wise available in boiled-down versions, so there may be some useful material here for certain college courses. The illustrations (all of them line drawings) are for the most part clear and well chosen, but I am disappointed that there are no photographs of living protozoa nor any electron photomicrographs. A few of the latter would have greatly enriched the chapter dealing with structure.

I do not care for the subtitle, partly because it is too emphatic. The protozoa represent a highly diversified assemblage of plant-like and animal-like organisms, some of them far less simple than others. Hall does, in fact, explain this quite nicely. I wish he had not treated the protozoa as a phylum. However, he has done no worse than the Committee on Taxonomy and Taxonomic Problems of the Society of Protozoologists. His outline of classification follows that in some of the early drafts prepared by the committee. This is perhaps fortunate, because, at least with respect to the classification of ciliates, the published version (1964) is stiffer than some of the dry runs. All this classification is heavy stuff anyway, and cannot be of much use unless it is very complete and thoroughly illustrated. In any case, I hope impressionable young readers will not lay the book down with the idea that microsporidians and ciliates are related.

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Analytical Chemistry

Organic Complexing Reagents: Structure, Behavior, and Application to Inorganic Analysis. D. D. Perrin. Interscience (Wiley), New York, 1964. xii + 365 pp. Illus. $12.

The object of this book is "to discuss the principles involved in analytical chemical methods so that the matter may be placed securely upon a modern theoretical foundation." Or, to quote again from the introduction, "The aim . . . is to present a coherent account, based on modern theoretical inorganic chemistry, that will enable the reader to understand the choosing of reagents for particular determinations and the kinds of conditions under which the reactions can be carried out."

Actually the volume is a survey of organic compounds that have been used in various ways for the determination of the metals and anions. The coverage in this respect is extensive. The array and variety of organic compounds that have been used in the chemical analyses of the metals is formidable indeed, and in this book Perrin attempts to cover the entire bag of tricks employed by the analytical chemist: the effects of complex formation on oxidation-reduction potential, kinetics and equilibria in the formation of complexes, surface phenomena, ultraviolet-absorption spectrophotometry, solubility, and extraction into immiscible solvents. A brief treatment is given of the principal reagents and their characteristics for each of the metals.

A few chapters are devoted entirely to theoretical aspects. These are so brief and sketchy that they provide little more than an introduction to some new terminology and some guideposts to other fields of knowledge.

References are given at the end of each chapter, and the lists are quite impressive, as one might expect in a volume that reviews one of the fields of chemistry that has been most active in the last two decades. No names are mentioned in the text, however, and the results of whole papers are condensed to single sentences or phrases. This gives the volume an authoritarian, jumpy style. Results and explanations are put forth as gospel, without immediate hint about the original author or about Perrin's evaluation of his contribution. A fair amount of trivial material finds its way even into scientific journals, and an unconscionable amount of current publication is given over to correcting incomplete and careless work. It is the duty of the author of a monograph to start the sorting-out process. No hint is given in this book about the real value of any of the analytical reagents mentioned. Yet the mere size of the current literature on any particular analytical reagent gives an immediate measure of its importance; bathophenanthroline and calcein, for example, treated in most cursory fashion in this book, have been the subject of no less than 50 papers each in the last decade.

The present position of chemistry on its exponential growth curve makes it evident that no book can possibly cover, except in a superficial fashion, so broad a field of chemistry as that attempted here. Certainly anyone who thumbs through this volume will pick up some new ideas, for there is now a vast literature in this field. Those analysts who have been out of school for a few years, however, are in for some shocks. In the 42 lines devoted to a survey of the reagents for zinc, the following statement is made: "Because there is no ligand-field stabilization energy involved in zinc complex formation (zinc having a filled *d* shell), ligands that also permit back-double-bonding probably form the most stable zinc complexes." The words used are changing, but whether this will help in tomorrow's problem of determining zinc in a urine sample is problematical.

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Philosophy of Science

Philosophical Problems of Space and Time. Adolf Grünbaum. Knopf, New York, 1963. xii + 408 pp. Illus. $10.75.

Although spatial and temporal concepts have always occupied a central position in physical theory, 20th-century physics has demonstrated the need for a thorough reexamination of them. Physicists and philosophers alike, realizing that conceptual clarity in this area is prerequisite to an understanding of modern physics, have devoted considerable energy to attempts to explicate these notions. A large and important post-relativity literature has grown up, but the roots of many of the most significant and puzzling problems antedate Einstein by far, in some cases reaching back even to antiquity. *Philosophical Problems of Space and Time* provides a comprehensive and detailed treatment of this whole range of problems.

