always represent up-to-date information, but these chapters trace very well the most important facts and are reliable guides into the original literature. A more detailed subject index and an index of authors would be helpful and would improve the book's value as a reference source. Since a sufficiently detailed, modern, and critical review of the biochemical, nutritional, and medical aspects of vitamin B_{12} and vitamin B_{12}-coenzyme is not now available, this part of the book should be supplemented in the next edition.

The small book is at the present moment the best well-balanced introduction to the continuously expanding field of research on vitamin B_{12} and its application. The book also documents how much the author and his associates have contributed since 1948 when vitamin B_{12} was isolated simultaneously in his laboratory and by Karl Folker's group in Rahway.

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Analytical Dynamics

The word treatise in a book title, as in L. A. Pars' **A Treatise on Analytical Dynamics** (Wiley, New York, 1965. 662 pp., $27.50), implies both a broad scope and a relatively high level of treatment. Although no book on dynamics can exhaust the subject, this one covers thoroughly a wide range of fundamental topics, and the treatment is indeed an advanced one. These topics include those that one expects to find in any general treatment of dynamics, that is, Newton's and Lagrange's equations, constraints, Hamilton's principle, rigid body rotations, small oscillations, Hamilton-Jacobi theory, Hamilton's equations, contact transformations, and the principle of least action. Some less-familiar topics are the Gibbs-Appell equations, impulsive motion, the three-body problem, and periodic orbits. A short chapter introduces the dynamics of the special theory of relativity, but merely as a class of problems concerning particles with a peculiar mass variation (the corresponding classical problems, such as rockets, are not treated). Several chapters on stability theory and nonlinear problems, and a discussion of the ergodic theorem, are welcome additions to the above.

As a theoretical physicist, I therefore view the book from a particular frame of reference. Thus I would like some discussion of the foundations of Newtonian and relativistic mechanics (which have been purposely omitted to save space), and some material indicating the power and usefulness of group theory in dynamics (a usefulness greater than that indicated in the author's introduction), and a treatment of its connection with invariance principles and conservation laws. Further, I would prefer a greater use of physical insight in setting up and attacking problems. But the book was not written by, nor primarily intended for, a physicist. The author is an accomplished mathematician, and uses the common language of mathematics in developing the subject for mathematicians, physicists, astronomers, and engineers. His concern for rigor is therefore greater than that exercised by many others writing on the same subject. Although this gives the reader a clear idea of the limits of theory, it also results occasionally in the omission of problems which may be of interest.

The author treats many famous problems as worked examples, often treating them in great detail and from several points of view (this method is perhaps overdone). There are no problems or exercises for the reader.

Comparing this book with a standard work in the field, Whittaker's book of similar title, one notes that the volume by Pars contains about twice as much written material, and that many of the topics mentioned at the end of the first paragraph above are not covered in Whittaker. Figures, eschewed by Lagrange and Whittaker, are used here, adding clarity to the presentation (even more figures might have been helpful, and the addition of titles would further increase their usefulness). Matrix and vector notation and methods increase the clarity and simplicity of the presentation; still greater usage of these tools would have been preferable.

There are some errors, mostly typographical, but considering the size and complexity of the book, they are not excessive, and most can easily be remedied in a later printing. Some terms (such as "kineton") will be unfamiliar to the American reader. Unfortunately, they are not defined in the text, nor found in the index (which could profitably be expanded).

But the deficiencies noted above either arise from the reviewer's viewpoint, or are minor. This is clearly a broad, careful, and sophisticated survey of most of the major areas of classical dynamics, apparently intended as the modern standard for the *mathematical* development of dynamics. These intentions are well met.

The book is large (11.25 by 8 by 2 inches) and heavy (6 lb) but beautifully done. It has obviously been produced with much care by both author and publisher, and it is a pleasure to read. It is not suitable for use as a textbook, owing to its size, cost, and lack of problems, but it should be invaluable as a reference book, and should be in every institutional scientific library. I hope that a smaller and less-expensive edition will be produced so that everyone interested in this field can have his own copy.

Considering the present state of scientific publishing, it is gratifying to find a new book that actually fulfills a need, is painstakingly prepared, and which should have permanent value.

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Developmental Biology Series

Fertilization (Prentice-Hall, Englewood Cliffs, N.J., 1965. 145 pp., $2.95), by C. R. Austin, is the first volume in the Prentice-Hall series, Foundations of Developmental Biology. The series is designed to provide introductory material and to review recent progress in selected fields for students at intermediate and advanced levels.

This volume presents a comprehensive treatment of fertilization, with emphasis on the "cytological, physiological, and behavioral mechanisms concerned with the union of the gametes." The range of organisms includes bacteria and fungi as well as higher plants, sea urchins, and mammals. This comparative approach is used to define those features and principles in fertilization that are common to all organisms. The book is, in part, a product of the summer training program on the physiology of gametes and fertilization, held at the Marine Biological Laboratory (Woods Hole, Mass.), where the author is a member of the staff.

