drogenases" (Paul Talalay); "Aldehyde dehydrogenases" (William B. Jakoby); "D-Glucose 6-phosphate and 6-phosphogluconate dehydrogenases" (Ernst A. Noltmann and Stephen A. Kuby); "Glyceraldehyde 3-phosphate dehydrogenase" (Sidney F. Velick and Charles Furfine); "Lipoyl dehydrogenase" (Vincent Massey); "Pyruvate and α-ketoglutarate oxidation enzymes" (D. Rao Sanadi); "Flavoprotein dehydrogenases of the electron-transport chain: A survey" (Thomas P. Singer); "Succinate dehydrogenase" (Thomas P. Singer and Edna K. Kearney); "Acyl coenzyme A dehydrogenase" (Helmut Beinert); "Electron-transferring flavoprotein" (Helmut Beinert); "Old yellow enzyme" (Ake Akeson, Anders Ehrenberg, and Hugo Theorell); "The pyridine nucleotide-cytochrome c reductases" (Youssef Hatefi); "Quinone reductases" (Carl Martius); "Xanthine oxidase" (R. C. Bray); "Lactate dehydrogenases of yeast" (Agnar P. Nygaard); "Glucose oxidase" (Ronald Bentley); "Nitrate reductases" (Alvin Nason); and "Flavoprotein amino acid oxidases" (Alton Meister and Daniel Wellner).

It is not feasible here to review critically each of the articles in this volume. Instead, I will attempt to indicate the present status of the field and some of the concepts that have recently undergone change.

Despite the wealth of information presented here on the mechanisms of action of the enzymes, it is important to realize that many of the basic questions remain unsolved and will require more intensive study with the most modern tools of chemistry and physics. Although the use of kinetic and analytical methods has provided much information about binary, ternary, and quaternary complexes that involve enzyme, substrate, coenzyme, and activators or inhibitors, the structural features of an enzyme which account for its catalytic activity and specificity remain largely unknown.

Many of the earlier concepts of oxidation-reduction must be revised. The occurrence of metals in the enzymes that transfer hydrogen from substrate to the nicotinamide nucleotides was considered earlier (Vallee) to be a general phenomenon, but it now appears to be limited to certain dehydrogenases in which the metal plays a role in binding the nucleotide. Similarly, the metals in the flavoproteins were thought (Mahler) to be generally involved in 1-electron transfer from 2-electron donors, but it is now recognized that many flavoproteins can function without metal; the common occurrence of 2 moles of flavin per mole of enzyme (or of 1 flavin molecule with an adjacent disulfide group) is believed to allow 1-electron transfer to each flavin molecule from a 2-electron donor. However, the assumption of free radical formation, based on spectral changes during reduction of flavoproteins by substrates, is in many cases not confirmed by electron spin resonance measurements. This has led to the view that the spectral changes in these cases are due to complex formation between flavin and substrate rather than to free radical formation.

Until recently the pure flavoprotein enzymes that catalyze the reduction of cytochrome c by the reduced pyridine nucleotides, TPNH and DPNH, were considered responsible for these processes as they occur naturally during electron transport in the cell. However, the present view is that the "DPNH-cytochrome c reductase" is an artifact derived during the isolation of DPNH dehydrogenase, a flavoprotein that normally is involved in a complex which reduces coenzyme Q (ubiquinone). The coenzyme Q, in turn, is able to reduce cytochrome c in a reaction catalyzed by a second complex that contains cytochromes b and c_1. Thus, the isolated DPNH-cytochrome c reductase exhibits a "short-circuit" which apparently does not occur in vivo. The extent of the occurrence of this type of phenomenon has not been assessed. In fact, the question of the identity of the natural electron acceptors for most flavin-linked oxidations remains open.

Although vitamin K was formerly believed to play a role in electron transport and oxidative phosphorylation in mammalian mitochondria, it now appears to be involved in the spatial transfer of electrons from DPNH and TPNH in the cytoplasm to the mitochondria, by "shuttle" mechanisms that are analogous to those postulated for glycerophosphate dehydrogenase. Vitamin K retains its status, however, as a participant in oxidation phosphorylation in bacteria.

The view that steroid hormones promote transhydrogenation by undergoing alternate oxidation and reduction, challenged earlier by Villee, now appears firmly established by Talalay. There is no evidence, however, that the major transhydrogenation activity of tissues is mediated by steroid hormones.

The view that certain steroid hormones can act by causing dissociation of glutamic dehydrogenase into inactive subunits (Tomkins) requires modification, because it has been shown that the dissociated enzyme is active (Frieden). The dissociated form is apparently inactivated by steroids or other agents to yield an altered subunit which fails to aggregate.

The studies of glutamic dehydrogenase provide an excellent model for changes in enzyme structure resulting from the action of regulatory compounds at allosteric sites. Thus far, similar regulation of structure and activity of dehydrogenases has been seen with succinate dehydrogenase and isocitrate dehydrogenase.

The authors, editors, and publishers are to be congratulated on the excellence of the current series. We now look forward to a third edition in which the problem of the mechanism of enzyme action will be brought even nearer to solution by a more complete knowledge of the 3-dimensional enzyme structure at the active center.

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Chemical and Physical Aspects

The Chemistry of Imperfect Crystals. F. A. Kroger. North-Holland, Amsterdam; Interscience (Wiley), New York, 1964. xvi + 1039 pp. $33.

