over, the author's method casts into bold relief a very important theme: what Sir Basil calls "[t]he process of mathematization of the laws of nature, the replacement of physical concepts by mathematical symbols." To quote Synge, "The robust body of the Cheshire cat was gone, leaving in its place only a sort of mathematical grin." The atrophying of physical concepts, the "aphasia of mathematics" as Kelvin put it, was indeed a source of concern to many British physicists of the last century, and emphasizes the gulf between their day and ours.

ROBERT KARGON
Department of the History of Science, Johns Hopkins University, Baltimore, Maryland

Survey of Genetics

Genetics. MONROE W. STRICKBERGER. Macmillan, New York; Collier-Macmillan, London, 1968. x + 868 pp., illus. $12.95.

The opinions offered here of Strickberger's book were formed from two vantage points: doing genetics and teaching genetics. In general the book should prove useful to the gifted beginning student, to intermediate undergraduate and beginning graduate students, and to teachers of genetics whose background and time prohibit continuous updating.

In explaining this general conclusion let me say first that like most general textbooks this book suffers from the author's attempt to be both comprehensive and broad in scope; the good chapters display his interests and competence, and the weak chapters his lacks thereof.

Strickberger's treatment of "classical" genetics is thorough, and most likely the best treatment of the subject to be found in a general textbook, but some of the interspersed, "nonclassical" chapters are correspondingly weak. For example, the chapter on cytoplasmic (maternal) inheritance is superficial, out of date, and misleading in that it strives for solutions to non-Mendelian problems via the Mendelian approach. Most of the examples used to illustrate cytoplasmic inheritance can be found in older, less comprehensive textbooks; only brief mention is made of the fact that mitochrondria, chloroplasts, and other organelles possess DNA and RNA (that is, their own hereditary information); and no mention is made of the presence in these organelles of unique ribosomes, amino acyl synthetases, transfer RNA's, and so on (unique protein-synthesizing machinery). As a consequence of this omission the author bypasses the opportunity to explore the interesting and profound means for assaying cytoplasmic inheritance, and the equally exciting relationships between organelle and bacterial heredity. Other examples of this kind of weakness (in the chapter on nucleic acids, RNA is mentioned only in passing) will be apparent to specialists in the various areas of nonclassical genetics. For this reason the book will be of limited usefulness to the professional geneticist.

For the teacher who is not a professional geneticist the book will be of value as a means of fortifying his background beyond the depth of the more usual textbook, but I question its usefulness for his beginning students. The book demands a prior interest in genetics; it is too professional for the general student. Gifted students headed toward a career in biology will find the chapters on Mendelian, quantitative, population, and evolution genetics a gold mine of information, but in other chapters the students will need to go to the original sources (as one example, the descriptions of *Neurospora,* in the chapter describing life cycles, were taken from another textbook, not from Beadle or Dodge; in such cases, and there are many, the book merely translates errors from one textbook to another). In short, some chapters seem too difficult for beginners and others too superficial for the serious student.

In a day when textbooks are yielding to the monograph and *"Scientific American* offprints," when new information is a daily experience, and when teachers are shying from methods involving memorization-regurgitation and canned questions, a textbook must be expected to convey excitement and generalizations, as a minimum requirement, and at the same time it must leave a platform from which the teacher can function effectively. Strickberger's book is not first-rate judged by these criteria.

The author has made himself familiar, in a detailed way, with many important areas of genetics and has presented these in a readable way for the initiated, but to capitalize on these admirable efforts for maximum usefulness to students I would suggest an organization along the lines of Hayes's *The Genetics of Bacteria and Their Viruses,* such that the beginner might see the big picture before getting into deep water.

I think the science of "genetics" has grown too large for detailed treatment in a beginning textbook, and probably too large for detailed treatment by one author. Much of my criticism of Strickberger's book may stem from the fact that he would not agree with me on these points. Apart from my criticisms, this book is not just another textbook of genetics but rather a pandect of Mendelian, quantitative, population, and evolutionary genetics.

VAL WOODWARD
Department of Genetics and Cell Biology, University of Minnesota, St. Paul

Developmental Botany

Morphogenesis in Plants. A Contemporary Study. C. W. WARDLAW. Second edition. Methuen, London, 1968 (distributed in the U.S. by Barnes and Noble, New York). 451 pp., illus. $14.50.

The scarcity of published books on plant morphogenesis is not surprising considering the often ill-defined and all-encompassing nature of the field. An author attempting to discuss the origin of form in plants and its experimental control not only sets an extremely high goal for himself but also must proceed towards that goal without benefit of any generally accepted outline of formalized and structured subject matter. Wardlaw emphasizes that for a satisfying account of morphogenetic phenomena "we must draw upon the whole corpus of botanical knowledge and of the physical sciences; and, not withstanding the difficulties, which are admittedly great, we must attempt to unify and to integrate our information." As a consequence of the extensive scope of plant morphogenesis, the approach taken and the material included in most available books concerned with organization and development in plants are highly individualistic. The book reviewed here is no exception. The reader is exposed to a very personal and somewhat restricted account of plant morphogenesis. Like its predecessor (published in 1952), this edition contains accumulated results of observations and experimentation from Wardlaw's laboratory and does not lack adequate discussion of the author's concepts of apical organi-

zation in relation to morphogenesis. In addition, the present expanded volume contains information on plant embryogenesis, tissue differentiation, and flowering and a brief examination of selected morphogenetic studies on nonvascular plants. These topics are considered largely in terms of the developmental changes occurring at and above the cellular level. Although some attention is given to cytological and biochemical studies, the paucity of ultrastructural and biochemical data, particularly in the section on embryogenesis, will no doubt disappoint those whose attempts to understand plant morphogenesis have led them to study factors controlling changes in form at the subcellular level. Many readers will question the omission of references to the recent exciting studies on oriented cell divisions, mitotic spindles, and microtubules which already have contributed to our understanding of morphogenetic events.

