or they may produce filamentous projections which interact and entangle. The acellular portion of the medium (plasma) may coagulate by association into cross-linked fibrils of solution components (coagulogens). The coagulogens may initially be sequestered, possibly in active form, in free cells and released rapidly in stimulation. In other systems, coagulogens may be free in plasma, and some component required to alter coagulogens so that they associate, or to initiate a chain of events which leads to coagulogen alteration, may be sequestered and released on stimulation.

In this brief book, introduced by R. G. Macfarlane, an objective is to make a comparative examination and by this means to reveal areas of research which might produce further understanding of evolutionary pathways of stasis, and of hemostasis in man. It is evident that, as the species examined become more closely related to man, the sum of experimental detail rapidly increases.

The view of the situation in the human, accepted by the Oxford group, is summarized under the title "Human blood coagulation and the haemostatic mechanism" by R. Biggs. For those who may welcome a reminder as to the general phenomena of stasis and coagulation, before involvement with detail, the "General summary and conclusions" provided by C. M. Hawkey might be examined next. The remaining chapters deal with mechanisms of stasis in species representing essentially all of the phyla, and with particular aspects of mammalian systems. Hemostatic mechanisms in invertebrates are dealt with by A. E. Needham, hemolymph coagulation in arthropods by C. Grégoire, the functional physiology of blood platelets by G. V. R. Born, the bound carbohydrates in platelets, plasma, and vascular endothelium by E. P. Adams, A. T. Nurden, and J. E. French, aggregation and nucleotide concentration of platelets in different species by D. C. B. Mills, hemostasis in the hamster by A. G. Sanders, blood coagulation in nonhuman vertebrates by R. K. Archer, fibrinolysis in animals by C. M. Hawkey, clotting defects due to "abnormal" clotting factors by K. W. E. Denson, selectional trends in the structure of fibrinogen by B. Blomback, comparative aspects of the subunit structure of fibrinogen by T. Cartwright, and the clottable protein of *Limulus polyphemus* blood cells by N. O. Solum.

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Thermodynamics

Entropy for Biologists. An Introduction to Thermodynamics. HAROLD J. MOROWITZ. Academic Press, New York, 1970. xvi, 196 pp., illus. $6.95.

The jacket of this little book depicts for us a cool, green glade among tall trees through which the sunlight gently filters, an inviting spot covered with ferns, moss, and lichen. The message seems to be clear, and in case anyone remains in doubt the author makes it even clearer in his introduction to the first chapter, when he points out that "biological energetics and energetic ecology have become major focal points in the life sciences." Unfortunately, this is as far as it goes—neither biological energetics nor energetic ecology receives further attention, unless it be a passing reference, until the very last chapter, which discusses briefly the information content of living systems. Any reader who starts off, as I did, in expectation of finding an analysis of specific biological or ecological problems in thermodynamic terms is doomed to disappointment. In fact, the book is precisely what its subtitle says it is. As such it is distinguished from most other introductory texts chiefly by its use of elementary information theory whenever possible.

The author states that he has written an introduction for people in the life sciences who wish to master the concepts of what he calls thermal physics "without being forced to a degree and rate of symbol manipulation foreign to their patterns of thought." I am afraid that this is a vain hope—the degree and rate of symbol manipulation are pretty high by the standards of most of the biologists I know who might be expected to profit from this account. Perhaps there are some for whom it will serve as the "what's it all about" book the author claims it is, particularly among undergraduate students. But I, for one, closed the covers with the impression that Morowitz has fallen with a resounding bump between two stools.

The need for a text of this kind can hardly be questioned. For example, the claim that thermodynamics is not relevant to biology (believe it or not) has recently been advanced in certain quarters with such vehemence that the innocent biologist may be forgiven if he begins to be convinced. In these quarters, it seems, the god of kinetics reigns supreme. From quite a different quarter the unsuspecting biologist is assailed by claims that classical thermodynamics, although relevant, contains serious flaws; and he is modestly offered a flawless version with which to replace it. Little wonder if he turns back to his microscope muttering "a plague o' both your houses." This book does make a serious attempt to provide him with a basis for critical assessment of such ideas, whether crackpot or otherwise.

The development follows fairly conventional lines except that, as mentioned above, a good deal of emphasis is placed on the relationship between entropy and information. The most successful chapter in many ways is the one dealing with probability and information, which gives an excellent thumbnail sketch of information theory. In a later chapter information is related to both entropy and energy, thus enabling Maxwell's demon to be exorcized with considerable dispatch. In between, a heroic effort is made to acquaint the reader with the essentials of statistical mechanics and statistical thermodynamics in 30 pages. I fear, however, that those who do not have a taste for mathematical argument will rather quickly fall by the wayside, while those who do will find the lack of rigor frustrating. The title of the book being what it is, I was somewhat startled to find nonequilibrium thermodynamics dismissed early on as "a field of study which is in its infancy and about which very little is known." So much for the Onsagerists, as Truesdell (who would surely applaud this remark) calls them. Messrs. Prigogine, de Groot, Mazur, Katchalsky, and Curran, take note!

Despite a sprinkling of minor errors, which can evidently never be completely eliminated and may have something to do with the subject of the book, the presentation is well done and attractive. (Some misquoted equation numbers have the appearance of leftovers from an earlier version of the manuscript.) The chapters are uniformly short, since the medicine obviously has to be administered in small doses, and each one finishes with a few representative problems (no answers given). The author has a regrettable tendency to write the first law as

$$dU = dQ - PdV + \sum_i \mu_i dn_i + \text{additional work terms},$$

a nice pitfall for the unwary student. The reader should be forewarned that this equation is meaningful only for closed systems, and reversible ones at that.