This book covers, in rather amazing detail, the subject of point defects in inorganic nonmetallic crystals, their formation, equilibrium condition, and effects. Despite the "chemistry" in its title, the book is as much or more concerned with physics, and it shows particular strength in the sections on the preparation of material, on theoretical aspects concerned with the equilibrium of impurities, on the effect of impurities on physical properties, and on the electrochemistry of impure materials.

The first of the three principal parts treats crystal growth and phase theory. The various methods of growth are described, and the limitations of the methods outlined. A table of substances and methods for growing them, complete with many references, is in-

cluded. The second part deals with a description of phases (solid, liquid, and vapor) and their interactions. The theory regarding the approach to equilibrium condition in both elements and compounds, and with both native and foreign atoms, is outlined in some detail and presented in graphic form. Several chapters present experimental results from the literature on defect crystals of compounds, relating Hall effect, conductivity, optical properties, and self-diffusion to the chemistry and past treatment of the specimen. A detailed comparison of theory and experimental results is discussed, with particular emphasis on PbS, alkali halides, BaO, and Cu_2O. Special cases of cation disorder-order relations in compounds such as spinels and doped ice are considered, and an excellent chapter on relaxation deals with the kinetics of precipitation and diffusion.

The final part (five chapters) is concerned with chemical and physical effects of point defects. Sintering, oxidation rates, the photographic process, the electrochemistry of cells of imperfect crystals, and phase transitions are the principal applications discussed.

Dislocations and their effect on chemical or physical properties are only briefly mentioned; reference is made several times to a companion book, *Imperfection in Crystals*, written by the author's colleague, H. G. van Bueren (Philips Research Laboratory, Eindhoven). With the exception of the first chapters, there is little discussion of experimental problems or instrumentation; however, the copious references (including some papers published in 1962) will lead the reader to such information.

This book is characterized by the unity that can be attained when one author treats a subject rather than by the disorder that one so frequently encounters in "edited" volumes produced by several contributors. This work should become a standard textbook for advanced solid-state courses, and it should be widely used by ceramists engaged in basic studies, particularly about phase theory, sintering, oxidation, and electrical properties. Although it is priced rather high, it is well bound, printed on excellent paper, contains excellent author and subject indexes, and does cover a tremendous amount of material.

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Zoology

Molluscs. J. E. Morton. Hutchinson University Library, London; Hillary House, New York, ed. 2, 1963. 232 pp. Illus. $3.

Morton's little book is a welcome addition to the zoological literature. The text, written in a simple and lucid style, is aimed to a broad audience of persons who have only elementary knowledge of zoology; at the same time the book contains a wealth of information that will be useful to biology teachers and malacologists. General features and habits of molluscs are rather briefly discussed in the first three chapters. Greater emphasis is placed, however, on the functional morphology of the following systems of organs: mantle and gills; feeding and digestion; blood and excretion; sex and reproduction; and the nervous system. The major structural features of the organs are discussed together with their function and evolution. Unfortunately, the major role of the mantle in the formation of shape and sculpture of the shell is only briefly mentioned, and no reference is made to geometrical regularity of the shape of the shell and its growth.

The last three chapters deal with evolution and classification. These chapters are an expansion of, and an addition to, the material presented in the preceding five chapters. The evolution of cephalopods is discussed vividly and interestingly. By reconstructing the life and habits of fossil *Nautiloidea* and *Ammonoidea*, the author arrives at the conclusion that "the advent of the ammonoids *saved* [my italics] the Cephalopoda from decline." This is an intriguing speculation, but it is very probable that some other line of evolutionary process would have developed, if ammonoids had not appeared. The evolution of cephalopods provides fascinating reading. The author wisely reminds the reader, however, that the philogeny of fossil cephalopods must be approached as cautiously as their ecology.

Regrettably, certain facts of great interest to the general public are not mentioned—for instance, Li's recent findings of antimicrobial agents in molluscan tissues; poisonous shellfish and poison conch shells; the role of tropical freshwater snails in transmitting schistosomiasis; Gabet's work on neurosecretory cycles in bivalves; the important role of squid nerve cells in neurophysiological research.

The "second edition" is in reality a reprint of the 1958 edition without additions or changes. This explains the absence of references to such an excellent book as *British Prosobranchia* (1962), by V. Fretter and A. Graham, and the monograph on Neopalina, (1959), by H. Lemche, in volume 3 of the Galathea Report. Only the preliminary note of 1957 to the latter, a major zoological discovery, is mentioned in the text.

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Mathematics

Structure of Algebra. Vincent H. Haag. Addison-Wesley, Reading, Mass., 1964. vi + 154 pp. Illus. $5.

What a wealth of books on algebra —elementary, intermediate, advanced, college, modern, and abstract algebra —are available today! However, it is probable that Haag's *Structure of Algebra* is close to unique; certainly it meets a definite need.

Haag seeks to explain the "why's" and the "wherefore's" of elementary algebra and in doing so he dips into the foundations of analysis and of modern abstract algebra. Although a student of modern algebra does study the ring of polynomial forms, for example, it is questionable whether he makes the connection with elementary manipulations or places "variable" and "indeterminate" in their proper relationship.

This book is not a treatise; it does not attempt to cover all aspects of a given topic. It does give considerable insight into mathematical systems; the concepts of finite, infinite, and countability; the apparatus of algebra, such as mappings and functions; and the language and applications of sets and basic logic. It treats real numbers as a model of a complete ordered field, beginning with a development of the properties of such a system and its principal subsystems. The reader should have a meaningful grasp of real number concepts by the time he finishes this volume, a grasp that he can put to effective use. The status and importance of complex numbers receive a thorough elementary treatment; the