NEW BOOKS

The Chemical Kinetics of the Bacterial Cell. By C. N. HINSHELWOOD, FRS, Dr. Lee's Professor of Chemistry, The University of Oxford. At the Clarendon Press, 1946, Oxford University Press, 114 Fifth Avenue, New York, N. Y., 1947. x + 284 pp. Price, $6.75.

Any book treating such different phenomena as cell growth, adaptation to drugs, adaptation to new sources of carbon and nitrogen, and cell division in the biologically simple but chemically complex systems known as bacterial cells must, as the author implies, have many "gaps and vaguenesses." None the less, the book is timely as is suggested by the devotion of a session of the Princeton Bicentennial Conferences on the Chemistry and Physiology of Growth to this very subject. Hinshelwood has succeeded in "placing certain matters in relation to one another" and, in so doing, should on the one hand make chemists aware that "bacteriology presents many problems that concern them" and on the other, make bacteriologists realize that chemists can materially help them. Even if there is "a certain frequency of domestic references," he has, on the basis of simple chemical kinetic considerations, suggested mechanisms which often accord with known facts. And they often suggest further experimentation.

A first introductory chapter of twenty-six pages defines the scope of the essay and briefly treats the kinetics used in his development. He considers successively the Langmuir adsorption isotherm, the kinetics of successive linked reactions, the concept of stationary states, what he calls the scale effect (that is the variation in the ratios of volumes and surfaces of solids as their linear dimensions are changed), spatial arrangements in lattices and the structure of complex molecules and even organisms. A second chapter of thirteen pages serves primarily to orient chemists not familiar with bacteriology concerning such matters as growth, classification and cultivation.

The third chapter in thirty-four pages deals with various phases of growth, lag, logarithmic phase and stationary phase. These are related to concentration of constituents in the medium, including H ions, size of inoculum and age of cells. Although the author's subsequent treatment has permitted analysis and often at least a partial explanation of the phenomena, which can and should be tested experimentally, this reviewer believes that a consideration of the logistic, to which growth more closely conforms, might have been included.

In the fourth chapter, the kinetics of reactions involved in linked cell processes and enzyme sequences are mathematically treated. Lag, cell division and adaptive phenomena are theoretically related to the velocity constants of postulated linked enzyme reactions and to the concentrations of intermediates formed.

The mode of action of certain drugs on bacterial cells and the adaptive reaction to drugs is discussed in the sixty-five pages of Chapters V and VI. Although the magnitude of distribution coefficients of the drugs between cells and medium, and the rate of penetration of these substances into the cells no doubt influence their effectiveness, Hinshelwood cites evidence which in certain cases clearly relates the observed phenomena to interference with definite stages in the reaction sequence. Evidence is also brought forward to illustrate the dependence of hindrance of growth in such factors as ionization, *p*H, chemical structure, and in particular the relation of the stereochemical structure of the interfering substance to that of the enzyme and substrates ordinarily present in the cultures. Adaptation (including cross adaptation to two dissimilar substances) and training, often considered the result of the natural selection of resistant organisms, are here considered as either a possible result of changing ratios between the velocity constants of the reactions between those enzymes and substrates ordinarily present within the cell, or as being due to the use of preëxisting alternative reaction routes which ordinarily are quantitatively insignificant. In certain cases, the theoretical explanations derived on the basis of kinetic equations set forth in Chapter III lead to qualitative and quantitative mathematical accord with observed data, in others the agreement is only qualitatively satisfactory. Further, it is suggested that induced reversion to drug sensitivity on the part of trained cultures may also be interpreted in these terms.

Chapter VII (33 pages) concerns adaptation to new sources of carbon or nitrogen. To the extent that the phenomena resemble those of drug adaptation similar kinetic principles should, and do in part, apply. Hinshelwood suggests, however, that in the case of drug adaptation, the inhibition of certain parts of enzyme systems is compensated for by increased activity of others. In the case of adaptation to a new specific sugar in the medium, increased growth is accompanied by parallel changes in specific dehydrogenase activity. This and other similar results are believed by the author to be due either to expansion of an existing enzyme system, or to a slight modification in structure of the enzyme. It is further suggested that rapid reversion is readily explicable if the adapted enzyme is equally as efficient as the original in utilizing the old substrate.

Chapters VIII and IX deal, in thirty pages, with variants and natural selection. According to earlier observers, the appearance at the time of cell division of abnormal variants having new and different properties, together with the natural selection of those cells adapted for growth in the new environment, would account for many of the phenomena already discussed. Without completely denying these possibilities, Hinshelwood suggests that adaptation is often sufficient to account for variation coincident with transplantation to new media, especially since the hypothesis of variability might entail greater bacterial instability than is ordinarily observed. He believes that except as an auxiliary hypothesis, selection is unnecessary to explain adaptation or reversion. But these are admittedly moot points, and further experimentation is necessary.

In Chapter X, one finds a brief discussion of cell division, and of changes in the external environment which give rise to abnormal shape and size distribution of the cells. The former process is not yet clearly understood; one can merely suspect with the author "that localized happenings within the cell precede the fission—and many very possibly occasion it." Chapter XI includes brief reviews of bacterial death rates, the influence of temperature on bacterial growth, the importance in nature of thermophilic bacteria, spore formation, adaptation of bacteria to changes in temperature, and lysis. With Chapter XII, which is devoted largely to comments on the type of mechanism necessary for bacterial growth, the nature of living matter, and what the author calls short and long range problems; these chapters cover fifty-two pages.

Subject and author indices together with an excellent initial table of contents complete the book.

