Bertalanffy) and provocative formulations of basic ideas and concepts. And even though, as indicated above, some very important ideas about systems may not be adequately discussed (and some unimportant ones overstressed), most of the main currents in system-theoretic thought are in fact represented.

In sum, I feel that this volume should be required reading for anyone interested in the natural and human sciences, in philosophy, or in human thought in general. It should be read by each individual through the eyes of his own discipline; the reader should examine each concept, seeking specific instances and examples within his field. He should then compare his own examples with those given in the book (which will generally involve other disciplines) to see how the general concepts provide a link which transcends disciplinary boundaries while simultaneously enriching all of them. It is to be hoped that many readers will be impelled to do more than this; that they will look further within their own specialties for new modes of thought, which will ultimately broaden their own insights, systems theory itself, and thus ultimately all of science.

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Hormonal Action

Steroid Protein Interactions. U. WESTPHAL. Springer-Verlag, New York, 1971. xiv, 568 pp., illus. $24.90.

This monograph describes the studies conducted on steroid-protein interaction by the author and his co-workers during two decades. The author does a creditable job of relating his studies to those of others. Blood components are given principal emphasis, tissue receptor proteins being covered by another volume in the series.

The concept of a dissociable protein-ligand complex is examined from the viewpoint that a substance must be in solution to exert an effect and that protein interaction is the connecting link to the site of action. Though basic concepts involved in the binding of ligands to proteins were elucidated with the use of dyes and drugs many years in advance of the identification of the first steroidal hormones, awareness of the relationship of protein binding to the biological action of the latter is a recent phenomenon. In fact, plasma steroids frequently are still determined without regard to whether they are free or bound.

A great strength of the volume lies in the fact that the author draws on his considerable experience to point out the many problems in technique which frequently are not dealt with in research reports—the importance of clean glassware, pure solvents, double-distilled deionized water, chelating agents, and an inert atmosphere and the potentially deleterious effects of excess light and elevated temperature. There is an excellent discussion of the pitfalls to be avoided in the use of radioisotopes for measuring steroid-protein interactions.

Discussions relating to experimental conditions and interpretation of data offer an explanation for the wide variations in the number of binding sites that have been reported for some proteins; the factors responsible for the variations include differences in the purity of the preparations, the presence of polymeric forms, and the influence of lipids and heavy metals.

The various methods used for studying steroid-protein interactions are discussed and evaluated. Gel equilibrium and equilibrium dialysis have, generally, found the most successful application; ultrafiltration is rapid, but its application can be limited owing to absorption by the membrane and the concentration of protein in the filtrans. The change in spectral characteristics of free and bound steroids has been developed into a useful tool in Westphal's laboratory. There is a valuable description and assessment of the procedures employed for the isolation and characterization of corticosteroid-binding globulin (CBG) from mammalian plasma.

The relationship between steroid structure and the extent of protein binding is examined in detail, as is competition of ligands for binding sites. The significance of these phenomena is discussed in relation to the effect of the binding of one steroid on the freeing of another for biological action.

It is of interest to note the endocrinological differences that exist among species. Thus, there is a high-affinity estradiol-binding protein in plasma of cow, frog, and fish but not of rat, rabbit, dog, and duck. Differences in CBG binding in rat, rabbit, guinea pig, and man are apparent. For example, the guinea pig has one protein for binding cortisol and another for binding progesterone, whereas in the rat the two steroids compete for the same protein. The CBG of rabbit plasma binds polar steroids more strongly than nonpolar ones; this is contrary to the polarity rule which obtains for the few other mammalian species investigated. Rabbit CBG is much more stable in the absence of corticosteroid than is human CBG. The ready polymerization of human CBG compared with rat CBG is also worthy of note.

Westphal examines the status of current knowledge to pinpoint problems that could profitably be investigated. We learn that consideration of protein-steroid interaction in relation to the thyroid-adrenal axis is highly desirable. Studies in the author's laboratory have contributed significantly to our knowledge of pituitary-adrenal-thyroid interrelationships as reflected by steroid-protein interactions. In this regard it is pointed out that androgens depress the plasma levels of thyroid-binding and corticosteroid-binding globulin; in view of the similarities in these proteins, it would be interesting to search for some kind of mechanism to explain the effect. Testosterone depresses the levels of CBG, but the mechanism is still to be elucidated. The effect of steroids on the production of CBG is well known, but though the thyroid has been implicated a direct action on the site of CBG production cannot be excluded; there is evidence implicating the liver, but further investigation is justified. Sialic acid in human CBG, testosterone-binding β-globulin, and α_1-acid glycoprotein can be removed without adverse effect on activity. This raises the question of whether this moiety has another role to play, possibly one involving the receptor in the target cells.

What's in a name? Just as the use of trivial names for poorly characterized or impure sterols hampered progress, the author suggests that the naming of the α-globulin as "corticosteroid-binding globulin" and "transcortin" may have had the effect of blinding investigators to the implications of Daughaday's early report that progesterone was strongly bound to the protein.

The small quantities of steroid-binding proteins in plasma have hampered investigations. Greater specificity in isolation procedures, such as that achieved by affinity chromatography, offers hope to the author that this limitation can be overcome.

For related subjects beyond the scope of the book (such as tissue-protein interactions), the reader is given adequate references to appropriate sources of information.

