mation on the synthetic procedures used for commercially available resins and discuss the general properties of these resins. A mathematical treatment of the bases of equilibrium, kinetics, and chromatographic plate theory forms the theoretical core of the book. This treatment is presented with adequate experimental support, including detailed descriptions of the manner in which supporting data were acquired. The subject of ion exchange chromatography is treated the most extensively from this mathematical point of view, and it is the authors' obvious intention to integrate analytical ion exchange into a generalized view of chromatography.

Since chromatography is the principal subject of the work and the one of most interest to analytical chemists, the theoretical treatment is accompanied by descriptions of techniques and tables of separations for both inorganic ions and organic compounds. The tables provide rapid reference for the practicing chemist. References run through 1967.

The separation of organic compounds by the use of ion exchange resins, where the underlying principles are not ion exchange at all but depend on van der Waals or Donnan forces, receives considerable attention. Salting out and solubilization chromatography are treated at length, and a comparison with gas-liquid chromatography is attempted. The authors maintain enough perspective to note that only in special cases is elution through exchange resins advantageous over gas-liquid methods.

The application of less common exchange materials is also detailed. These include macroreticular resins, ion retardation resins, ion exchange membranes and papers, liquid ion exchangers, and inorganic exchangers of the hydrous oxide types. The coverage here is extensive enough to allow the reader to become aware of the many existing possibilities.

The book is well printed and contains only a few errors in typography. Indexes and references are adequate. The authors have made a comprehensive study of ion exchange theory and capabilities and have exercised sufficient restraint so that the reader may obtain a realistic view of ion exchange among the many branches of chromatography.

C. A. STREULI
Lederle Laboratories,
Pearl River, New York

Biological Spectroscopy

Fluorescence Assay in Biology and Medicine. Vol. 2. SIDNEY UDENFRIEND. With a contribution by J. D. Winefordner, P. A. St. John, and W. J. McCarthy. Academic Press, New York, 1969. xii, 660 pp., illus. $19.50. Molecular Biology series.

Fluorescence spectroscopy, once the province of the analytical chemist, has recently emerged as an important technique for the study of macromolecules. It is gratifying that the second volume of *Fluorescence Assays in Biology and Medicine* has been expanded to satisfy the needs of newcomers interested in this aspect of fluorescence.

This monograph is actually a compromise between a second volume and a new edition of the previous book. Whole sections have been rewritten and considerable new information has been introduced, and the volume stands as a complete entity and may easily be read independently of the previous version.

Initial chapters give an excellent review of the basic concepts of fluorescence and phosphorescence couched in nonmathematical terms, providing a readable and rewarding introduction to fluorescence for graduate students and other novices in the field. The section on instrumentation is extensive and has been updated since the first volume. It gives detailed information regarding various commercial spectrophotofluorometers and also includes descriptions of several laboratory-constructed instruments.

The recent literature abounds with the presentation of uncorrected fluorescence spectra. Frequently the possibility of various artifacts has been ignored. It is fortunate that this volume includes a clear and detailed discussion of the practical aspects of spectrophotofluorometer calibration and some proposals for standardization of the reporting of fluorescence spectra. The discussion of several of the artifacts common to fluorescence measurements should be extremely helpful, particularly to those who have newly become interested in the technique.

In recent years there has been a renewed interest in fluorescence lifetime measurements. Advances in instrumentation and theory have led to novel applications of this technique in studies of macromolecules. It is unfortunate that this aspect of fluorescence is treated only in a cursory manner.

The main portions of the monograph are devoted to detailed descriptions of the fluorescence of amino acids, lipids, coenzymes, and drugs, as well as of carbohydrate and nucleic acid derivatives. There is also considerable information regarding the fluorescence of proteins and peptides, including the relation of fluorescence to protein structure.

The novel subject of fluorescence probes is treated in some detail; new sections on probes per se and on fluorescence polarization and energy transfer provide more detail than was available in the first volume.

The monograph will continue to be useful as a reference work for those who are interested in a particular assay as well as for those who desire a general introduction to fluorescence.

LUDWIG BRAND
McCollum-Pratt Institute,
Johns Hopkins University,
Baltimore, Maryland

Embryological Technique

Organ Culture. J. ANDRÉ THOMAS, Ed. Translated from the French edition (Paris, 1964) by the Express Translation Service. Academic Press, New York, 1970. xiv, 512 pp., illus. $29.50.

The practice of organ culture owes a great debt to Etienne and Emilienne Wolff and the group that has worked under their direction at the Institute of Embryology and Experimental Teratology in Paris for about a quarter of a century. J. A. Thomas, himself a pioneer in tissue and organ culture, edited (for publication in French in 1964) a series of lectures delivered in 1963 by the members of this group. The present book is a translation of that work. Each chapter has been supplemented with an addendum reviewing work since 1964. It is a measure of the rapid growth of the use of organ culture techniques that, for example, the chapters on synthetic media, on hormones and inhibitors, and on invertebrate organ culture have smaller bibliographies than their respective appendices.

Though the emphasis is on the work of the Paris school, from which most of the examples and the numerous illustrations are drawn, relevant studies elsewhere are adequately covered by most of the contributors. No other book dealing so extensively with the many manifestations of organ culture is available. The perspective of the

authors is strongly embryological, morphogenesis and differentiation being the central themes. Tissue interactions (including interspecific interactions), the study of which has contributed much to the understanding of morphogenetic mechanisms, and the effects of environmental factors, including those of hormones and teratogens, on differentiation are extensively covered. The wide diversity of organs and combinations of organs from mammalian, avian, and invertebrate sources studied is impressive. Among the most significant accomplishments documented here are the analyses of the effects of dissociation and reassociation of organ rudiments on differentiation and morphogenesis. The culture of gonads, and of secondary sex structures, has been one of the most substantial contributions of the Paris group to our knowledge of sexual differentiation and intersexuality. This book provides indispensable background for those who want to explore and exploit the potentialities of in vitro systems for the solution of morphogenetic problems.

