2. In our experience these counts are fully more accurate than those by the plate method, although not directly comparable with them.

3. The centrifugal method of concentrating the bacteria after "flocking," is the most rapid, but is less efficient and accurate than filtration.

4. The morphological character of the organisms themselves, rather than the appearance of their growth, is considered in judging their possible general characters.

5. These total counts are in no sense intended to supersede the specific cultural and other tests for *B. coli* or other individual groups of organisms.

NELSON AND LAUDER,
BINGHAMTON, N. Y.

NEW BOOKS.

The Organism as a Whole from a Physicochemical Viewpoint. By JACQUES LOEB, Member of the Rockefeller Institute for Medical Research. New York and London: G. P. Putnam's Sons. 1916. Price, $2.50.

The fact that living organisms, always highly complex and in many respects unstable systems (besides being subject to continual chemical change), nevertheless maintain and perpetuate themselves in their appropriate environments, each preserving its characteristic unity and individuality, furnishes a problem of unexampled difficulty to the physical scientist. Each animal develops from an apparently undifferentiated germ, the fertilized egg-cell, by means of a most complex yet orderly transformation of material taken from egg and surroundings; in every case both structure and activities show a striking correspondence with —or "adaptation to"—certain features of the surroundings; and most animals behave as if actuated by purpose or intelligence. Can these peculiarities, which the organism, considered as a whole, typically shows, be adequately interpreted and accounted for by the methods of physical science? This is the question which Professor Loeb discusses in the interesting book before us. In general his answer is a decided and enthusiastic affirmative. He sees biology as a department of physical science, and living organisms as physicochemical systems of a special kind; he holds that biology should aim at quantitative exactitude in the description and analysis of vital processes; only in this way can the possibilities of prediction and control (the criteria of true science) be realized; biology is a science "only to the extent that it succeeds in reducing life-phenomena to quantitative laws;" in many cases this is already possible, and unlimited further progress in this direction may be hoped for. Professor Loeb's discussion of the light-reactions of animals—a field in which much of his best known work has been done—illustrates his method and point of view with especial clearness. The heliotropic reactions of many animals may be classed as elementary instincts; in some cases, *e. g.*, the caterpillar of the butterfly Porthesia, the securing of food, and hence the continued existence of the species, is directly dependent upon its characteristic heliotropism. Yet in this and similar cases the reaction itself results from the operation of a photosensitive mechanism which in its general plan is extremely simple, consisting essentially of two symmetrical sensory areas (eyes) provided with photosensitive substances and connected by means of a bilaterally symmetrical neuro-muscular arrangement with the locomotor organs. This mechanism is activated by chemical changes in the photosensitive substances, and hence operates in accordance with the Bunsen-Roscoe law—*i. e.*, its mode of response (and hence the behavior of the animal) is quantitatively determinable. Artificial mechanisms similar in the arrangement of the light-reactive and locomotor parts may be constructed, and these show a similar power of light-orientation (*e. g.*, the light-guided torpedo of Hammond). This illustration is typical of the manner in which Professor Loeb treats biological problems. He seeks to establish an identity—if possible a quantitative identity—between the manner in which a physicochemical system of known constitution is influenced by the conditions acting upon it, and the manner in which the living organism reacts or behaves under similar conditions. A strong endeavor to reach clear and simple explanations is always apparent, and the mode of approach tends to be experimental rather than speculative. This tendency is well illustrated by his treatment of the problem of adaptation. He shows that adaptiveness is by no means a necessary or invariable characteristic of living beings, any more than it is of non-living beings; it is a simple matter to produce experimentally organisms that are ill-adapted to their environment, *e. g.*, by crossing different genera of teleost fishes. Such organisms, however, are incapable of surviving in free nature; hence they do not ordinarily come under the observation of naturalists, and the impression that adaptation is an inherent peculiarity of living beings has arisen from this fact; obviously all organisms that survive and perpetuate themselves in free nature must be in harmony with their surroundings. This is essentially Darwin's explanation of adaptation restated in modern form. But Loeb also points out that organisms may exhibit definite structural characters, and reactions analogous to instincts (*e. g.*, galvanotropism, or artifically induced heliotropism) which are not adaptive in any sense—*i. e.*, have nothing to do with survival under normal conditions; such characters are incidental (so to speak) to the physicochemical constitution of the organisms, but they may be just as constant as the "adaptive" characters. Structural or physiological peculiarities which are inconsistent with survival are naturally enough not met with in normal organisms, although they may be experimentally produced; but other non-adaptive peculiarities not inimical to survival frequently occur.

