tation has its virtues. For example, we cannot but become impressed with the relation of photosynthesis to other biological activities which build organic compounds by reducing carbon dioxide. Some plants require light but use H_2S as a reductant instead of H_2O. Others do not even require radiation, but rely on the energy they get from simple organic substances. The pattern is the same, but the specific means vary. This hierarchy of CO_2 reduction processes may help us imagine the origin and development of photosynthesis. It shows us simpler systems which could have furnished energy for life before the invention of chlorophyll, a substance which is high in the structural scale and needs living tissue for its manufacture.

This is a great book, which will serve for many years as *the* source book of critically digested information about photosynthesis. It is to be hoped that Rabinowitch will not keep us waiting too long for the second volume and that, having acquired all this erudition about photosynthesis, he will take his learning lightly and write a small book for the uninitiated so that the general scientific public may profit from his prodigious labors.

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Sampling statistics and applications: fundamentals of the theory of statistics. **James G. Smith and Acheson J. Duncan. New York and London: McGraw-Hill, 1945. Pp. xii + 498. (Illustrated.) $4.00.**

This volume is a very well-presented combination of advanced statistical method and both elementary and advanced sampling theory. It is intended for advanced students and research workers and is gauged at a level which makes a thorough knowledge of elementary statistics a prerequisite to its enjoyment and comprehension. However, granted a thorough training in the elements of statistics, basic concepts and definitions in advanced theory are clearly presented. Symbols are well defined, and the scope of mathematical treatment is chosen in a manner which makes the volume very valuable as a text and as a reference book.

After the general theory of frequency curves has been discussed, the theory of random sampling is presented in Part II, proceeding to an advanced exposition in Part III. Parts II and III deal with important sampling considerations not usually found in statistical texts. The advantages and necessities of random sampling are discussed, and a very careful treatment of the practical difficulties encountered in the use of random sampling is included. In this connection the authors explain why it must be admitted "that confidence in an inference based on a random sample is dependent on the 'thought' or firm belief that it is a truly random-sample. Whether thought with respect to randomness is any sounder, as a basis for inferences, than thought with respect to representativeness of a sample obtained by some other method is a debatable question." Recent conflict of theory among experts indicates the vital significance of this consideration.

A portion of the section devoted to elementary sampling theory discusses the value of stratified or representative random sampling. The authors point out the value of stratification when it is based on correlates with the survey objective. They recognize a reduction in error when proper representation is achieved: "The significance of stratified or representative random samples is that it reduces sampling errors."

Sampling is discussed in relation to the assembly of evidence and also in relation to the estimation of population parameters. This allows an extension of the theory to our ordinary statistical conceptions of reliability and confidence. The boundaries of statistical inference are defined, and examples of their application are given.

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The bacterial cell. **René J. Dubos (with an addendum by C. F. Robinow). Cambridge, Mass.: Harvard Univ. Press, 1945. Pp. xix + 460. (Illustrated.) $5.00.**

This thought-provoking discussion integrates our knowledge of the biological and chemical architecture of bacteria with the classical techniques of cytology and interprets some of the phenomena of the infectious process in terms of the biochemical architecture of the bacterial cell. The author makes the point in his Preface that "in addition to physicochemical properties shared by all living forms, each bacterial type possesses a structural and biochemical individuality which could serve as a basis for an orderly statement of the problems of cellular organization, and for a rational system of classification based on phylogeny." Known facts, however, are too few for convincing integration and generalization—thus a plea for more fundamental investigations in the field of bacterial physiology.

The volume is the outgrowth of a course of eight lectures delivered under the auspices of the Lowell Institute in Boston. The chapter titles are important enough to note: "Materials, Problems and Methods," "Cytology of Bacteria," "Physicochemical and Staining Properties of Bacteria," "Analysis of Cellular Structure by Biochemical and Biological Methods," "The Variability of Bacteria," "The Nature of Virulence," "Immunization Against Bacterial Infection," "Bacteriostatic and Bactericidal Agents," and "Trends and Perspectives." The addendum is entitled "Nuclear Apparatus and Cell Structure of Rod-shaped Bacteria."

The author discusses the many controversial questions impartially and with credit to the protagonists of both sides. Where final conclusions are unwise, they are not made by the author.

The author's statement, "Even among the Eubacteriales—the so-called true bacteria—one finds strange bedfellows, such as small Gram-negative autotrophic organisms, the Gram-positive proteolytic spore formers, acid-fast bacilli, which differ so profoundly from each other in metabolism, structure and even mode of division as to have little in common except microscopic

dimensions,'' should engender lively discussion. Perhaps ''the methods employed by bacteriologists rather than the biological material'' are defined by the microscopic size of the bacteria which impose certain physical and chemical characteristics, rather than the biological material.

In speaking of the phylogeny of bacteria, if we accept with the author the principle of ''retrograde evolution by loss of certain characters,'' one may beg the question in reasoning that heterotrophs preceded autotrophs. The latter possess so many physiological abilities, e.g. formation of vitamins and enzymes, that the argument works both ways, and no conclusion is reached. Apparently we have not determined what are the essential losses which constitute ''retrograde evolution'' or ''loss variation.''

Until the Twentieth Century bacteriology was a science of new forms of life without much regard to activities. The great productivity era in bacteriology came with the realization that bacteriological phenomena constitute events of great importance to man—transformation of organic matter and parasitism. During the past few decades the problems of bacteriology have been stated in terms of the classical sciences and of the prevalent biological, physiological, and biochemical philosophies. Dubos points out that much of our theoretical knowledge was a by-product of the solution of practical problems by empirical methods, and examples are given of the practical advantage of theoretical knowledge, e.g. development of vaccines, therapeutic sera.

Bacterial specificity is discussed from the point of view of its various levels, *i.e.* strain, species, genus, etc., and of its type, *i.e.* immunologic, enzymic, structural, or biochemical.

The author points out that a too narrow interpretation of the dogma of the fixity of bacterial species led to a neglect for nearly 50 years of one of the most intriguing and important characteristic properties of the bacterial cell, namely, its ability to undergo environmental and hereditary transformations. Final recognition of this phenomenon suggested powerful and original techniques for the study of cellular organization and provided new points of view which define the place of bacteriology among the biological sciences.

Pertinent to the systematic chaos occurring in the classification of bacteria is the statement to the effect that in the description of bacterial groups (e.g. species) descriptive characters are used which are precisely those that have been found to undergo variation. It seems likely that the progress of bacterial taxonomy and the study of evolutionary trends among bacteria will require that cultures be described in terms of their multiple potentialities and not of an accidental phenotype.

The chapters are well organized and interestingly written. The reviewer appreciated particularly the author's discussions of bacterial variability (Chap. V) and bacteriostatic agents (Chap. VIII). This book is essential to bacteriologists, biochemists, and biologists.

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