ies. This seems to be particularly true for the contributions in the section Topics in Cancer. Here it is stressed that several environmental factors have been implicated as important agents in carcinogenesis among vertebrates, including fish, where hepatomas, epithelial papillomas, and other neoplasms have now been studied. Fish offer several advantages for the experimental investigation of cancer: their total environment can be readily altered; they are poikilothermic and growth and metabolism often depend on temperature; growth is normally slow and often continues throughout life; large numbers of animals can be obtained from a single mating. Except for melanomas in killifish hybrids, epitheliomas in catfish, and hepatomas in trout, there is little detailed work on neoplasms in fish, and the comparative approach may prove to be very productive. Parallel comments can be made with respect to the other topics considered.

Even though some of the contributors did not deal with the specific question raised by the sponsors of the symposium, each of the authors is a leader in his field, and these reviews of recent findings should prove valuable to comparative biochemists, physiologists, and geneticists. This book is a useful addition to the fisheries literature. Moreover, it may direct the attention of some scientists working on the higher vertebrates to novel systems for comparative study; at the same time it provides worthwhile reviews of the literature in the areas considered.

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Proteins and Small Molecules

Multiple Equilibria in Proteins. JACINTO STEINHARDT and JACQUELINE A. REYNOLDS. Academic Press, New York, 1969. xii, 396 pp., illus. $15. Molecular Biology.

The understanding of the factors governing the interaction of proteins with small molecules is of central importance in enzymology, immunology, pharmacology, and diverse other areas of study. The appearance of a book that attempts a synthesis of the knowledge in this field is therefore of particular interest. This is a well-written compendium dealing with those compounds for which multiple binding sites on proteins have been observed. This category encompasses the interaction of proteins with hydrogen ions, detergents, urea, guanidine, organic solvents, hydrocarbons, dyes, and metal ions. The major strength of the book lies in the clear treatment of the thermodynamics of complex formation and in the exploration of the practical aspects and pitfalls of the various methods used for the determination of binding isotherms and hydrogen ion titration curves. The extensive reference lists should prove to be of considerable help to those who are interested in protein-small-molecule interactions.

The authors account with some success for the stabilizing and cooperative unfolding effects of certain ligands in terms of the interplay between the forces involved in complex formation and those responsible for maintaining the native protein structure. In this context, it is interesting to note that the more recent studies have forced little revision of the mechanisms of protein denaturation elegantly presented by Kauzmann in 1954 (in *The Mechanism of Enzyme Action*, W. D. McElroy and B. Glass, Eds., Johns Hopkins Press).

Not unexpectedly, considerations of binding phenomena involving bovine and human serum albumins dominate the discussion. However, despite an abundance of experimental data, few satisfying answers to the questions as to the nature of the binding sites and the apparent "configurational adaptability" of these proteins have been provided. The suggestion that "compared to other proteins, the surface of bovine serum albumin contains many hydrophobic patches or sites, and . . . fewer or smaller stabilizing clusters will be found in the interior of the molecule" has considerable appeal.

Specific complexes of antibodies with antigens, or of enzymes with cofactors, substrates, or inhibitors, are excluded from detailed consideration as not representative of multiple equilibria. One would be more readily reconciled to this arbitrary restriction if the authors adhered to it fully. Thus, specific complexes involving enzymes are examined, but in a purely descriptive and fragmentary manner, with little use of the results of recent x-ray crystallographic studies.

Aside from hydrogen ion equilibria, the attempt to interpret multiple equilibria in proteins is complicated by the lack of knowledge of the structure of the complex formed, the possible contribution of ligand-ligand interactions to the observed energy changes, and the changes in the distribution of conformational forms that the protein can assume at different ligand concentrations. Clearly, these factors will differ from one protein to another. Ultimately, the understanding of protein-small-molecule interactions, as well as the interpretation of the thermodynamics of complex formation, requires knowledge of the details of the interaction at the atomic level. Such information is available for a limited number of cases, principally those of enzyme-inhibitor complexes, or unproductive complexes of enzymes with substrates. Consideration of these complexes falls beyond the deliberately restricted scope of this book.

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Virology

The Chemistry and Biology of Viruses. HEINZ FRAENKEL-CONRAT. Academic Press, New York, 1969. x, 294 pp., illus. $9.

The author of this book has set himself the task of introducing students in biology, biochemistry, bacteriology, and the premedical sciences to the chemistry and biology of viruses. The book is also intended to help research workers in these fields broaden their specialization. As the author mentions in the preface, he has handled the material in a fairly elementary manner, avoiding especially higher mathematics and physics.

As tools of the molecular biologist, the geneticist, the biochemist, and more recently the immunologist, viruses have often been as well studied as the systems they are being used to explore. Assembling this information into a readable book is a worthwhile venture, and Fraenkel-Conrat has succeeded in nearly accomplishing the objective that he set for himself.

The book includes the methods used in isolation and purification of both viruses and subviral components and contains excellent chapters on the properties of viral proteins and nucleic acids, a subject on which the author is a recognized authority. A good background in biochemistry, however, is helpful in understanding these chapters. The relation of subviral structure to function is well described, as is the replication of plant and bacterial vi-