for sugars, rectangular rings for purines and pyrimidines, and un-ionized formulas. Ideally, when students first study molecules, they should make three-dimensional models of them. But such models cannot easily be made for the more complex molecules, nor are their fine points always evident; here *The Architecture of Molecules* fills an important role. It is entirely fitting that Linus Pauling, one of the earliest and foremost advocates of the importance of molecular architecture in chemistry and biology, should produce the present text.

One can safely predict that every reader will disagree in part with the selection of molecules. However, in general, they well illustrate the main points of molecular structure. One might take exception to some discussions. In Figure 17, the reason why free rotation cannot occur in the ethane molecule is not made at all clear by the ball and stick illustration. Would not a representation showing a van der Waal's type structure, as in Figure 10, be much more appropriate? In Figure 9, where the halogen molecules are illustrated, a text relating the drawing to the periodic table and electron shells would make the relation between these members of the same family more apparent. To compensate for these less striking texts, some discussions are indeed remarkable. Probably every reader will discover new insights into the structures of molecules when he reads the book and examines its pictures.

Some great insights and a tremendous amount of hard work are summarized in the final simplicity of this volume. Anyone who is interested in the structure of matter should read through this book.

ARTHUR B. PARDEE
Department of Biology,
Princeton University

A "Three Plus One" Dimensional Treatment

The Special Theory of Relativity. David Bohm. Benjamin, New York, 1965. xvi + 236 pp. Illus. Paper, $3.95; cloth, $7.

It is admittedly difficult nowadays, in an exposition of special relativity, to find something new to say. David Bohm has solved the problem by adding a 45-page appendix in which he describes the views of J. Paiget on the development of our "common notions" of the external world in infants and children and the views of J. G. Gibson and others on the nature of perception. The upshot is the conclusion that "Science may then be regarded as a means of establishing new kinds of contacts with the world, in new domains, in new levels, with the aid of different instruments, etc."

The first 184 pages of Bohm's work are divided into 31 brief chapters in which special relativity is developed by the historical method. Pre-Einsteinian notions of relativity, the Michelson-Morley experiment, the Lorentz theory of the electron, and the hypothesis of the aether lead up to a demonstration of the inherent ambiguity in the meanings of space and time measurements. Einstein's views are then explained together with the new interpretation of the Lorentz transformation. This transformation, however, is not derived formally from Einstein's ideas: reliance is placed on a piecemeal demonstration after the fashion of Lorentz. Applications of special relativity include discussions of the decay of mesons, the Doppler effect, and momentum and mass. The equivalence of mass and energy is interpreted in terms of the notions of the "energy of inward movement" and the "energy of outward movement." Bohm is thus led to the conclusion that elementary particles will have to be understood "as structures arising in relatively invariant patterns of movement occurring at a still lower level than that of these particles." Other mathematical developments are the "K calculus" which is essentially based on E. A. Milne's interpretation of the Lorentz transformation, although Bohm appears to be unaware of the fact. He also ventures cautiously onto the space-time continuum and its interpretation by means of the diagram in which one coordinate is the time and the other, space. This "Minkowski diagram" is discussed at length, and the conclusion is that it is "a kind of map of the events in the world . . . but which is not itself the world as it actually is." I should have thought that this statement was self-evident a priori. The twin paradox is also described under the usual assumption that clocks measure proper time.

The treatment throughout is "three plus one" dimensional, very little use being made of four-dimensional ideas. For example, it is never made clear that the energy and momentum of a particle are components of a single four-vector. Bohm also writes as if the principle of special relativity demanded the invariance of mathematical form in the basic equations of mathematical physics. If this were so, an investigator would be debarred from using spherical polar coordinates, instead of the usual rectangular ones, in treating the motion of a particle in special relativity. He frequently suggests that a coordinate system, accelerated relative to a Lorentz frame, is possible only in the domain of general relativity. A four-dimensional point of view would show him that this need not be so. When Maxwell's equations, for example, are expressed as four-dimensional tensor equations, they can be transformed mathematically to an accelerated system without violating the principle of special relativity. In abandoning the assumption that space-time is flat, general relativity does much more than employ accelerated frames. Incidentally, the statements on page 101, which imply that the law of gravitation, like the laws of electromagnetism, can be thrown into a Lorentz invariant form, are entirely misleading. Bohm also has his own version of Newton's second law of motion for a particle (pp. 81 and 100); he adds the condition that the mass of the particle must be constant with time. If this were so, it would be impossible to set up a Newtonian equation for the motion of a rocket. In chapter 23 it is implied that the notion of "mass" ceases to be difficult after a person has reached the age of 4. I do not know what experience Bohm may have had in teaching University students, or whether he has ever tried to explain "weightlessness" to a newspaperman. Too often I have found that "mass" is inextricably confused with "weight." The idea of mass is one of the hardest departures from the common-sense view of the world that has to be made if mechanics is to be understood. My own experience during the process of learning physics leads me to question Bohm's implicit assumption that the world of common-sense, with which we become familiar in childhood, is a guide to the basic ideas of physics. Learning physics seems to me to imply much "unlearning" of common-sense notions.

The exposition is marred by many

careless misprints. Lower case and capitals are used indiscriminately for the velocity of light (pp. 15, 16, 21, 31, 35, 38, 75, and 98); formula (18-19) should contain the factor v_2/v_1 and not v^2/v; and the lines immediately preceding formulas (26-4) and (26-5) are grammatically unintelligible.

