graph on coupled reactions. But I am not too happy about the treatment of a simple phosphate transfer reaction such as that from adenosine triphosphate to arginine as a coupled reaction. Biochemists prefer to reserve the term *coupling* for transmission of potential between different groups, and in particular from electron transfer to group potential, to which *coupling* and *uncoupling* refer almost specifically.

The book contains ingenious applications of thermodynamics. For example, tre ΔG for hydrophobic bonding is deduced from a comparison of solubilities of a series of amino acids in ethanol with glycine. It appears that to shift a mole of isoleucine from alcohol to water, 3 kilocalories have to be expended. This kind of treatment offers a background for evaluating the much-talked-about functioning of clusters of hydrophobic side chains in enzyme proteins.

I like most the last section, on the relationship between energetics and molecular statistics. It deals in a commonsense manner with problems that are often submerged by high-powered formalism. It makes one realize one is in the presence of a person who is enviably familiar with his tools and able to use them ingeniously.

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Sites of Photosynthesis

Biochemistry of Chloroplasts. Proceedings of a NATO Advanced Study Institute, Aberystwyth, Wales, Aug. 1965. T. W. GOODWIN, Ed. Academic Press, New York. Vol. 1, 1966, xvi + 476 pp., illus., $18; vol. 2, 1965, xviii + 776 pp., illus., $29.

These two volumes provide a striking demonstration of the proliferation of studies on chloroplast biochemistry that has occurred since the announcement in 1954 of photosynthesis by isolated chloroplasts. Before this time the study of chloroplasts was not generally regarded as a branch of biochemistry. Goodwin was fortunate in being able to assemble at the conference of which these volumes are the published record a large proportion of the workers who have contributed to this field in recent years, so that the books represent a summary of current results and thinking on chloroplast structure and function which should be useful both to the student entering the field and to the researcher who is trying to keep up with the flood of papers which now appear on chloroplasts and their activities.

The first volume is concerned with the structure and composition of chloroplasts. The first seven papers, dealing with studies of the ultrastructure of chloroplasts, done mostly by electron microscopy, but also with the use of x-ray scattering, fluorescence properties, and other physical methods, illustrate vividly the variations on a basic structural theme which can be derived by different investigators from quite similar data. Most current work on the ultrastructure of chloroplasts is concerned with attempts to make models of the chloroplast lamellae, regarding whose organization there is not as yet general agreement, at least not in detail. The fact that the method of isolation of the chloroplasts may have a great influence on the structure observed is being increasingly recognized.

Studies of the chemical composition of chloroplasts, including the lipids, the proteins and nucleoproteins, the nucleic acids, and the pigments, comprise the remainder of the first volume. Since most of the investigators are interested in the localization of these components in the chloroplast structure, these studies often merge closely with the more strictly structural investigations described in the first few chapters, and, on the other hand, lead into the studies on the biochemical activities of chloroplasts to which the second volume is devoted. Subjects of papers in this section include elucidation of the unusual types of lipids found in chloroplasts; the organization of these with proteins and lipoproteins in the lamellae; description of a distinctive DNA in chloroplasts, providing support for earlier suggestions from genetic experiments that at least some chloroplast syntheses and functions may be independent of nuclear control; the observation of RNA, ribosome-like particles, and protein synthesis in chloroplasts; and last, but by no means least, continuation of studies on one of the most important types of chloroplast components, the photosynthetic pigments.

Anyone familiar with the photosynthesis literature of a few years ago who had not followed the field since would probably be surprised at the small amount of space in the second volume devoted to the subject of carbon dioxide fixation, although the papers in this section, like most of the others, are careful and detailed. The greatest portion of this volume is concerned with the biosynthesis of the various chloroplast components, including the carbohydrates (some of this is closely related to CO_2 fixation), lipids, proteins, and amino acids. These subjects are treated in considerable detail from many points of view, and, like the chemical studies of volume 1, are often related to ultrastructure. The biochemistry of photosynthetic phosphorylation, which provides the energy to drive the biosynthetic mechanisms in the light, receives considerable attention, with particular emphasis on naturally occurring cofactors of the reactions involved and on a possible relation between cyclic (only ADP formed, no oxygen liberated) and noncyclic (ATP and NADPH both formed, oxygen liberated) photosynthetic phosphorylation and the two light reactions of photosynthesis. The work finally comes full circle with a consideration of biosynthetic mechanisms in relation to morphogenesis.

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Quantum Substances

The Properties of Liquid and Solid Helium. J. WILKS. Oxford University Press, New York, 1967. xii + 703 pp., illus. $24.

Experimental and theoretical investigations of the quantum liquids, liquid helium-3 and liquid helium-4, have a long history of rich accomplishment. Intensive study of the quantum solids, solid helium-3 and solid helium-4, which is relatively more recent, promises to be very fruitful for basic solid-state research. Most of this monumental book by John Wilks is devoted to quantum liquids (chapters 1–19, 560 pages); the last three chapters deal with quantum solids. Wilks, a major contributor to the experimental literature on both liquid and solid helium, approaches the exposition of the properties of these substances as an experi-