

brief, as it should be for the beginner; and the details of the treatment have been carefully thought out and clearly written. The result is probably as satisfactory a student's text as we have.

But a general comment in conclusion seems to be called for. Many people like to have their thermodynamics developed as a sort of sub-topic of the theory of ideal gases. They appear to think it suitable that one of the most beautiful and wide-reaching branches of physical theory should be developed largely from the properties of bodies that exist only in the imagination. In the reviewer's opinion, this procedure is neither necessary nor wise. There are two ways in which an exposition of theoretical thermodynamics can be written. One can reach the absolute temperature and the entropy from the properties of ideal gases, as Professor Buckingham has done; or he can arrive at these functions from fundamental physical postulates. The latter method reaches true results from true premises; while the former jumps to true results from untrue premises. The latter method, properly worked out, is fully as easy of comprehension as the former; and it gives a broader view: for it parallelizes the thermodynamic temperature with other potentials, and the entropy with other quantity-co-ordinates; and it brings out the distinction between forces and potentials, and between spaces and quantity-co-ordinates. As a plain matter of fact, the theory of thermodynamics of the present day is a symmetrical mathematical analysis of the general problem presented by a small number of inductively established postulates; and, in consequence, it cannot be grasped until it is comprehended as a logical system of mathematically developed theory.

J. E. TREVOR.

Microorganisms and Fermentation. By ALFRED JORGENSEN. Third edition. Translated by ALEX. K. MILLER and A. E. LENNHOLZ. The Macmillan Co. Pp. 318.

A practical knowledge of the phenomena of fermentation has been possessed by man from time immemorable. Until the present century, however, this knowledge has been purely an empirical one, the real cause of the phenomenon

not being suspected. The present century has seen the development of the subject from a scientific standpoint, until to-day our knowledge of the process of fermentation is thoroughly systematic and based upon accurate experimentation. The development of our present knowledge upon the subject is properly divided into three periods. The first was that of the indefinite work of the early decades of the century, when Schwann and others were demonstrating that fermentative processes were closely related to the life activity of microorganisms. The second period was dominated by the revolutionary work of Pasteur. Under his influence not only was it demonstrated that fermentations were caused by microorganisms, but various types of fermentation were recognized and found to be produced by different species of microorganisms. Under Pasteur's influence the microscope came to be an aid to the fermentative industries and many a valuable practical method was suggested and applied to the fermentative processes. The third period has been the most fruitful in results and in many respects the most important. This period has been dominated by Hansen, of Copenhagen. So valuable has the work of Hansen been to the brewing industry that a large brewery of Copenhagen has erected for his use one of the best equipped laboratories in Europe, designed both for practical experiments and for pure scientific investigation. This third period of discovery has been dominated by the invention of methods of procuring *absolutely pure cultures* of yeasts.

There is no one better able to write an account of the relation of microorganisms to fermentation than the author of this work, who lives in close relation to Professor Hansen, and if his presentation of the subject is possibly unduly influenced by Hansen's work it is not to be wondered at. The fact is that the whole subject of fermentation has been entirely changed in the last two decades as a result of the study of the strictly pure cultures obtained by Hansen's methods. The earlier theories of fermentation have given place to the theory that fermentations are the results of enzymes produced by microorganisms. The knowledge of the yeast organism has been completely changed as the result of the study of pure cul-

tures. The few species known to Pasteur have become many and distinct in the hands of modern students. The diseases peculiar to fermented products, attributed by Pasteur to bacteria, have been found to be frequently due to yeasts which are present as impurities, and the whole method of conducting fermentations in the great breweries has been modified in consequence. All these facts are brought out in more or less detail in this work of Jorgensen, who shows on every page of his writing a knowledge of the facts at first hand.

The whole work is not confined to the fermentations produced by yeasts. The growing knowledge of the significance of bacteria in fermentations has demanded attention, and the more important species of moulds are not overlooked. The treatment of this side of the subject is much less satisfactory than the study of yeasts. In his discussion of the butyric fermentation, the lactic fermentation and other strictly bacteriological phenomena Professor Jorgensen is evidently not so much at home as when he is writing of yeasts.

The most valuable part of the work is, therefore, the review of our present knowledge of yeasts. He describes the methods of studying air and water; the most recent methods of obtaining absolutely pure cultures of yeasts, the methods of cultivating them and experimenting with them. A considerable part of the work is taken up by a description and by figures of the many species of yeasts which have been differentiated from each other by modern study. Their methods of forming spores, of germinating, of forming films, and, in short, all of the characters of yeasts which are used today by the specialists in describing yeasts are carefully and fully discussed. As a morphological and physiological study of this extremely important group of plants the present work is complete and unequalled. Certainly there is no work in English that contains such a comprehensive account of the modern knowledge of yeasts and their relation to fermentation.

The name of The Macmillan Company on the title page is a sufficient guarantee of the excellence of the press work, as the name of the author is a guarantee for its scientific accuracy. It seems strange, however, that the author, the

translators and the publishers should have allowed such a book to be published without an index. A book of this sort may perhaps be designed for consecutive reading, but it will be much more commonly used as a book of reference. As a book of reference its value would be doubled by the presence of a good index. No excuse can be given in these days of many books for omitting such an indispensable part as an index. The lack of the index is in part made up by a magnificent bibliography containing references to all the important works bearing directly or indirectly upon the problems of fermentation. This will be to the student perhaps the most useful part of the whole work.

H. W. C.

BOOKS RECEIVED.

Air, Water and Food from a Sanitary Standpoint. ELLEN H. RICHARDS and ALPHEUS G. WOODMAN. New York, John Wiley & Sons; London, Chapman and Hall, Limited. 1900. Pp. iv + 226. \$2.00.

Prehistoric Implements. WARREN K. MOOREHEAD. Cincinnati, The Robert Clarke Co. 1900. Pp. xv + 429.

Die Chemie in täglichen Leben. LASSAR-COHN. Fourth edition. Hamburg and Leipzig, Leopold Voss. 1900. Pp. viii + 320. 4 Mark.

A Brief Course in General Physics, Experimental and Applied. GEORGE A. HOADLEY. New York, The American Book Company. 1900. Pp. 463. \$1.20.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, April. 'A Preliminary Investigation of the Conditions which determine the Stability of Irreversible Hydrosols,' by W. B. Hardy; 'On the Mechanism of Gelation in Irreversible Systems,' by W. B. Hardy; 'Isohydric Solutions,' by W. D. Bancroft; 'Vapor-pressure Relations in Mixtures of Two Liquids,' by A. E. Taylor; 'In Reply to a Statement made by Dr. R. Cohen in a Paper on the Theory of the Transition Cell of the Third Kind,' by H. T. Barnes.

May. 'On the Weston Cell as a Transition Cell and as a Standard of Electromotive Force, with a Determination of the Ratio to the Clark Cell,' by H. T. Barnes; 'On the Electrolytic Deposition of Metals from Non-Aqueous Solu-