efforts to have the 'honest heretic' locate in Philadelphia instead of in Northumberland." The reviewer has been unable to determine who first gave rise to this pleasing phantasy. It is too bad to brand it as a figment of the imagination; Franklin died in 1790 and Priestley did not arrive in America until 1794.

Following the statement about Franklin, we note another oft-repeated legend that "Priestley discovered carbon monoxide after he came to America." This story has been reiterated so often by various writers that the reviewer, after a long belief in its truth, was finally led to ascertain the facts which, upon inspecting Lowry's excellent "Historical Introduction to Chemistry," were found to be as follows: Lassone first prepared carbon monoxide in France in 1776 by heating zinc oxide with charcoal and reported its property of burning with a blue flame; in 1777 Lavoisier independently prepared the same gas by heating charcoal with alum; in 1785 (nine years before he came to America) Priestley prepared the same gas by heating smithy scale and charcoal, noting, as did Lavoisier, that the inflammable air on combustion yielded fixed air (carbon dioxide), which led him to conclude that it was composed of fixed air and phlogiston; in 1801 Cruikshank, in England, proved the gas in question to be a new compound of carbon and oxygen, which he named gaseous oxide of carbon, but this view was criticized by Berthollet, who argued that the gas must contain hydrogen. Désormes and Clément, in France, proved, however, that no water was formed when the gas was burned, and hydrogen must therefore be absent; in 1849 Stas made the first accurate analysis of the gas, proving it to contain 57.16 per cent. oxygen and 42.84 per cent. carbon.

All this is a far cry from the statement that Priestley discovered carbon monoxide in America. Let us hope that these and other misleading legends about eminent chemists may cease to be published. The repetition of every kind of chemical hearsay is not the history of chemistry. The historians of our science should check quoted statements so far as possible with original sources of information. Students should be trained to cultivate this critical attitude in their history of science courses, and a more complete bibliography of reference works might have been given in the present volume to assist them in such collateral reading. The omission, for example, of a reference to the works of von Lippmann, the dean of historians of chemistry, is an unfortunate oversight.

The quotation on page 16 of the book that to one man science is a sacred goddess and to another only a cow who provides him with butter is not original with Liebig, as stated, but was taken by Liebig from Schiller's famous couplet entitled "Wissenschaft." The misspellings "Société d'Arceuil" (p. 122) and "Genthe" (pp. 335 and 438) are among other minor inaccuracies which should be corrected in a future edition.

The publishers must also do their part in helping to maintain the fine excellence of the first edition of Moore's "History of Chemistry." A comparison of the same illustrations in the first and third editions indicates a marked deterioration in some of the plates. The reinsertion of the list of plates, which is omitted in the present edition, would also be an added convenience.

C. A. BROWNE

BACTERIAL METABOLISM

Bacterial Metabolism. By MAJORY STEPHENSON, Sc.D. Second Edition. 391 pp. London, New York, Toronto: Longmans Green and Company. 1938.

SOMEWHAT chemical, perhaps, for the average bacteriologist, and rather bacteriological for many biochemists, the book illustrates well the position of the worker in this field. Welcomed to neither group by its prophets, yet impelled to be on speaking terms with the subject-matter and disciplines of both, he is blessed with an abundance of problems, theoretical and practical, whose solutions frequently become incorporated in the thought of one or the other of the basic sciences, and in any event supply comfort to the discoverer in his academic solitude.

Perhaps the picture is not quite so dreary, for if one may judge from the bibliography, which covers fifty pages, great numbers of investigators, at one time and another, have invaded this scientific no-man's-land. Many of these have clearly returned unharmed to their own lines. Others have remained as prisoners, perhaps not entirely unwilling, in the other camp. But a third group (and here the metaphor fails) have elected to continue as Miss Stephenson herself has done, in the somewhat nebulous, but none the less fruitful field of bacterial chemistry, or chemical bacteriology, and to make contributions of general and far-reaching importance.

The book includes chapters on "Respiration," "Polysaccharides," "Fermentation," "Decomposition of Proteins," "Nucleic Acid," "Nutrition and Growth," "Nitrogen Fixation," "Autotropic Bacteria," "Bacterial Photosynthesis" and "Enzyme Variation and Adaptation."