The most striking feature of organisms, their development from a germ or egg by a process of increasing structural and physiological complication, is also treated by Loeb as a purely physicochemical problem, although here the difficulties in the way of adequate analysis are very much greater. Some features of the developmental process, *e. g.*, its initiation by fertilization, can be simulated with remarkable completeness by artificial means (artificial parthenogenesis); but the main problem, that of accounting for the orderly transformation of the egg into the adult organism, remains untouched by this partial success. This problem is the fundamental one of the nature of vital organization, and still baffles physicochemical analysis. Loeb attempts to simplify the problem by pointing out that the egg-cell is already organized at the beginning of development, and, indeed, may be regarded as the organism itself at an early stage; but it is obvious that the essential difficulty cannot thus be evaded; we have still to account for the organization of the egg. His attack here is largely directed against Driesch and other vitalists, who assume extraphysical agencies as directive factors in development. This view he quite rightly regards as untenable; the orderly and determined character of the developmental process is the expression of a similarly orderly sequence in the physicochemical processes at work in the organism at all stages, in the egg and embryo as well as in the adult. The cytoplasm of the unfertilized egg is "the embryo in the rough," as shown by the work of Conklin and others; the later appearing characters are represented or determined in some unknown manner by chemical substances (possibly enzymes) which appear to be carried chiefly in the chromosomes. This last is indicated by the facts of Mendelian heredity and of sex-determination; the chromosome theory of these phenomena is accepted, and is expounded in considerable detail; the part played by hormones in development is also considered. A separate chapter is devoted to an analysis of the phenomena of regeneration from the physicochemical standpoint. The discussion of the different problems of development occupies almost half of the whole book; the basis of specificity is also discussed at length and is referred to the proteins; and there is a final chapter on the death and dissolution of the organism.

Loeb's standpoint is always strongly antivitalistic, and he manifests much impatience with vitalistic interpretations. These he evidently regards as quite incompatible with mechanistic or physicochemical methods of physiological analysis; yet such condemnation may easily become too undiscriminating; there are vitalists and vitalists. Claude Bernard, certainly one of the greatest of physiologists, expressly affirms that "vital properties are complexes of physical properties," and that "determinism is the only possible scientific philosophy;" nevertheless his conception of the ultimate nature of vital processes is frankly vitalistic. In reality there is no necessary inconsistency between the two points of view; the problem is rather how to combine both into a consistent general theory, having regard to all the facts of life and nature. Few serious students of this subject dispute the unlimited applicability of physicochemical methods and formulae in the analysis of the constitution and activities of organisms. The opposition of certain extremists appears to be based chiefly upon misapprehension of what physicochemical methods of explanation consist in and presuppose. Now the fundamental presupposition of such methods may perhaps be most briefly stated as follows: given any material system in which the chemical composition, physical state and spatial distribution of the components are fixed or constant, the transformations undergone by the system will also be constant. In other words, two or more such systems will undergo identical transformations. This principle is amply borne out by facts; any scientific device, however delicate and complicated, can be reduplicated; and the possibility of reduplication evidently depends on the constancy of the principles governing the behavior and interaction of the parts composing the system. The same must be true for the organism, since here also we find the same repetition, constancy, and predictability of behavior which we find in inorganic systems. When two similarly organized living systems, *e. g.*, two identical twins, behave differently, it is safe to say that the external conditions acting upon them are, or have been, different. All of the evidence indicates that this general law—the law of uniformity of action in uniformly constituted systems under uniform conditions—applies to living as well as to non-living systems. Further, it seems clear that without such uniformity any definitely directed or orderly evolution would have been impossible.