The translation is for the most part excellent, though nuances are occasionally lost. The illustrations are good but lack some of the sharpness of reproduction of those in the original French edition.

CHARITY WAYMOUTH
The Jackson Laboratory,
Bar Harbor, Maine

Teaching Science as Enquiry

A Strategy for Education. HERMAN T. EPSTEIN. Oxford University Press, New York, 1970. x, 122 pp., illus. $4.95.

A tension between the teaching of science as a rhetoric of conclusions and the teaching of science as enquiry has existed, doubtless, since Galileo presented one of his major works in the form of a dialogue. At any rate, in the early 19th century, Auguste Comte could remark with no air of originality that

> Every science can be viewed according to two modes of development—the historical and the dogmatic. According to the first, one considers the science successively, following the order by which the human mind has really acquired the knowledge. . . . According to the second, one presents the system of ideas as they would be conceived today by a mind which . . . is concerned with remaking the science as a totality.

Comte goes on to remark that the first mode treats original works (research papers) with primary emphasis on the manner in which the science has been formed.

In 1937, the University of Chicago refurbished the idea of making research papers accessible to beginning undergraduate students, using them as exemplars of scientific research and as occasions for participation by students in some of the activities of scientific enquiry. A report of this extensive experiment, including a bibliography of some 60 research papers in six series used and tested in the program, is contained in *The Idea and Practice of General Education* (various authors, University of Chicago Press, 1950). In 1950 the University of Puerto Rico launched a similar endeavor on a substantial scale, and currently such schemes are used occasionally or systematically in a number of colleges and universities. Indeed the use of original papers in the social sciences is so widespread that one publisher (Bobbs-Merrill) has made reprints of some 1100 papers available in loose-leaf form.

In the Inglis lecture delivered at Harvard in 1961, I argued for a similar treatment of science at the high school level (*The Teaching of Science*, Harvard University Press, 1962) and described a number of alternative means for doing so. The Biological Sciences Curriculum Study adopted one of these, "Invitations to Enquiry," and published 44 such "Invitations" together with suggestions for their use by high school teachers (*Biology Teachers' Handbook*, Evelyn Klinckman, Ed., Wiley, 1963, pp. 45–226). More recently, the Elementary Science Study has developed and published a large and varied body of material, much of it highly ingenious and extremely sensitive to the needs and limitations of very young students, all of it designed to bring activities of enquiry to students at the elementary level (Webster Division, McGraw-Hill, various publication dates).

This highly incomplete review is by way of saying that Herman Epstein has apparently rediscovered, quite independently, two of the principles which generate these varied efforts. He has rediscovered the extent to which participation by students in the solution of significant problems challenges many of them to renewal of interest and marshaling of energy. He has rediscovered also that primary sources (research papers) constitute accessible occasions and effective springboards for posing problems of scientific enquiry and inviting participative solution. In his slim volume (81 pages plus 41 pages of appendices) he presents one pattern of instruction for realizing these principles. The collegiate teacher of science unfamiliar with such modes of instruction may find the work suggestive. He is warned, however, that there are numerous alternatives to the kind of material and pattern of instruction suggested by Epstein and a great many issues involved in the curricular choices among them that are entirely omitted from Epstein's treatment.

JOSEPH J. SCHWAB
Department of Education,
University of Chicago,
Chicago, Illinois

Books Received

Active Filters. Lumped, Distributed, Integrated, Digital, and Parametric. Lawrence P. Huelsman, Ed. McGraw-Hill, New York, 1970. xii, 372 pp., illus. $16.50. Inter-University Electronics Series, vol. 11.

The Analysis, Design, and Synthesis of Electrical Filters. DeVerl S. Humpherys. Prentice-Hall, Englewood Cliffs, N.J., 1970. xii, 676 pp., illus. $18.95.

Annual Reports on NMR Spectroscopy. Vol. 3. E. F. Mooney, Ed. Academic Press, New York, 1970. xii, 506 pp., illus. $19.50.

Automated Cell Identification and Cell Sorting. George L. Wied and Gunter F. Bahr, Eds. Academic Press, New York, 1970. xii, 404 pp., illus. $19.50.

BASIC. For Beginners. Wilson Y. Gateley and Gary G. Bitter. McGraw-Hill, New York, 1970. xviii, 152 pp., illus. Paper, $3.95.

Basic Engineering Sciences and Structural Engineering for Engineer-in-Training Examinations. H. Jack Apfelbaum and Walter O. Ottesen. Hayden, New York, 1970. xvi, 408 pp., illus. $13.95. Professional Engineering Examination Series.

Basic Statistical Methods. N. M. Downie and R. W. Heath. Harper and Row, New York, ed. 3, 1970. xii, 356 pp., illus. $9.95.

Behind Ghetto Walls. Black Families in a Federal Slum. Lee Rainwater. Aldine, Chicago, 1970. xii, 446 pp., illus. $12.50.

Biological Studies of the English Lakes. T. T. Macan. Elsevier, New York, 1970. xvi, 260 pp., illus. + plates. $13.

Brown Adipose Tissue. Olov Lindberg, Ed. Elsevier, New York, 1970. xiv, 338 pp., illus. $24.50.

Cell and Tissue Culture in Biology and Medicine. A symposium, Edmond, Okla., December 1969. Paul F. Kruse, Jr., Ed. Oklahoma Academy of Science, Norman, 1970. vi, 102 pp., illus. Paper, $5. *Annals of the Oklahoma Academy of Science*, No. 1.

(Continued on page 1434)