Technically the book is well printed and free from obvious uncorrected errors.

Altogether, this book effectively reconciles available, but often superficially unrelated data on the basis of simple theoretical considerations. A more extensive discussion relating stereochemical configuration and energetics as well as discussion of the significance of the logistic would have been appreciated by this reviewer. The evidence supporting some of the postulated mechanisms is sometimes admittedly scanty. And, even if some of the phenomena discussed can be mathematically described in

terms of the assumptions made, further experimentation is, as the author indicates, necessary for complete confirmation. Neverthless, it represents a real contribution to an understanding of living matter.

The validity of Hinshelwood's conceptions and the importance of this contribution will presumably be measured largely in terms of further investigations, many of them presumably suggested by his book. Fortunately new tools, which should facilitate the enormously difficult task of investigating enzyme systems do exist. Their use may well be influenced by the ideas assembled by the author.

RONALD M. FERRY

Fourier Transforms and Structure Factors. By DOROTHY WRINCH, B.A., M.A. (Camb.), M.Sc., D.Sc. (Lond.), M.A., D.Sc. (Oxon.), Lecturer in Physics, Smith College. ASXRED Monograph Number 2. Published by The American Society for X-Ray and Electron Diffraction (February, 1946), 96 pp. (Copies obtainable at a cost of $4.00 each from Dr. C. C. Murdock, Treasurer, Department of Physics, Cornell University, Ithaca, New York.)

In this monograph, Dr. Wrinch has made a study of the Fourier analytical methods which may be used in the calculation of the structure factors for hypothetical distributions of matter within the unit cell of a crystal. She has considered in particular the cases in which the atoms in a molecule are located on a lattice which may or may not be rationally related to the crystal lattice. She has also considered the structure factors of continuous distributions of matter. Application is made of these results to the calculation of the structure factors of many special sets of points of crystallographic interest. Comment is also made on the use of these methods in the calculation of the diffraction from small particles and in the consideration of vector distance maps.

The results of this monograph should be of interest to the crystal analyst who wishes to consider the application of the "molecular structure factor" method to problems which involve relatively large molecules. The monograph should also be of interest to the student of the Fourier transform and of diffraction theory since it presents, in analytical and in graphical form, the transforms (*i. e.*, the diffraction patterns) of a large number of distribution functions.

A. L. PATTERSON

Meson Theory of Nuclear Forces. By WOLFGANG PAULI, The Institute for Advanced Study, Princeton, New Jersey, and Federal Polytechnicum, Zurich, Switzerland. Interscience Publishers, Inc., 215 Fourth Avenue, New York 3, N. Y., 1946. 69 pp. 14 × 21 cm. Price, $2.00.

Beginning in the fall of 1944 a series of "rehabilitation" lectures was arranged at the Massachusetts Institute of Technology, primarily for the benefit of the staff of the Radiation Laboratory. There was such eagerness for "rehabilitation" that the lectures, each of which took the heart out of a Saturday afternoon precious to people still heavily engaged in war work, drew large audiences.

This little book reproduces, with a few small changes and a division into six chapters, the notes prepared by J. F. Carlson and A. J. F. Siegert on the first series of five lectures, given by W. Pauli. The lectures were by no means a course of instruction; they rather presented, in compressed form, the material which, in normal times, might have been encountered from time to time by attending colloquia and society meetings and browsing in the literature. This could be valuable both to those wishing to get back into the field as specialists and to physicists who value a general acquaintance with developments in the subject.

Some of the material is extremely technical, but much of it also offers some satisfaction to those with comparatively little background—say only a thorough course in quantum mechanics. Much of the generally interesting material appears in Chapter I, on the relation of the various types of meson fields to nuclear forces, Chapter II, on the extended-source model, and Chapter V, on neutron–proton scattering. Harder knots of technicalities occur in Chapter III, on meson scattering and magnetic moments, Chapter IV, on Heitler's and Heisenberg's ideas for eliminating divergences, and Chapter VI, on the two-nucleon system with strong coupling. Passages in which difficulties seem to come from inadequate presentation, rather than mere mathematical complexity, appear in connection with the strong coupling theory, pages 34–35, 57 and 61. Most of the references are to recent and specialized work rather than to background material.

Every serious student of relativistic quantum theory will own and read this book.

WENDELL H. FURRY

BOOKS RECEIVED

July 10, 1947–August 10, 1947

T. R. HOGNESS and WARREN C. JOHNSON. "Qualitative Analysis and Chemical Equilibrium." Third Edition. Henry Holt and Co., 257 Fourth Ave., New York 10, N. Y. 553 pp. $3.20.

WERNER KUHN. "Physikalische Chemie." B. Wepf and Co., Verlag, Basel, Switzerland. 374 pp. 15 francs.

Y. R. NAVES and G. MAZUYER. "Natural Perfume Materials." Translated by Edward Sagarin. Reinhold Publishing Corporation, 330 West 42d St., New York 18, N. Y. 338 pp. $6.75. (Corrected notice.)

F. C. PHILLIPS. "An Introduction to Crystallography." Longmans, Green and Co., Inc., 55 Fifth Ave., New York, N. Y. 302 pp. $6.50.

M. W. WOERDEMAN, General Editor. "Radiology." (Section XIV of *Excerpta Medica*.) Vol. I, No. 1. *Excerpta Medica*, 111 Kalverstraat, Amsterdam C, The Netherlands. 56 pp.

FREDERICK A. WOLF and FREDERICK T. WOLF. "Fungi." (In two volumes.) John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Volume I, 438 pp. $6.00. Volume II, 538 pp. $6.50.