

citing and illuminating panorama of their subject, rather than a conglomeration. Their lively style and constant sense of interconnection make the treatment of each example a vivid lesson relating in some way to larger topics. Themes such as complex numbers and groups are woven through the material in a way which illustrates nicely how underlying structures can appear in widely separated areas of mathematics. By often following their presentations of well-known results with unsolved problems arising from them, the authors manage to keep their material from appearing too settled and fixed, and succeed well in presenting a picture of mathematics as it appears to a working mathematician.

Although not useful as a source or reference volume, this book is a valuable contribution. It provides a perspective and distance which most modern scientists must struggle to obtain, and does this with grace and good sense. The philosophical points to be found in it will probably not strike the mathematician as remarkable, but they are refreshingly sound in comparison with the oversimplifications often made by philosophers when speaking of mathematics. And the authors' suggestions concerning what may be in store for mathematics, especially as regards the use of computers and of ideas from the life sciences, are thought-provoking and worthy of consideration.

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Farbwerke Hoechst

A Century of Chemistry. ERNST BÄUMLER. With contributions by Gustav Ehrhart and Volkmar Muthesius. Translated from the German edition (1963). Econ, Dusseldorf, 1968. xi + 365 pp., illus. Available for limited distribution from Donald Morgan Associates, 36 West 56 Street, New York 10019.

This is a translation of a festschrift published by the Farbwerke Hoechst AG. vorm. Meister Lucius & Brüning to commemorate the firm's 100th birthday. Those familiar with this company's earlier anniversary volumes and various histories of the I.G. Farbenindustrie will find little that is new as the story is retold of the firm's meteoric rise to preeminence among dye and pharmaceutical manufacturers and its subsequent participation in the formation of

the I.G. trust. However, since the anniversary year, and probably stimulated in part by the preparation of this book, a series of "Documents from the Hoechst Archives" have been published. These splendidly edited publications represent a pioneering effort in company history disclosure whose public relations value exceeds considerably that of the anniversary volume under review here.

The main theme of this book is the resurrection of the Hoechst company from the disaster of World War II. Aside from the enormous task of rebuilding antiquated or destroyed plants, of reestablishing markets and capital, of reassembling and providing for a work force, of catching up with American and British scientific and technical advances in order to market a broad range of chemical products, of switching from coal tar to petrochemicals as the chief source of organic raw materials, the men of Hoechst had also to contend for over six years with American occupation authorities determined to shatter the former I.G. Farben combine into the smallest possible pieces. How the Germans finally succeeded in limiting the fragmentation to three major successor corporations (Hoechst, B.A.S.F., and Bayer) and how they fought each other over the industrial pieces makes interesting reading. One cannot peruse this success story without being impressed again with mankind's toughness and ability to rebound from disaster quickly especially when, as in Germany, the surviving population still possesses a vast accumulation of skills, of disciplined habits, and of high material aspirations.

Since it is always illuminating to observe how others experienced certain well-known events, many will read with profit Hoechst's view of the commercial synthesis of such products as penicillin, insulin, Salvarsan, ammonia, acetylene and its derivatives, dispersion and reaction dyestuffs, polyvinyl acetate and chloride, cellophane, Nylon, Perlon, polyester fibers, and many others. The closing chapter makes some revealing comparisons between the managerial philosophy and financial posture of the company today and before World War I; but its apologetic and defensive tone vis-à-vis the critics of big business seems to this reviewer of questionable necessity and certainly an inappropriate way to close a festive volume.

One can hardly expect objectivity in such a work or extensive discussion of failures or unpleasant topics (such as the firm's relations with the Nazis), but

the reader should have been spared numerous and lengthy repetitions, mediocre to outright incomprehensible translation, and an astonishing profusion of typographical and technical errors (such as a reference to a graph which was left out of the English version of the book). Though hardly an unqualified success at public relations, this beautifully illustrated book does offer the public a fine overview of the chemical industry's historic development and of its ever changing and proliferating products and processes. Professionals in this industry will discover here and there in the chapters points of view and facts that will be new to them and that invite further reflection.

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Actions of Drugs and Subjects

Behavioral Pharmacology. TRAVIS THOMPSON and CHARLES R. SHUSTER. Prentice-Hall, Englewood Cliffs, N.J., 1968. xvi + 297 pp., illus. \$14. Prentice Hall Psychology Series.

Behavioral pharmacology is a first-generation discipline. It was born in the mid-1950's after the introduction of the tranquilizers revolutionized the treatment and management of behavioral disorders. Now it has its first text. It is a book of only 229 pages (excluding appendices and bibliography), and its chief weaknesses stem from its brevity. However, it is successful in enough ways to make it worth recommending to anyone wishing a first look at this field. Thompson and Schuster address themselves to graduate and postdoctoral students who have backgrounds in either pharmacology or psychology and who have been inadequately prepared in the other discipline. This book tries "to provide a systematic introduction to the principles and techniques of experimental psychology and the principles of pharmacology as they are applied in behavioral pharmacology."

The authors divide their book into three main sections. First, a 65-page introduction to pharmacology sets out some of the basic principles of this field, sketches the theory of neurohumoral transmission, and lists some of the drugs that are of behavioral interest. The authors then devote about 70 pages to the principles that underlie the experimental analysis of behavior. This section seems to me the least satis-

factory, partly because the chapters that comprise it have not been well integrated. Those who wish to use this book as a text for a course in behavioral pharmacology will be tempted to supplement it with, say, G. S. Reynolds' *A Primer of Operant Conditioning* (Scott Foresman, New York, 1968, 135 pp.), which sets down the principles of the experimental analysis of behavior in greater detail and more clearly than Thompson and Schuster's account.