Chapter 1 gives a brief introduction into general cytology. Chapter 2 discusses the genetic and biological significance of fertilization in the propa-

gation and evolution of species. Chapter 3 deals with the morphological and functional differentiation of gametes (or conjugants) in various groups. Chapter 4 reviews the special mechanisms, often ingenious devices, which facilitate meeting of the gametes, such as chemotaxis and trapping of male gametes, mating behavior, and seasonal effects. Chapter 5 is devoted to the cellular mechanisms in the cytoplasmic and nuclear union of the gametes. Specific receptor substances, egg-membrane lysins, and the role of the acrosome in sperm entry are discussed, including recent electron microscopic observations. Chapter 6 gives an account of the general structural and metabolic changes observed in eggs upon sperm entry, with special reference to the mechanisms excluding supernumerary spermatozoa from the fertilization process. Chapter 7 discusses some unusual and aberrant types of fertilization.

The text is concisely and clearly written, with abundant illustrations. A detailed subject index is provided. There is a classified and selected bibliography.

This is an excellent book, and the author is to be congratulated for having selected so many illuminating examples and for integrating the data into broad principles and generalizations. The general reader should find it a useful, and conveniently compact, source of information. It is indispensable reading for students of fertilization. The broad scope and unifying concept of the book should help fill the gap that often exists between workers in various fields of reproductive physiology.

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Chemical Properties of Thermal and Mineral Waters

Japan is noted for its numerous hot springs of widely differing chemical types, and for its extensive utilization of these springs for bathing and therapeutic purposes. Because these thermal and mineral waters are important in the lives and economy of the Japanese, hot springs have been studied extensively by geochemists, geologists, and geophysicists. To a far greater extent than in any other country, this effort has been made by the staffs of the chemistry departments of universities.

Since 1935, more than 500 papers have been published, almost all of them in Japanese, in chemical journals. Thus, the literature is not well known outside Japan, nor is it readily available to most earth scientists. Yasumitsu Uzumasa's purpose in writing this book, **Chemical Investigations of Hot Springs in Japan** (Tsukiji Shokan, Tokyo, Japan, 1965. 189 pp.), was to review the more important results and to make these results available in concise form to non-Japanese scientists. Professor Uzumasa is well qualified for this task because he, his associates, and his students at the University of Hokkaido have been responsible for a very considerable part of the total output.

Prior to 1935, nearly all analyses of spring waters included only the common constituents—sodium, calcium, magnesium, silica, the carbonates, sulfate, and chloride. Since then, many advances have been made by the Japanese and others in developing new methods for water analysis, and much attention has been focused on the minor or trace constituents of hot spring waters.

The nine chapter titles are: "General aspect," "Methods of analysis," "Common constituents," "Minor constituents," "Radioactivity," "Hot spring deposits," "Origin and mechanism of flow of hot springs," "Activity of mineral waters," and "Utilization of hot springs."

The author has accomplished his first objective admirably. The text and its extensive bibliography (535 items) give earth scientists a very good coverage of the Japanese literature to date. A few of the more notable springs of each region are described briefly. Relatively little original data are quoted; instead, constituents are arranged statistically on graphs or are grouped by concentration range.

In the chapter on minor elements, frequency diagrams of individual elements are plotted on a logarithmic scale; each element tends to occur through a concentration range of about three orders of magnitude. A few conclusions that relate content to type of water are reached in this section. The ratios of lithium/sodium in hot spring waters, for example, range from 0.1 to 6×10^{-3}, and these values are higher by one or two orders of magnitude than those of oil-field brines and sea water. The author and his associates have made many careful searches for the minor alkali metals lithium, rubidium, and cesium. Frequencies of occurrence of each metal in the different concentration ranges (log scale) are compared with the ranges that Japanese geochemists have observed in river water, sea water, oil-field brines, and average igneous rocks; other ratios are similarly compared. The graphs emphasize previously recognized tendencies for enrichment in lithium/sodium, cesium/sodium, and cesium/potassium in hot spring waters relative to other natural waters.

Japanese geochemists have been interested in the radioactivity of thermal and mineral waters for more than 50 years, and have paid special attention to radium. Other studies are concerned with the disintegration products of radium, uranium, and the thorium series.

Results of Kitano's studies of carbonate deposits, and natural conditions of formation of calcite versus aragonite are reviewed. Aragonite is favored by high rate of precipitation and high content of strontium, magnesium, and to lesser extents of other substances. Many thermal springs deposit native sulfur. Arsenic sulfide (orpiment?) is abundant at Nasu. Tamagawa Springs in Akita Prefecture deposit a lead-bearing variety of barite, called hokutolite, which is also rich in radioactive elements.

The author's summary of current interpretations by Japanese geochemists of the origin and mechanism of flow of hot springs of different types is one of the most useful chapters of the book. All gradations may exist between high-temperature, acid, volcanic fumaroles, discharging from new lava at the surface, and neutral alkali chloride waters related to magma at considerable depth. The fascinating Tamagawa Springs are the most notable example of an intermediate type. The chemistry of these springs has been studied in detail by Minami, Iwasaki, and their associates; the rate of discharge of the main spring is an astonishing 9200 liters per minute at a temperature of 98°C; *p*H of the water is only 1.2! In this chapter, Uzumasa also emphasizes the importance of the halides in distinguishing oil-field brines from sea water and most hot spring waters. Oil-field waters are generally slightly enriched in bromine/chlorine and are markedly enriched in iodine/chlorine and bromine/iodine relative to most other waters.

Some recent Japanese studies on the influence of precipitation and tides on