The book is highly recommended to all who are involved in the study of steroidal hormones.

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Plant Bodies

Structure and Function of Chloroplasts. MARTIN GIBBS, Ed. Springer-Verlag, New York, 1972. xvi, 286 pp., illus. $22.60.

The nine articles in this book present fairly comprehensive reviews of current areas of research on chloroplast structure and function. The topics covered are the ultrastructure of plastids, light-induced chloroplast contraction and movement, plastid inheritance and mutations, nucleic acids and information processing in chloroplasts, lipids of chloroplasts, biochemistry of photophosphorylation, carbohydrate metabolism by chloroplasts, and biosynthesis by chloroplasts. In addition there is an introductory article by Robert Hill which is easily one of the best historical overviews of the field of chloroplast structure and function ever published in such a brief and well-written form. Each article is accompanied by an impressive bibliography.

Since each author apparently was charged to be as comprehensive as possible, the articles are a gold mine of tabulated material. This is the sort of book one uses when one wants to know, for instance, the nature of all lipids found in chloroplasts, or the DNA content in grams of the chloroplasts of a particular organism. Indeed, one of the best articles is one, by Woodcock and Bogorad, in which is tabulated for easy reference nearly all the information available on the nucleic acids of chloroplasts as well as ideas about their probable function. Comparison between chloroplast DNA's and those of mitochondria, bacteria, viruses, and higher plant nuclei is presented in well-referenced tables.

Another compendious article is by Goodwin on biosynthesis by chloroplasts. Here, in the encyclopedic style we have come to stand in awe of from this author, is presented a magnificent review of the synthetic prowess of chloroplasts. He presents not merely a description of biosynthetic abilities but a discussion of their control and regulation.

Most of the articles are illustrated, and the reproduction of electron photomicrographs is of high quality.

Photosynthetic functions of chloroplasts are reviewed in an article on photophosphorylation by Avron and one on carbohydrate metabolism by Gibbs. The book does not present a review of what might be termed the "photophysics" of photosynthesis, although electron flow is covered in the article on photophosphorylation. Action spectra for various light reactions in plastids, fluorescence in vivo, delayed fluorescence, and light-capturing pigment systems are among topics not reviewed separately.

There is a good subject index at the back of the text. This volume will be of use to students and researchers in plant physiology, biochemistry, and cellular physiology. It is a marvelous source of information for the teacher seeking a comprehensive review of chloroplasts and would be an excellent beginning reference for the graduate student or researcher who is contemplating work in the field of chloroplast structure and function.

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Cytogenetics

Cytoplasmic Genes and Organelles. RUTH SAGER. Academic Press, New York, 1972. xiv, 406 pp. + plates. $12.50.

My own decision to study cytoplasmic inheritance was made largely because of a review paper written a dozen years ago by Ruth Sager describing her work on cytoplasmic genes in *Chlamydomonas*. It was clear then that she had uncovered some fascinating genetic phenomena although the significance of these phenomena was obscure.

A wealth of information published in the years since has shown that the chloroplasts and mitochondria of eukaryotic cells contain DNA distinct from the nuclear DNA and that these organelles possess unique protein-synthesizing systems as well. Recent work has established that chloroplast and mitochondrial DNA's have limited coding capacities when compared to the DNA of the eukaryote nucleus. It has also been established that the ribosomal RNA's and some, if not all, of the transfer RNA's present in these organelles are gene products of their respective DNA's, but as yet not a single protein has been identified as a product of chloroplast or mitochondrial DNA. It seems likely that if we are to determine what proteins are coded by organelle DNA, it will be necessary to use the classical genetic approach of establishing the primary defects present in mutants residing in these DNA's. Through the study of selected cytoplasmic genetic systems which are probably localized in organelle DNA, it may be possible to ascertain not only what proteins are coded by organelle DNA but also how the genes resident in chloroplasts and mitochondria segregate and recombine.

Sager has been in the thick of the research described, and, although much of the work has been summarized in review articles and symposia, nowhere has it all been brought together recently under the critical eye of a principal investigator in the field. The great virtue of Sager's book is that it does just this and at the same time puts the recent findings in perspective with respect to an extensive older literature dating its beginnings almost to the time of the rediscovery of Mendel's principles.

After a review of what is now known about organelle DNA the book is divided into two sections. The first, Genetic Analysis of Cytoplasmic Systems, deals principally with Sager's own research on the inheritance, segregation, and recombination of cytoplasmic, possibly chloroplast, genes in *Chlamydomonas* and the extensive literature on these same topics with respect to mitochondrial genes in yeast. Cytoplasmic genes affecting mitochondria in *Neurospora* and cytoplasmic genes affecting chloroplasts in higher plants are also considered. Even the less well defined cytoplasmic genetic systems known in fungi and higher plants are also discussed especially with respect to whether they may be related to organelles or not.

The second part of the book, Cytoplasmic Genes and Organelle Biogenesis, reviews in two extensive chapters what we know about the structure of chloroplasts and mitochondria; their protein-synthesizing systems; and what the functions of these protein-synthesizing systems may be.

The only important flaw in the book has to do with the author's discussion of her own work on *Chlamydomonas*. One of the difficulties in writing a book such as this is the great temptation to include one's own unpublished data. Sager has succumbed to this temptation and has presented experiments on the physi-