Does this say that the special peculiarities of living organisms can be fully accounted for on mechanistic grounds alone—*i. e.*, by assuming them to be nothing but orderly aggregates of uniformly acting substances and properties? By no means. The historical factor enters here, as is always the case when special configurations or otherwise highly individualized properties of any kind come under consideration. How, for instance, are we to account for the land-contour of North America? or the shape of Mont Blanc? No doubt the masses of material have been aggregated in strict conformity with physical laws; but the precise result attained has depended on pre-existing conditions, and these must again be referred to pre-existent—and so on in infinite regression back to the original constitution of nature (whatever such a phrase may mean). This conclusion follows inevitably, *provided* we are strictly mechanistic in our point of view and admit of no interruption in the causal nexus. It is impossible to account for the individual characteristics of any system by reference to the general characters of its components. In nature the particular cannot be deduced from the general. This is not to say that novelty cannot arise from the bringing of previously isolated elements into conjunction; it is of course a fact that novelty does thus arise, as every chemist well knows. But in order to account for the origin and the precise character of the novelty the causes determining both the occurrence and the nature of the conjunction have to be ascertained; obviously these causes are themselves determined by pre-existing causes, and we have again the infinite regression. Now this is exactly the kind of problem presented by the living organism; its special features of organization and behavior cannot be fully accounted for in a mechanistic sense except historically; and the historic method can in practise be applied to only a limited degree. To account mechanistically for the character of an individual man, it would be necessary to consider the entire ensemble of the conditions that have brought him into being and influenced his development. The same is true for any organic species. An ultimate reference to the original constitution of nature is implied; *at the outset* the universe must have been so constituted that in the course of mechanistically determined evolution the particular organism under consideration was at length produced; *i. e.*, it was *potentially* present at the beginning. The responsibility for its appearance and its special character is thus thrown upon the original constitution of nature—something with which science, as science, has no concern. This is what Claude Bernard meant by saying (in a passage quoted by Professor Loeb) that we can know only the material conditions and not the intimate nature of life-phenomena, and that the vital force and life belong ultimately to the metaphysical world. It seems useless to dispute this conclusion. Such a saying does not mean to us—any more than it meant to Claude Bernard—that we must deny the validity of physicochemical interpretations of life-phenomena; Bernard was himself a convinced and signally successful exponent of the mechanistic method in physiology. But he regarded this method as valid *just as far as experience proves it to be so*, and he avoided dogmatism on the subject; for him, as for most other scientific men, observation and experiment were the only means of settling questions of natural science. Life presents many philosophical as well as scientific problems. Design may express itself in a mechanistically actuated medium. This, however, is no place to consider the ancient question of the respective roles played by "final causes" and "efficient causes" in the production and activities of organisms. To uphold the claims of the one and to deny the other seems merely futile at present; the evidence, taken impartially, indicates that both are concerned; even a consistently mechanistic view leads eventually to this conclusion, and partisanship does nothing but obscure the issue.

RALPH S. LILLIE.

General Chemistry. By HAMILTON P. CADY, Ph.D., Professor of Chemistry in the University of Kansas. The McGraw-Hill Book Company, New York. Price, $1.50.

"This book is something of an abridgment and much of a simplification of the author's earlier work entitled 'Inorganic Chemistry.' " It is the fourth important book on general chemistry, recently observed, in which the authors have felt obliged to trim the later editions to bring them within the capacity of students to do the work, or the ability of teachers to exact it.

In this revision 107 pages have been eliminated. Water softening, the phase rule and many other subjects difficult for beginners or foreign to the purposes of a beginner's course have been left out or simplified.

The book is much improved. The teacher will find it accurate, fairly well balanced, teachable; the student should find it clear and interesting. With little exception the theory is stated clearly, simply and logically. Formulas and equations are withheld till the student has been prepared to understand their origin and meaning. The tabulation of the elements of the groups with their properties and compounds to show relationships is admirable. The chemical technology is well represented, up to date and illustrated by many original drawings.

In naming apparent pedagogical defects it is held in mind that here opinions justly differ. "Each law and theory has been presented at the point which seems best fitted both to the student and to the subject." On this basis some points of presentation seem to depend upon accident, and the theory as a whole seems to want logical sequence. Thus, the law of multiple proportions is placed after atomic and molecular weights have been discussed, and under hydrogen peroxide which happens to be the first illustration. Under the same head is placed molecular weights by the freezing point, since the molar weight of hydrogen peroxide can be determined by the method. Mass action is placed under hypochlorous acid; voltaic batteries come under copper, and osmotic pressure under copper ferrocyanide. Valence is treated very briefly at the end of the chapter on halogens.

Whether intended or not the book may stand as a protest against the over-emphasis of valence and the ion theory in some text-books. The ion theory is well illustrated and used where needed, but not enough seems to be made of valence, there being almost no valence formulae in the book. Another lack is an adequate presentation of ordinary chemical arithmetic of which there is scarcely a trace. There are also no problems or questions to draw the student out in this or any other subject. However, these are minor matters. The able teacher will make changes in any book, and this one is likely to prove easily adaptable to his methods and purposes.