It may seem paradoxical to say, after raising these objections, that I found the book very interesting and stimulating. I recommend it unreservedly to those who already have some knowledge of relativity and particularly to persons who, like myself, teach general relativity to graduate students in physics. Such readers will discover, as I did, why their students have the ideas that they do have about relativity!

G. C. McVittie
University of Illinois Observatory, Urbana

Traditional Statistical Methods

Statistical Inference. vols. 1 and 2. vol. 1, *A Non-Mathematical Exposition of the Theory of Statistics* [678 pp.; rev. ed. of *Introduction to Statistical Inference* (1957)]; vol. 2, *The Multiple Regression and Its Ramifications* [589 pp.]. Jerome C. R. Li. Edwards, Ann Arbor, Mich., 1964. Illus. $10 each vol.

This is a large, but not particularly expensive, exposition of the traditional statistical methods on a nontheoretical level. Volume 1 is very nonmathematical and covers such topics as descriptive statistics, "test of hypothesis," one- and two-sample *t*-tests, the *F*-test, confidence intervals, one-way analysis of variance, randomized blocks, linear regression, factorial experiments, analysis of covariance, binomial and multinomial sampling, transformations, and some distribution-free methods. It has an adequate selection of the standard tables. It uses sampling experiments to demonstrate the properties of many of the standard distributions. It uses 1.75 inches of a page to prove that $\Sigma(y - \bar{y}) = 0$. Volume 2, on the other hand, starts a 39-page chapter in which the author expounds the techniques useful for a matrix exposition of multiple regression, and subsequently uses these techniques for curvilinear regression, unbalanced two-way analysis of variance, and the like. The treatment of such topics as confounding and fractional replication is probably too brief even to convey the ideas of these techniques.

The style is at times somewhat quaint —for example, "Mergence of factorial experiment and analysis of covariance causes a conflict in notations" (p. 430); Section 31.10 is headed "Advantages of Response Surface," and "In order to use u-test" (p. 64). Section 23.4, "Logarithmic Transformation," begins with "The logarithmic transformation, like the square root transformation, is used on the data which consist of counts," which I interpret, perhaps mistakenly, to be an implied recommendation for such a procedure.

There are a number of similar texts available, and they have their relative strengths and weaknesses. Li's main strength is undoubtedly the enormously detailed exposition of multiple regression and its application to analysis of variance. Weaknesses include a rather light treatment of distribution-free methods, in effect dealing only with the sign and median tests, and omitting the various rank tests. The mixed model in two-way analysis of variance is omitted. There is no probability theory.

Each chapter is well supplied with numerical exercises (with answers), which frequently deal with real data from real problems.

K. A. Brownlee
Department of Statistics, University of Chicago

Biology Laboratory Guide

Practical Biology. C. Dodds and J. B. Hurn. Arnold, London; St. Martin's Press, New York, 1965. 112 pp. Illus. $3.

This is a laboratory guide for use in secondary school biology courses. The authors have "aimed at developing the powers of observation, using the three fundamental techniques of biology; dissection, microscopy and simple experiments with living organisms." To this end the manual is divided into a section of 44 double-column pages on zoology, which covers in systematic and comprehensive fashion the animal kingdom, with some attention also to development and to cells and tissues. There follows a 26-page equally comprehensive section on botany. The final section (24 pages) is concerned with experiments on irritability, movement, nutrition, respiration, excretion, and growth and reproduction.

The approach to the observation of plants and animals is carefully and systematically developed to provide a rich and extensive experience in biology for the secondary school student. The number of forms covered is far more than can be accommodated in the average high school biology course, but this manual seems to be ideal for use with the new AIBS biology courses, particularly since the section on experiments is not only comprehensive but well designed for the use of simple apparatus for effective investigation of living phenomena. This is an excellent way to introduce the student to the scientific method.

The manual is profusely illustrated with good three-dimensional drawings. Interlaced with the directions throughout there is sufficient discussion of the interrelation of structure and function to interest and challenge the student. This, in brief, is a very useable "practical biology."

Charles S. Thornton
Zoology Department, Michigan State University

New Books

Biological and Medical Sciences

The Action of Neuroleptic Drugs. A psychiatric, neurologic, and pharmacological investigation. Hans-J. Haase and Paul A. J. Janssen. Year Book Medical Publishers, Chicago, 1965. 182 pp. Illus. $7.75.

Acute Problems in Resuscitation and Hypothermia. Proceedings of a symposium (Moscow), September 1964. V. A. Negovskii, Ed. Translated from the Russian edition (Moscow, 1964) by Basil Haigh. Consultants Bureau, New York, 1965. 99 pp. Paper, $15.

Adaptive Growth. Richard J. Goss. Logos Press, London; Academic Press, New York, 1965. 360 pp. Illus. $12.

Adrenal Steroids and Disease. Cuthbert L. Cope. Lippincott, Philadelphia, 1965. 839 pp. Illus. $24.

Antimicrobial Agents and Chemotherapy, 1964. Proceedings, Fourth Interscience Conference (New York), October 1964. J. C. Sylvester, Ed. American Soc. for Microbiology, Ann Arbor, Mich., 1965. 803 pp. Illus. $15. One-hundred and thirty-six papers.

Annual Review of Medicine. vol. 16. Arthur C. DeGraff and William P. Creger, Eds. Annual Reviews, Palo Alto, Calif., 1965. 481 pp. $8.50. Twenty-four papers.

(Continued on page 480)