falls to most American teachers. In this way the retiring allowance will contribute directly to research.

The abuses which, it is intimated, have led to the withdrawal of the service pension, seem to have been on the whole far less serious than has been assumed. The forcing of professors of long service to resign their positions has generally carried with it such danger to the president's own tenure of office that it has rarely been undertaken. There has been additional difficulty in that an aged professor whose efficiency had been impaired would be left without adequate financial support though fully deserving of rewards upon the basis of his earlier work. With the service pension provision withdrawn it will now be incumbent upon university presidents to retain upon their staffs all professors not physically disabled up to the age of sixty-five, no matter what may be their efficiency as teachers. It can hardly be doubted that the effect will be to lower the efficiency of teaching in the universities.

Wm. Herbert Hobbs
University of Michigan,
March 15, 1910

SCIENTIFIC BOOKS

The Oxidases and other Oxygen Catalysts concerned in Biological Oxidations. By J. H. Kastle. Hygienic Laboratory Bulletin No. 59, December, 1909.

The bulletins issued by the Hygienic Laboratory at Washington constitute a most interesting and valuable series of contributions which reflect the greatest credit upon the organization and spirit of this important department of the Public Health and Marine Hospital Service. For the most part these publications consist of experimental researches dealing with topics of timely interest to physicians and biologists in general, while some of them are of the nature of résumés of the literature and the condition of our knowledge in regard to special problems. The bulletin to which attention is called here belongs to this latter class. It contains an elaborate and thorough review of the history and present status of the difficult and complex subject of oxidations particularly as they occur in living things. Since this review is written by one who himself has been a distinguished contributor to the experimental investigation of the subject it possesses the additional value of being an authoritative presentation which other biologists may use with a feeling of confidence in its accuracy. Professor Kastle modestly disclaims any pretention to completeness as regards the literature consulted in the preparation of the bulletin, but it will be noted that four hundred and sixty-seven references are given in the appended bibliography, and those who read the contribution will be impressed with the fact that the author writes out of an unusual fullness of knowledge of the subject in its chemical as well as its biological bearings. After the discovery of oxygen by Lavoisier the history of the attempts made to disclose the nature of the processes involved in the physiological oxidations of plants and animals may be divided, according to Kastle, into three periods. The first of these deals with the bluing of guaiacum, especially by extracts of plant tissues. The names that are important in this connection are Planche, Taddei and particularly Schoenbein. The last-named observer studied the subject from many sides and arrived at a clear understanding of the fact that plants and animals contain special substances, destroyed at temperatures below that of boiling water, which have the property of combining with atmospheric oxygen and activating it so that it is capable of effecting the wonderful oxidations characteristic of living things. Schoenbein himself believed that these substances render the oxygen active by ozonizing it, but this view has not been confirmed by subsequent work. The second period is connected with the work of Traube, who was responsible for emphasizing the importance of hydrogen peroxide in all oxidations, including those of living things. His peroxide theory as developed later by Bach, Engler and others does not assume that hydrogen peroxide itself is formed in the processes of physiological oxidations, but that the organic substances which combine with the oxygen, designated

by Traube as oxidizing ferments, form compounds of the nature of peroxides which promote and accelerate the oxidation of other substances. This view may be represented in its simplest form by the two following equations in which A constitutes the oxidizing ferment and B the substance whose oxidation is effected through the agency of this ferment:

$$A + O_2 = AO_2$$
$$AO_2 + B = AO + BO$$

The third period considered by the author extends to the present time and begins with the work of Yoshida, Bertrand and others upon specific oxidases, particularly upon laccase and tyrosinase. The very interesting literature upon these and related oxidases is reviewed at length, and the author suggests the following classification of the oxidases as being in accord with our present knowledge:

1. Laccase; ferments oxidizing guaiacum, guaiacol, hydroquinone, phenolphthalin, tannin, etc., directly by means of atmospheric or dissolved oxygen, and without the intervention of hydrogen peroxide.

2. Tyrosinase; ferments acting on tyrosin and related substances, and responsible possibly for the production of melanin and other pigments in plants and animals.

3. Aldehydases; ferments oxidizing aromatic aldehydes and related compounds.

4. Indophenol oxidase; ferments oxidizing a mixture of α-naphthol and para-phenylene diamine to indophenol.

5. The purin oxidases.

6. The glycolytic ferments, causing the disappearance of sugar from animal tissues.

Closely related to these oxidases are the following catalytic agents which act in conjunction with hydrogen peroxide or related organic peroxides:

1. Peroxidases; ferments which exert an oxidizing reaction only in the presence of a peroxide, such as hydrogen peroxide.

2. Catalases; ferments which actively decompose hydrogen peroxide.

3. Oxygen carriers (not true ferments); this class includes substances such as hemoglobin and hemocyanin which are capable of activating the oxygen of hydrogen peroxide, even after their solutions have been heated to 100° C.