W. S. HENDRIXSON.

A Text-Book of Inorganic Chemistry. By A. F. HOLLEMAN. Issued in English in coöperation with Hermon Charles Cooper. Fifth English Edition, 1916. New York: John Wiley and Sons. Pp. viii + 521, 15 × 23 cm. Cloth, price $2.25 net.

The previous editions of this standard work have already been reviewed in THIS JOURNAL, so that the general character of the book, which has remained unchanged in the present new edition, is already familiar to the reader. Indeed, the changes in the present edition are few in number. They are summarized by the authors themselves in the preface in the following words: "Very many of the descriptive portions have been rewritten, notably those on sulfur, ammonia, the nitrogen oxides and the phosphorus sulfides, as well as the sections on atomic and molecular weights, colloids, noble gases and rare earths, while the subjects of gaseous equilibrium, association, metallic state and intermetallic compounds, and atomic structure furnish new material."

The book is essentially a text-book for students, but it was written primarily to meet the needs of students in the universities of Holland rather than those of students of American universities, whose initial training and aims must be kept in mind in preparing a text for them. As a text for the basal work in chemistry in American institutions the book presents too much and is too detailed. It fails to emphasize essentials as compared with non-essential features, and introduces too many methods and conceptions, thereby greatly reducing its teachableness. The use of mathematical formulas, including the nomenclature of the calculus, really makes the book impossible as a general text for American students. On the other hand, those who intend to become professional chemists will find the volume a profitable one to peruse after they have had the usual basal preliminary courses in class room and laboratory. The new matter which the authors have added will prove specially welcome to such students.

The new edition is printed on good paper. The typography is clear, and the cloth binding is neat and durable.

LOUIS KAHLENBERG.

Conférences de Chimie Minérale, Faites a la Sorbonne. Par MARCEL GUICHARD, Maitre de Conférences. Métaux. Deuxiéme édition entièrement refondue. Gauthier-Villars et C^ie^, Éditeurs. Paris, 1916.

These lectures, the author informs us, were prepared for students who have finished their first year at the University. They were published at the request of the students of the Faculty of Sciences of Paris and correspond to some thirty hours of lecture-room work.

If, as is stated in the preface, "to teach is first of all to choose," the author must be an able teacher, for the choice of material seems to us to be excellent.

The principle underlying the classification of Mendeléeff being too uncertain for purposes of instruction the metals are taken up in the following order: The metals of the alkalies, of the alkaline earths, magnesium, the iron group, the copper group, lead, the platinum metals, gold, and finally the more metallic métalloïds (métaux métalloïdes), such as bismuth, antimony, vanadium, tin, etc. At the end of a group the analogies existing between the members are clearly pointed out, as well as any relationships existing between them and members of other groups. The author's idea is that in the study of a metal the reader should get the impression that its compounds are related to each other as are the links of a chain. He selects, therefore, some natural compound of the metal more important than others and describes how the various compounds are derived directly or indirectly from it. The importance of the oxides, chlorides, sulfides, their derivatives and the alloys is emphasized, these being the substances which are particularly characteristic of a metal. Such phenomena as the solidification of salt solutions and of alloys, the application of the phase rule to a study of these phenomena, the preparation and composition of glasses, catalysis, complex compounds and classification are treated somewhat in detail. Analytical reactions have been for the most part omitted, and there are no descriptions of industrial apparatus. The reactions involved in the extraction of copper and nickel from their sulfur ores, of nickel from garnierite, the working up of the Joachimsthal pitchblende and the treatment of platinum ores from the Urals are very briefly but simply and clearly set forth. Less attention is given to the methods for reducing the lead and silver ores. As one would expect, the use of the electric furnace (Moissan) in preparing the difficultly reducible metals and their carbides is frequently mentioned. While the old dualistic system of notation is employed again and again, scant notice is taken of the ionic theory. An account of it is given in the part which treats of the general properties of metallic compounds, but later it is seldom mentioned. In general, theory is subordinated to fact, but the presentation of the facts is so satisfactory that to criticize would be trivial. On page 260 it is stated that Scheele discovered tungstic acid in 1871. It should of course be 1781. There are no drawings, but diagrams are constantly given, especially in connection with the discussion of alloys.

Since the chemical knowledge acquired in the lecture room is necessarily incomplete, the author recommends that his lectures be accompanied by collateral reading. A number of original articles are, therefore, cited which the student is strongly advised to read.

Both table of contents and index are very complete. In a brief review it is impossible to do justice to this work. We have read it with much interest and profit, and recommend it warmly to teachers and students.

L. W. McCay.