Grünbaum's book is divided into three major parts. Part 1, Philosophical Problems of the Metric of Space and Time, deals mainly with problems arising from the 19th-century development of non-Euclidean geometries. Given a variety of formally self-consistent geometries, we naturally ask about the choice of a geometry to de-

scribe physical space. Rejecting the a priori, the naively empirical, and the totally conventionalistic answers, Grünbaum argues that there is a delicate balance between conventional and empirical elements which, when handled with proper care, allows us to formulate genuine empirical questions about the metrical character of physical space. Problems that are to some degree analogous arise for physical time. Also treated in this part is a geometrical paradox dating back to Zeno of Elea in the 5th century B.C. Though less famous than the paradoxes of motion, it is logically prior to them, and it poses profound difficulties in the very concept of an extended continuum.

Part 2, Philosophical Problems of the Topology of Space and Time, centers chiefly upon the causal theory of time and the problem of temporal direction. Grünbaum rejects the opinion that the second law of thermodynamics itself is temporally asymmetric; he argues that only in conjunction with specifiable initial conditions does this law provide a physical basis for the asymmetry of past and future. He claims, moreover, that the laws of classical mechanics, in conjunction with specifiable initial conditions, likewise provide a physical basis for the anisotropy of time.

Part 3, Philosophical Issues in the Theory of Relativity, consists mainly of a chapter devoted to philosophical and historical analysis of the fundamental principles of special relativity. Grünbaum emphatically reiterates Einstein's distinction between the *conventionality* of simultaneity and the *relativity* of simultaneity. The former is the more basic, for it arises within a single inertial frame and does not depend upon relative motion. Indeed, Grünbaum shows that by adopting a logically permissible, though otherwise unappetizing, *definition* of simultaneity, the *relativity* of simultaneity can be made to disappear! This distinction is intimately involved in an understanding of the relations among the following principles: (i) The speed of light is independent of the direction of its travel. (ii) The speed of light is the same in all inertial systems. (iii) Light is a fastest signal. Failure to make the necessary distinctions has led, Grünbaum charges, to widespread historical and logical confusion regarding the special theory. The remaining brief chapters in part 3 deal with specific problems in special and general relativity raised by Milne, Jammer, and Whitehead.

So remarkable is the scope of this book that it is difficult to think of any important philosophical problem of space or time that is not treated, or to find any important contributor whose views are not taken into account. These authors—including such men as Bridgman, Duhem, Eddington, Einstein, Milne, Poincare, Reichenbach, Riemann, Russell, and Whitehead—are discussed with scrupulous care. The book exhibits thorough scholarship and complete mastery of technical detail. Unmatched in breadth and rigor by any other recent book on the subject, *Philosophical Problems of Space and Time* is a significant contribution to contemporary philosophy of science.

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Genetics Yesterday

Genetics and Man. C. D. Darlington. Macmillan, New York, 1964. 382 pp. Illus. $7.50.

Genetics and Man is a revised edition of *The Facts of Life*, first published in 1953. Although the title is changed, less than 10 percent of the first edition is altered: discussion of some new subjects has been included, two concluding chapters have been deleted, but no basic change has been made in the organization. Such revision is surely minimal in view of the almost revolutionary discoveries in molecular genetics and the advances in human genetics during the past decade.

Darlington is at his best in describing the excitement and far-reaching implications of the genetic discoveries made at the turn of the century and during the next few decades. These were exciting times in genetics, but the past decade has been no less exciting; however, this is an excitement in which Darlington apparently does not share. Only 2½ pages are devoted to an elementary discussion of the chemical nature of DNA. No hint is given in this discussion of the great impact that the Watson-Crick model of DNA structure has had on current genetic experimentation. The implications of this model pervade genetics from viruses to man, from the molecular level of biological organization to the population level, and are being used as working hypotheses by many geneticists and cytologists.

Although this revision does not bring the book into step with the times, reading it does give one a deeper appreciation of our current knowledge of inheritance because Darlington places it in its proper historical perspective. This historical summary is only slightly biased by the fact that Darlington has viewed genetics primarily through a microscope. He clearly portrays the reasons why genetic concepts have successfully infiltrated practically all aspects of biological thought. His succinct discussion of the genetic basis of evolution is outstanding.

The second half of the book provides a persuasive argument for viewing many of the problems of man and his society in terms of their genetic and evolutionary components. The coverage is broad, including such topics as race and class, sexual behavior, marriage and divorce, Freudian psychology, immortality, and free will.

There is a great deal of value here for the general biologists, the new generation of geneticists, the social scientists, and the interested laymen who are not familiar with the first edition. One only wishes that Darlington's fertile mind had provided some new meat to chew on in his revision.

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Vermilion Sea Expedition

Marine Geology of the Gulf of California. A symposium (Memoir No. 3). Tjeerd H. van Andel and George G. Shor, Jr., Eds. American Association of Petroleum Geologists, Tulsa, Okla., 1964. vi + 408 pp. Illus. Charts. $12.50.

In 1747 Ferdinand VII of Spain issued a royal decree stating that "California no es isla." For about 100 years prior to that proclamation California was thought to be an island separated from the mainland by the Vermilion Sea, which, regrettably, is now better known as the Gulf of California. This mariner's mirage evaporated in 1698 when Father Kino, a Jesuit priest,