I was immensely charmed by the quotations used by the author to introduce each chapter, and cannot resist the temptation to end with Pope's oft-quoted but nonetheless profound dictum:

> A little learning is a dang'rous thing;
> Drink deep, or taste not the Pierian spring:
> There shallow draughts intoxicate the brain,
> And drinking largely sobers us again.

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Fresh Water and Ocean

Aquatic Chemistry. An Introduction Emphasizing Chemical Equilibria in Natural Waters. WERNER STUMM and JAMES J. MORGAN. Wiley-Interscience, New York, 1970. xvi, 584 pp., illus. $24.95.

The teaching of the chemical aspects of rivers, lakes, and oceans has normally been part of some general course in limnology, oceanography, or geochemistry. With the recent upsurge in interest in the natural environment, however, many colleges and universities have started formal courses in freshwater chemistry and in marine chemistry. Logically a need arose for a comprehensive textbook on aquatic chemistry. Many excellent texts on limnology and oceanography are available, such as the monographs of Hutchinson and of Sverdrup, Johnson, and Fleming. Hem has recently updated his Geological Survey Water Supply Paper on the study and interpretation of the chemical characteristics of natural waters. But a thorough introductory textbook on the physical chemical principles underlying the evaluation of either freshwater or marine chemical data was lacking until the appearance of Stumm and Morgan's book.

As the authors point out, this book is not intended as a survey of the field of knowledge in aquatic chemistry, but rather as an introduction to the quantitative description of the measured data in terms of physical chemical phenomena. For this reason great attention has been given to chemical equilibria in aqueous electrolyte solutions. The reader will find chapters on acids and bases, dissolved carbon dioxide, precipitation and dissolution, coordination chemistry, oxidation and reduction, and the solid-solution interface, the last treating not only adsorption phenomena but also ion exchange. The text is well written, and the illustrations are abundant and clear. The level of the book is such that it should present no difficulty to chemistry students in their senior year or to first-year graduate students.

Many of the topics discussed in this book—for instance, the use of the master variables pE and pH—have been extensively treated in the literature. It is, however, of great use to have these various topics combined in one monograph that is clearly designed to collect and explain them in particular relation to problems arising in aquatic chemistry. There is one topic that I would have liked to see discussed in this book, and that is the use of isotopes and radioactive tracers in studies of the aquatic environment; stable isotope ratios and their fractionation factors especially are of great importance in understanding processes occurring in the various parts of the hydrosphere. Also, the chapter on the solid-solution interface could have been stronger if ion exchange were related somewhat more directly to problems of bottom water interchange and to the ground water problem.

The chapter on chemical thermodynamics assumes that the reader has had exposure to a rigid course in thermodynamics. If so, he will find this chapter a most useful resume; if not, he can skip the chapter without necessarily losing touch with the rest of the book.

The use of logarithmic diagrams or Bjerrum plots as discussed in the chapter on acids and bases should be advocated. Such diagrams provide a clear insight into the chemical speciation in a particular body of water as a function of pH or pE.

In the chapter on dissolved carbon dioxide, carbonate alkalinity is defined in terms of the carbonate ion concentration, which in freshwater chemistry is probably the correct definition. In marine chemistry, however, carbonate alkalinity is defined quite differently, as the sum of the equivalents of both carbonate and bicarbonate ions in the solution. In general the discussions of the various topics are geared more to freshwater chemistry than to marine chemistry. Nevertheless, chemists in the two fields will find much common ground in this book.

The chapter on metal ions in solution and the possible complexes these ions can form with various anions is well written. It becomes clear that one can very often discuss the concentration of trace metal ions in terms of complexes with inorganic ligands without having to invoke a deus ex machina in the form of "organic" complexes.

The chapter on chemical modeling is interesting and should serve as a stimulus to investigators who want to relate their results to the geochemical environment. Besides, with modeling one can often come to a better understanding of some geochemical cycles or can find obvious defects in particular proposed cycles.

In general the book presents an array of topics that will be of great use in the teaching of a course in hydrogeochemistry. The book may have some ill-chosen examples, but it also provides very valuable lists of references for further reading. I do not think a course in aquatic chemistry can be taught on the basis of this book only, but it should provide one of the underpinnings of such a course. It is hoped that the publisher will soon make available a paperback edition so that the student will have easier access to this valuable book.

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Deposits

Desert Sedimentary Environments. K. W. GLENNIE. Elsevier, New York, 1970. xvi, 222 pp., illus., + maps. $20. Developments in Sedimentology, vol. 14.

The stated aims of this book are to enable the reader to recognize ancient desert sediments and to differentiate between aeolian and water-laid deposits. The author achieves both of these objectives. Chapters 4 through 9 are concerned with the description and genesis of sediments deposited in various modern desert environments: wadis and river valleys, lakes, dune fields, and the littoral fringes. Glennie is obviously at home with these matters and brings to bear firsthand knowledge, wide experience of desert sediments, a keen eye, and a lively mind. After each discussion of present-day desert conditions, modern and ancient desert sediments are compared in order to demonstrate how old sedimentary formations can be interpreted in light of modern deposits. Criteria whereby to identify desert sedi-