor Symposium on Muscle Contraction, the published proceedings of which became a standard work of reference, many reviews and monographs dealing with muscular and nonmuscular motility have appeared. There has, however, been a dearth of major single-author books dealing with muscle, *Machina Carnis*, the monumental, essentially historical, book by Dorothy Needham being an exception. On this score alone the present volume is a most welcome addition to the literature on muscle.

Squire deals primarily with muscle structure as revealed by electron microscopy and x-ray diffraction. Throughout the book, however, structural information is presented and discussed with an eye to major issues that are of interest to muscle physiologists, biophysicists, and biochemists. Thus muscle structure at the molecular level is looked upon as a means of answering questions concerning the conversion of chemical energy from adenosine triphosphate (ATP) into mechanical work, the changes in myosin crossbridge configuration, including its relation to the actin filament, as adenosine diphosphate and phosphate are released, and the finer details of the control by calcium of the actin-myosin interaction.

The introductory chapter reviews the fundamentals of muscle physiology and provides a bird's eye view of muscle structure, including an account of the sliding filament model. The ideas that independent force generators reside in the crossbridges formed by myosin attachments to actin and that ATP hydrolysis serves as the immediate source of energy are introduced, and the chapter is

rounded out by a description of relaxation-contraction coupling and of various fiber types differing in structure and function.

Two major chapters deal with techniques of x-ray diffraction and electron microscopy as applied to muscle research, including technical details of sample preparation and image analysis. Both of these chapters include topics that usually receive a heavily mathematical treatment; Squire manages to convey the important ideas of x-ray and optical diffraction and of image reconstruction from electron micrographs with a minimum of mathematical apparatus. For readers wishing to go deeper into the subject appropriate books are recommended.

A review of current ideas of protein structure introduces ordered forms such as the β-conformation and the α-helix as well as the coiled coil structure that plays an important role in many fibrous proteins. The discussion of the three-dimensional packing of coiled coil molecules prepares the reader for the detailed analysis of structural elements of muscle in terms of the constituent molecules and their assemblies. The biochemistry and structure of actin, tropomyosin, and troponin, the proteins composing the thin filaments, are discussed, as is the organization of the proteins in the filament. This is one of the subjects about which controversies abound. X-ray diffraction evidence concerning changes in thin filament structure during regulation and the subject of the movement of tropomyosin in relation to actin and to myosin binding are clearly presented. Work on this subject is moving rapidly, and there have been new insights since the completion of the book. The structure of the thin filaments is discussed along similar lines; the assembly of the filament from myosin is analyzed on the basis of known properties of myosin and its aggregation tendencies. After a detailed review of the structure of various vertebrate (including smooth) and nonvertebrate muscles an extensive chapter deals with the molecular packing of myosin filaments, a subject on which Squire has made significant contributions. Though the subject is one about which there may be unresolved questions and differences of opinion, the presentation is fair and well balanced.

The last two chapters deal with evidence concerning the contractile event and the various models that attempt to give a detailed molecular understanding of the events that occur during contraction. A variety of biochemical, structural, and mechanical evidence is brought together with a view to establishing correspondences between physiologically distinct states such as relaxation, activity, and rigor and crossbridge motion and interactions between myosin and actin.

The book has many excellent illustrations, both original x-ray diffraction patterns and electron micrographs, as well as clear and instructive diagrams. There are an extensive list of references, with a separate list of various types of books and review articles, and a well-organized index. Newcomers to the field will find the book a valuable introductory guide, and experienced workers will undoubtedly find it of value on subjects somewhat removed from their own research. All in all, it is a book to be highly recommended.

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History of Chemistry

Jacob Berzelius. The Emergence of His Chemical System. EVAN M. MELHADO. Almqvist & Wiksell, Stockholm, and University of Wisconsin Press, Madison, 1982. 358 pp. $40. Also published as Swedish History of Science Society Studies and Sources, No. 34.

The historiography of 18th- and 19th-century chemistry has been conditioned by the response to the chemical revolution. Wurtz in the 1860's was able to begin his dictionary of chemistry with the statement that chemistry was a French science, invented by Lavoisier. So successful had Lavoisier been in laying the foundations for this view that 18th-century chemistry came to appear as simply what Lavoisier had to transcend; and Jöns Jacob Berzelius, by far the most important chemist in the first half of the 19th century, is featured often in the literature as Lavoisier's heir, a consolidator essentially derivative in his views.

Those writers who have sought to understand Berzelius's achievement have, moreover, generally found some one thing "characteristically Berzelian"—for example, his electrochemical dualism—to which his other achievements could be referred. H. G. Söderbaum in 1899 was a significant exception in his recognition of the importance of the construction of the *system*. In the present book Melhado follows that approach, seeking to develop a "genetic analysis" of Berzelius's thought and to observe the "functions performed by the system." The result is a significant contribution to the history of chemistry and the most coherent account to date of Berzelius's innovative research program, although there are reasonable and deliberately imposed limitations that make this study less than comprehensive.

In order to understand Berzelius's achievements, Melhado has to provide an account of the background. He draws skillfully on a wide literature, giving deserved prominence to the writings of Hélène Melzger and constructing an admirable primer in 18th-century chemical issues. The synthesis achieved in this part of the book is important in its own right. Melhado discusses two-component theories of classification, in which bodies are assigned to a chemical genus on the basis of a constituent principle, phlogiston for example, and then identified as particular species according to different specific ingredients. He considers the relation between corpuscular theory and the qualitative chemistry of principles and shows how Lavoisier was heir to these theories and debates. He also shows how French supporters of Stahl encouraged the resurgence of affinity tables in chemistry and laid the foundation of a radical theory. These are complex issues; but Melhado argues convincingly that their effect was to emphasize generic over specific properties, for example in Lavoisier's theory of acidity, that depended upon oxygen as the acidifying principle.

The second part of the book provides a clear demonstration that Berzelius developed a chemistry of specific components and specific properties, with both the acid and basic components in salts having equal importance. He did so by applying stoichiometric principles about the simplicity and invariance of chemical proportions and by using highly accurate analytical techniques that enabled him to distinguish specific compounds from one another and from mixtures. This research program was particularly effective in handling oxides, sulfides, and salts. The second part of Melhado's book is, indeed, entitled The Berzelian Theory of Salts.

Electrochemistry is discussed briefly for its contribution to the qualitative specification of compounds; and aspects of Berzelius's work not immediately germane to this goal are ignored or deemphasized, so that there is little or no discussion of affinity theory, atomism, and the like. But these conceptual aspects of Berzelius's thought were not unconnected to his overall research pro-