Finally the authors devote a little less than a hundred pages to behavioral pharmacology itself. The best parts of the book appear here. Rather than trying for broad coverage they give extensive accounts of how specific problems are attacked by research workers. Here they talk to the reader in an almost conversational fashion about the problems they are tackling. Especially in the long sections that contain reports of their own work with drugs administered by the subjects themselves and Schuster's work (in collaboration with Zimmerman) on the development of behavioral tolerance to amphetamine, they succeed in giving the reader the feeling that he is watching intelligent men search for answers to difficult questions that, since posed in behavioral terms, will almost surely be answered.

The authors point out that whereas workers in more mature areas in pharmacology can look to physiology for background information, the behavioral pharmacologist usually cannot look to the psychologist for comparable information concerning behavior. This lack of knowledge of whether even slight changes in the parameters of the behavioral situation will lead to changes in the action of a drug forces the behavioral pharmacologist to spend much time studying the behavior itself.

One product of this study has been the growing realization that parametric variation is as essential on the behavioral side as is dose variation on the pharmacological side. I would predict that one day it will be thought as foolish to study a single example of the behavior as it now appears foolish to study a single dose of a particular drug.

The goals of behavioral pharmacology, according to Thompson and Schuster, are first, "to devise the most parsimonious techniques of behavioral control in the investigation of drugs," and second, "to use these behavioral control techniques to investigate the mechanisms of drug action." The "mechanisms of drug action" they refer to are

behavioral rather than physiological or biochemical; the questions asked concern which aspects of behavior and its controlling variables are affected by particular drugs. The examples they give all reflect this emphasis upon behavioral mechanisms of action. However, perhaps because of space limitations, the authors nowhere attempt a more theoretical account of these mechanisms. Fortunately such an account does exist, and the interested reader could supplement this text by referring to R. T. Kelleher and W. H. Morse's recent article "Determinants of the specificity of behavioral effects of drugs" (*Ergebnisse der Physiologie*, vol. 60, pp. 1-56, 1968).

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Vertebrate Structures

The Membranes. ALBERT J. DALTON and FRANÇOISE HAGUENAU, Eds. Academic Press, New York, 1968. xiv + 224 pp., illus. \$12.50. Ultrastructure in Biological Systems, vol. 4.

This volume contains four review articles which are clearly written and well illustrated. There are no cross-references and only the membranes of vertebrate cells are considered. No explanation for this is given. In a book on the ultrastructure of membranes in biological systems protozoa, bacteria, and higher plants deserve some attention. In his foreword, J. F. Danielli points out some other recent work that is pertinent but not covered here and summarizes new results from his laboratory. He also reemphasizes the limitations of his model, which are sometimes forgotten by its more ardent proponents.

Audrey M. Glauert and J. A. Lucy in their contribution mainly recount experiments on the electron microscopy of negatively stained mixtures of different lipids in water. The results are of interest; however, their relevance to the elucidation of ultrastructure in biological membranes remains to be demonstrated. The bibliography covers literature up to 1964 very well; there is one reference to an abstract from a meeting dated 1965 and one quotation of a 1967 paper "in press."

The paper on isolated liver cell membranes by E. L. Benedetti and P. Emmelot gives by far the most comprehensive and unbiased review available

of present knowledge and views of membrane ultrastructure. Some minor inaccuracies can be found in the historical introduction; for instance, the orientation of the lipid molecules in the bimolecular leaflet was already specified by Gorter and Grendel in 1925 and should not be attributed to Danielli and Davson. Most of the space is devoted to a very detailed morphological analysis based on many technically excellent electron micrographs. The otherwise lucidly written paper becomes somewhat confused and hazy in the attempt to apply to membranes the subunit concept developed by Caspar and Klug for virus structure. Biochemical studies on the membrane fractions are presented concisely with a short but comprehensive coverage of related studies in other laboratories including papers up to 1967. The conclusions, that so far there is no chemical evidence for a subunit structure and that an integrated picture of membrane ultrastructure from chemical and morphological data cannot at present be constructed, may fall short of what readers might expect and what other workers are willing to conclude from similar or poorer data. In my opinion, it reflects a realistic evaluation of the experimental results.

The title of G. de-Thé's paper, "Ultrastructural cytochemistry of the cellular membranes," is misleading. The paper is essentially a catalog of the different phosphatase activities that can be demonstrated in cellular membranes by cytochemical techniques.

"Ultrastructure and function of cellular membranes" by F. S. Sjöstrand is based mainly on the morphological work done in the author's laboratory during the last 20 years. Sectioned material is used almost exclusively. The electron micrographs show a resolution far superior to that achieved by most other workers in the field; detail down to a size of 10 Å is clearly shown. The style is rather polemic and sometimes flamboyant; for instance, the inner membrane particles of mitochondria are consistently referred to as "lollipops" and judged to be "artifacts introduced by a primitive preparation procedure" yielding pictures that "would lend themselves beautifully as a source of inspiration for the creation of abstract art or for fortune tellers" (pp. 185-86). These particles have, however, been isolated by Racker and his group and shown to be a protein with adenosine triphosphatase activity and part of the oxidative phosphorylation mechanism. From the results obtained