The excellence of the chapters on "Respiration" and "Fermentation" perhaps reflect their writer's interest in these particular phases of the subject. Among the past generation of bacteriologists were a few sometimes referred to not quite reverently as "sugar-fermentators." Their aim was to collect all possible kinds of bacteria, or strains of one variety, and all conceivable (or available) carbohydrates, subject each of the latter to the influence of every one of the former, construct

a large chart presenting the results, and write a paper. Could some of these earlier workers but have foreseen the gold mine of facts underlying each appearance of acid in his culture tubes, the history of much scientific progress in the last twenty years might have been quite different. Even now, decomposition of glucose to alcohol and CO_2 by yeast appears to be the best understood of these fermentative processes, resembling in many ways the oxidation of sugar in the animal body and involving the recognition of both the nature and function of certain "vitamins." Before these chapters can be extended to describe the detailed mechanisms of all the various types of bacterial fermentation and respiration, other equally important substances will have to be sought and their actions clarified.

The chapter on "Enzyme Variation and Adaptation" also bears directly on this problem, as well as on other matters of very broad biological interest. The purposeful production of strains of bacteria showing abnormal sugar fermentation, the development of an enzyme specifically decomposing the polysaccharide of the Type III pneumococcus or of one which oxidizes thiocyanates of gas-waste liquors may seem to be unrelated phenomena. One may well inquire, however, what further practical applications will develop from this ability of unicellular organisms to produce specific enzymes in response to particular stimuli and how far an understanding of the principles underlying it will go toward explaining, for example, antibody formation in the animal body.

The chapter on "Nutrition and Growth" provides a further example of the recent advances which characterize the entire subject-matter of the book. It is stated in the preface that "this subject (bacterial growth) now attracts mathematicians and statisticians less than formerly, but has passed into the hands of biochemists interested in problems of nutrition." The new type of investigations began to bear fruit not more than five or six years ago, and a rich harvest of new facts is appearing annually. Miss Stephenson's chapter admirably summarizes the situation at the moment of publication. The discovery by the L'Woffs that the V factor for the growth of the Pfeiffer bacillus was identical with cozymase, and that of Knight that vitamin B was essential to the growth of the staphylococcus, attracted the immediate attention of investigators of animal nutrition to the possibility of using bacterial growth as a tool in their own field. The recognition that nicotinic acid was essential to the staphylococcus and the nearly simultaneous isolation of this material from liver extract in connection with studies on growth of the diphtheria bacillus were followed in a matter of weeks by the demonstration that the same substance cured black tongue in dogs and pellagra in man. With the continued extension of the subject-matter of this chapter will come many further contributions of the greatest importance to both biochemists and bacteriologists.

Other chapters merit equally favorable comment. Those dealing with nitrogen fixation and photosynthesis are particularly stimulating. In short, it is not too much to say that the biochemist or bacteriologist who reads this book will not fail to derive profit from the variety of facts now available in this borderline field, and to see many applications of possible new methods to his own particular problem.

The book is well printed and singularly free from typographical and editorial mistakes. Miss Stephenson recently told the reviewer that it was full of errors of omission and commission, but to the casual reader, at any rate, this would appear to be an over-statement. It is replete with excellent charts and tables, which illustrate many of the actual experiments of those workers who have contributed to the establishment of bacterial metabolism on a basis where it may now perhaps be considered to represent a science in its own right.

J. HOWARD MUELLER
DEPARTMENT OF BACTERIOLOGY
AND IMMUNOLOGY,
HARVARD MEDICAL SCHOOL

SPECIAL ARTICLES

A KINESTHETICALLY CONTROLLED MAZE HABIT IN THE RAT

THE problem of the role of kinesthesis in the control of such serial responses as are present in the maze habit has been investigated for thirty-odd years without a clear-cut proof that kinesthesis can control maze behavior. Watson believed that kinesthesis was the only necessary type of stimulus control, but later investigators were prompt in indicating the functioning of other types of stimulation both from within and without the maze. Lashley and Ball,[1] who used a simple alternation maze that was not rotated and whose units were not interchanged, severed practically all tracts in the spinal cords of rats, some tracts in one rat and other tracts in other rats, and found that the ability to perform the maze habit survived the operation irrespective of the locus of injury. The authors concluded that "the maze habit can not be interpreted as a series of kinesthetic-motor reflexes but must be referred to some intraneural mechanism capable of producing an integrated sequence of movements in the absence of directive sensory cues" (p. 100). These results were extended by Ingebritsen[2] to show that rats could acquire the maze habit after extensive cord lesions.

[1] K. S. Lashley and J. Ball, *Jour. Comp. Psychol.*, 9: 71–106, 1929.

[2] O. C. Ingebritsen, *Jour. Comp. Psychol.*, 14: 279–294, 1932.