

not turn out a standardized product of salable packages of information, but an infinitely variable and intangible thing the importance of which to the world can not be measured by the demand for it reckoned in dollars and cents. The world ultimately owes far more to the institution which produces men who guide the world's destinies in any department of activity than it does to the graduate factory that adds yet more to the rank and file of the mediocre. This at least is the situation regarding the very class of institutions the investigation of which was undertaken in the report before us. Its whole tenor was to lay emphasis upon the destruction of the academic freedom and initiative that is necessary to the advancement of human intelligence and to promote that kind of organization which, under the disguise of uniformity and system, effectively suppresses progress. It is an application to educational institutions of the methods too common in American manufacture, which insure a large output of the tolerable rather than a small output of the desirable.—*The Electrical World and Engineer.*

SCIENTIFIC BOOKS

Théorie physico-chimique de la vie et générations spontanées. Par STÉPHAN LEDUC, professeur à l'école de médecine de Nantes. Paris, A. Poinat. 1910.

Life as a physico-chemical process, and the analogy between living and lifeless, would possibly have been a better heading for this little book of Professor Leduc, for it does not consider spontaneous generation in the fashion which the reader is apt to expect from its title. On the other hand, it may well be that the post-Pasteurean biologist is over-sensitive as to the words "spontaneous generation," and he is apt to give them in latter days a cabalistic meaning: he inclines to dismiss the rare papers which deal with the theme as anachronisms—and he is careful not to recommend them to publishers. Even the French Academy has become so modern that it will not admit to its shelves any treatise which deals with this "exploded theory"!

Nevertheless, a whisper comes occasionally

out of the wilderness and reminds us that this is the problem of all biological problems and that it is still neglected. Perhaps our conscience is touched by the feeling that if we are consistent evolutionists we must have some manner of faith that the living came from the lifeless, and that, in the pursuit of biological happiness, we have been drifting in past years towards vitalism in some type or another. We recall too, that in the last decade, steps have been taken in the analysis of biochemical phenomena, in matters of enzymes, catalyzers, ions, tonicity and similar physical facts which have all an intimate bearing upon organisms and are paving the way for a new biological era. After all, many of us are convinced mechanists, and there should therefore be no reason why a book like Leduc's, title and all, should not be welcomed. It is certainly the first work to bring up to date the documents upon which a synthetic biology—as distinguished from descriptive and analytical—may be founded.

Let us see how his theme is handled: There is as yet no satisfactory definition of life: in spite of the efforts of many biologists, we know it by its presence or absence, by phenomena of nutrition, sensibility, growth, organization, reproduction, processes all of which are known in some degree in the inorganic. Moreover, as Leduc declares, life is in itself different in quality in its different manifestations in various organisms; thus he leads us to infer that the life of man differs more widely from the life of a protozoan than the life of the protozoan from the "life" of liquid crystals, for example. Life is to be studied as the transformer of matter and energy, it is a specialized phase of matter, the organic as opposed to the inorganic, and like a current it changes ephemerally. Its expression can best be studied in nutrition and in morphogenesis. And these are the lines of study which the author has developed. Nutrition is in essence chemico-physical, especially concerned with the phenomena of contacts between fluids of different characters, whether electrolytic, osmotic, colloidal, crystalloidal. In this connection he considers the laws of solutions,

matters of molecular concentration, osmotic tension, cryoscopy, periodicity, Ostwald's surface energy, relations to thermodynamics, diffusion, fields of force, all considered as elementary factors which enter into the synthesis of organic phenomena. In the matter of diffusion Leduc's experiments show curiously close parallels with organic processes, producing geometrical forms, circulation of "cytoplasm," "life" which survives freezing or drying, pseudosegmentation of a "germ," and phantoms of karyokinetic figures. Especially striking are osmotic growths, which are unquestionably the most complete parallels between the lifeless and the organic which have been devised. Following Leduc's formulæ one may cause "organisms" to grow which are curiously like algæ or fungi. Leduc points out that they will grow roots, stems and "fruit," the last sometimes appearing quite different in color. The growths have their periods of "youth, maturity, senility and death," they exhibit periods of activity and rest, they show cell-like divisions, definite form relations, and a circulation of their fluid contents; they will repair wounds, and show responses to external and internal stimuli. Peculiarly sensitive are these colloidal osmotic productions to changes in milieu: thus those "growing" around the sides of a jar will occasionally behave differently from those in the middle. Each salt, it appears, has its specific morphogenic properties. With some salts the "productions" are first attached: they then become amœboid and motile, sometimes forming spicules at the surface. The degree of concentration of the solution, also, determines sensitively the branching or the heaviness of the growth, the outcome of reactions which Leduc compares, by numerous chemical formulæ, to metabolism.

Altogether Leduc's book is interesting and it deserves to be carefully read. We need not admit that it is biology; but we must admit that the inorganic conditions which here are given detailed consideration have occurred and are occurring constantly in organisms. And we shall be apt to admit that the synthetic method promises results which will

prove of great value. Leduc would be the first to agree that living substance may not be synthetized for ages, if at all. But each advance brings the goal nearer, in the solution of single problems, and even of their separate components. Leduc points out the immediate task of synthetists, and an essential one, is not the artificial production of albumenoids, but of a chlorophyllian substance which will decompose carbon-dioxide dissolved in water and be capable of assimilating carbon. In this direction one recalls the interesting notes of Matthews and of McPherson in recent numbers of SCIENCE.

BASHFORD DEAN

Praktikum der Bakteriologie und Protozoologie. Von KISSKALT und HARTMANN. Zweite, erweiterte Auflage. Zweiter Teil: Protozoologie. Von Dr. M. HARTMANN. Pp. vi + 106. Mit 76 teils mehrfarbigen Abbildungen im Text. Jena, Gustav Fischer. 1910. M. 4.

The task of securing adequate laboratory material for instruction in protozoology has been considerably simplified by the "Praktikum" of Kisskalt and Hartmann. The author of the second part, Dr. Hartmann, is the director of the laboratory of protozoology in the Royal Institute for Infectious Diseases at Berlin, a pupil of Professor R. Hertwig and the successor of Schaudinn as editor of the *Archiv für Protistenkunde*. The work is therefore authoritative and reflects the current practise in one of the greatest centers of research. The hand-book is written primarily for the medical student and includes only parasitic forms and especially those of medical interest. It is not a book therefore primarily for the biological laboratory though the range of forms it discusses is sufficiently wide to make the work indispensable to every student of the protozoa, and of greatest value in all laboratories in which the protozoa are studied.

The second edition has been considerably enlarged by the addition of a section on the technique of investigation in protozoology and by a chapter on the Myxosporidia and the Sarcosporidia. A number of new parasitic