anaerobic, in which it comes from their fermentation. The comparative study of these two processes—respiration and fermentation—forms the subject of one of the most interesting chapters of the book, to which the previous sections on the mechanism of cell respiration and autoxidations in the cell serve as an introduction.

The author traces in detail the intimate relations which have been established between these two apparently independent but in reality closely allied processes, and concludes on a justifiably triumphant note: "It may indeed be considered a success of general physiology and its mode of experimenting, that the chemical dynamics of a highly differentiated organ like the muscle could be partly revealed by the study of the alcoholic fermentation of yeast."

The ensuing chapter, on the transformation of energy in muscle, carries the tale a stage further, and shows how far the tangled skein of physical and chemical changes involved in the contraction and relaxation of muscle has been unravelled. To appreciate the boldness of idea and skill in technique which have gone to the solution of this problem, this work must be studied in detail. To summarise very briefly and imperfectly, it may be said that during the contraction of a muscle, glycogen is rapidly converted into lactic acid, energy being thus rendered available by the chemical change and by the reaction of the resulting lactic acid with the alkali protein of the cell, too great a change of hydrogen ion concentration being at the same time avoided. So far the change is anaerobic and independent of the presence of oxygen. Relaxation is accompanied by the absorption of oxygen and the complete oxidation of a varying fraction, a quarter to a sixth, of the lactic acid, the remainder of the lactic acid being at the same time reconstituted into glycogen and the alkali protein of the cell restored to its original condition. Truly a remarkable device.

The concluding chapter is more general and speculative in its character, and deals with the difficult question of the constant exchange of energy which goes on in cells which perform no external work. No complete answer to this question has been obtained, but its investigation, particularly with respect to the metabolism of bacteria and algæ, has led to many important results which are here chronicled. One interesting point alone can be picked out for reference. The author has shown by direct experiment—poisoning a mass of respiring avian blood corpuscles in a calorimeter—that the old idea that living protoplasm has a higher energy content than dead is incorrect. No evolution of energy occurs at the moment of death, and the mysterious difference between living and dead matter cannot be explained on energetic grounds.

This short work must be regarded as a true romance of science, and to the sufficiently prepared reader its pages present a theme of the most enthralling interest. A pleasant feature of the book is the ungrudging recognition of the contributions of other workers to a subject which has aroused widespread interest and has been approached from many different directions.

ARTHUR HARDEN.

Our Bookshelf.

The Nature of Life. By Prof. W. J. V. Osterhout. (Brown University: The Colver Lectures, 1922.) Pp. vii+117. (New York: Henry Holt and Co., 1924.) 1.50 dollars.

A MOST pleasantly written book that discusses such questions as the origin, criteria and control of life in a manner making the story of what the biologist has done and is doing in that particular field readily intelligible to the educated lay reader. The United States is to be envied in having endowments permitting public lectures of this quality to be published in book form.

The question of the origin of life is discussed and, as is inevitable just yet, is not answered. This is followed by a discussion as to the criteria by which the living is to be distinguished from the dead. Growth is not a criterion, for there can be life without growth and growth without life. There can be life without reproduction; in individual cells, such as nerve cells, or organisms, such as the resting seed, there is no reproduction, no suggestion of cell-division, yet life may go on for many years. Motion is not one of the essential characteristics of living matter. There is no logical necessity for regarding the simplest cases of irritability as essentially different from certain reactions found in non-living systems. Constructive metabolism may cease, yet life may go on for many years; but the cessation of destructive metabolism marks the end of life. In the case of the resting seed, so long as it is alive it produces carbon-dioxide: when this ceases it is dead. Life as manifested in the simplest organisms is a physico-chemical process in which destructive metabolism plays a fundamental rôle. As soon as a cell dies its power of selective absorption ceases. Certain dyes will not enter a living cell; others will do so and become stored within, reaching a higher concentration than outside. The process obeys a definite mathematical law. This storage does not occur in dead cells to so great an extent. Another method is to send an electric current through the cell; by measuring the amount of the current the progress of death can be followed with the same exactitude as that of a chemical reaction. Death is an orderly process following a definite law that can be expressed mathematically. In order to control life it is first necessary to control mutation, and before this can be done the physico-chemical factors on which mutant characters are based must be completely analysed. With the control of mutation will come the power to create new species.