This classification brings up the perplexing question of the distinction made between the oxidases and peroxidases. According to the well-known views of Bach and Chodat all oxygen-activating ferments are really peroxidases. So-called oxidases, such as laccase and tyrosinase, consist of certain substances (oxygenases) capable of forming with oxygen unstable compounds of the nature of peroxides. The oxygen in these peroxides is rendered active by the ferment bodies designated as peroxidases. Laccase differs from tyrosinase in the specific nature of the constituent peroxidase. Kastle evidently does not hold to this or similar views, but recognizes the existence of at least two classes of oxidizing ferments, the oxidases and the peroxidases, as defined in the classification given above. As far as the peroxidases are concerned, he conceives that they are substances which are capable of producing peroxides either by double decomposition with hydrogen peroxide, or by forming an unstable addition product with hydrogen peroxide. These two possible reactions and the resulting activation of the oxygen are indicated schematically in the following equations in which P represents a peroxidase:

(1)
$$P + H_2O_2 = PO_2 + H_2O$$
$$PO_2 + B = BO + PO, \quad \text{or}$$
$$PO_2 + 2B = P + 2BO$$

(2)
$$P + H_2O_2 = H_2PO_2$$
$$H_2PO_2 + B = P + BO + H_2O$$

Kastle emphasizes the fact that the peroxidase reaction, as also the catalase reaction, constitutes one of the most universal and persistent properties of living tissues. When these reactions fail there can be no question that the tissue or organism concerned is dead.

In other sections of the review the author treats of the oxygen catalysts of blood in health and disease; of the very interesting discoveries in regard to the part taken by certain metals such as manganese, copper and iron in the activity of the oxidases and the peroxidases, and of the suggestive work done

upon the production of artificial oxidases; of the nature and supposed functional importance of the catalases, etc. It would be scarcely possible in fact to enumerate in a brief notice all of the important points which are discussed and reviewed. The author has laid his fellow biologists, who may be concerned in understanding the nature of physiological oxidations, under a debt of gratitude for his able and exhaustive presentation of this difficult subject. We can only wish that with his own extensive first-hand knowledge of the facts he had attempted to winnow from the great mass of contradictory or divergent observations those that to him might seem to be entitled to at least provisional acceptance at the present time. The reader who is not a specialist in this line of work is somewhat at a loss to appreciate how the balance of evidence tends in regard to many of the disputed points.

W. H. Howell

The Evolution of Worlds. By Percival Lowell. Pp. xiii + 262; 12 plates and 56 text cuts. New York, The Macmillan Company. 1909. $2.50 net.

This work is written in the well-known attractive style of the author. It is interesting and will probably fascinate and charm many readers of popular science. Its charm, however, lies in the literary skill of the author, in the attractiveness with which the book is manufactured, in the heavy paper, its clear type and its beautiful illustrations. As a work of art the book is charming and valuable; as an exposition of scientific facts and theories it is exasperating.

The theme of the book is the evolution of the solar system, the process by which the planets came into existence, the phases through which the world has passed, and through which it is destined to pass. Ever since Laplace, in 1796, formulated and published the nebular hypothesis, the subject of the birth, growth and death of worlds has aroused great interest and has attracted many able investigators. For nearly one hundred years the beautiful and simple theory of Laplace was accepted in its entirety by scientific writers. During the last quarter of a century, however, much has been learned concerning the present condition of the solar system, and many facts have been developed which, while establishing the broad underlying idea of planetary evolution, can not be reconciled with the simple Laplacian hypothesis. Sir George Darwin accepted the main outlines of the nebular hypothesis and accounted for the discrepancies between theory and fact by the agency of tidal friction. But there are limits to the potency of tidal friction and even in its modified form the nebular hypothesis fails to account in a satisfactory manner for all the complicated details of the solar system.

Within comparatively recent years Chamberlin and Moulton have advanced what is called the "planetesimal" or "spiral" hypothesis. It explains many of the difficulties encountered by the Laplacian or nebular hypothesis and is undoubtedly the most satisfactory working theory yet advanced. Their first papers were published as early as 1900, since which date they have from time to time elaborated and developed their theory.

Now, Lowell's book, in its main features, is an exposition of the "planetesimal" theory, but an exposition with no reference to, or mention of, the work of Chamberlin or Moulton. It is like the play of Hamlet with Hamlet left out. Neither Chamberlin's nor Moulton's name appears in the index, nor, in a careful reading of the book, do we find any mention of them or of "planetesimal" or "spiral" hypothesis. This is not so strange as at first glance it might appear, for Professor Lowell has recently attacked the scientific value of the theory and the standing of its authors. In the *Atlantic Monthly* for August, 1909, Lowell refers, in a foot note, to Chamberlin and the planetesimal theory in the following words: "Astronomically he is unaware that what prompted his contention, the planetesimal hypothesis, is *mathematically unsound.*" The publication of the "Evolution of Worlds," with its nameless presentation of the planetesimal hypothesis, shows that while Lowell appreciates the fundamental correct-