Selected recent contributions from the literature on growth and form in plants are used to illustrate advances in specific topics. Unfortunately, they do not clarify materially such terms as "physico-chemical reaction systems," "physiological fields," and "growth centers," which are used frequently throughout the book to explain various morphogenetic phenomena.

It is not clear what audience the author had in mind when writing the book. The treatment is too detailed to permit its use as an introductory text in plant morphogenesis or for courses where developmental aspects of plants are briefly considered. A background in plant morphology and physiology is necessary if one is adequately to follow the author as he summarizes and integrates results of numerous investigators from Goethe (1790) to Waris (1967). The book is best suited for the advanced student and active worker in the field, who will find it useful for the comprehensive summation of experimental work performed on apical meristems.

More than half of the book is directly concerned with apical organization. The surgical experiments developed by Wardlaw and his colleagues and used so successfully during the past two decades to investigate the potentialities of the shoot apex are considered in great detail. These contributions have been extensively reviewed elsewhere, and readers will find much familiar material in this volume. Some will undoubtedly question the value of the present treatment, since much of the same material is covered in the authoritative chapters contributed by Wardlaw to the *Encyclopedia of Plant Physiology*. To others who, like myself, early followed closely the exciting developments in plant morphogenesis depicted in Wardlaw's writings, the book may be a poignant reminder of how little is known of whole-plant morphogenesis and how much remains to be accomplished.

A. E. DEMAGGIO
Department of Biological Sciences,
Dartmouth College,
Hanover, New Hampshire

A Question in Astrophysics

Spectral Line Formation. JOHN T. JEFFERIES. Blaisdell (Ginn), Waltham, Mass., 1968. xxii + 298 pp., illus. $10.50.

Much of the total information we obtain from the solar atmosphere and almost all our data concerning stellar atmospheres come from the shapes and total intensities of the dark lines in their spectra. Accordingly, astrophysicists have devoted much effort to trying to understand the exact mechanisms involved in spectral line formation. The shape, or profile, of a spectral line is determined by a number of factors, including line broadening due, for example, to Doppler effects produced by thermal motions of atoms or by their mass motions (turbulence); "density" broadening due to encounters between radiating atoms and perturbing particles; natural broadening (radiation damping); and—for some elements such as manganese—hyperfine structure. Stellar rotation or magnetic fields also tend to broaden spectral lines. Precise calculation of the profile of any line becomes a formidable task. One must know certain atomic constants such as transition probabilities and collisional line-broadening parameters, how the number of atoms capable of absorbing the line varies with depth in the stellar atmosphere, and finally the "mechanism" of line formation. Are the absorption and emission of radiation determined entirely by the local temperature and density (assumption of local thermodynamic equilibrium = LTE) or are they fixed primarily by the radiation field (non-LTE)? Earlier work on stellar atmospheres employed the simple LTE approach—which fortunately turns out to be a better approximation than we might have deserved. Some of the earlier work on non-LTE effects yielded spurious results because of bad observational and experimental data. With an improved understanding of stellar atmospheres and better data this situation is being remedied.

Jefferies' admirable contribution to the literature on the theory of spectral line formation constitutes a volume which every serious student of astrophysics will want on his shelf within easy reach. Emphasis is placed more on basic physics than on applications. The book is particularly valuable in the context of line-formation problems where deviations from LTE must be taken into account; these include the most important and challenging tasks in spectral-line-formation theory. One of the most difficult of these is to determine the solar iron abundance. If solar and chondritic silicon : iron ratios are indeed identical and the transition probabilities are not wrong, there is something very fundamental about spectral line formation we do not understand. Deviations from LTE apparently cannot remove this discrepancy in silicon : iron ratio. Publication time lags being what they are, there is no reference to promising brand-new developments such as the technique of spectrum synthesis developed by B. J. O'Mara and John Ross whereby the exact shape of even complicated regions of the solar spectrum can be reproduced.

L. H. ALLER
Department of Astronomy,
University of California, Los Angeles

Analytical Technique

The Practice of Gas Chromatography. LESLIE S. ETTRE and ALBERT ZLATIKIS, Eds. Interscience (Wiley), New York, 1967. xvi + 591 pp., illus. $14.95.

Despite a welter of theory on gas chromatography it is still difficult for an analyst, even if he has digested the theory, to make precise decisions on the design of his analyses, and much remains a matter of judgment. This book provides guidance for the necessary judgments without requiring the reader to absorb more than the bare minimum of theory.

Inevitably this leaves the reader at the mercy of the authors of the chapters. At times their guidance is not what this reviewer would have given; however, this occurs only where differ-