ment of a personal philosophy that it represents, it will appeal to the specialist in astrophysics as well. Amply sprinkled throughout the book are skeleton diagrams of nuclear transformation chains and photographs of spectacular stars, stellar regions, and galaxies, all of which contribute to the reader's understanding and enjoyment. The author's insistence on laboratory measurements as a foundation for nuclear astrophysics and his obvious delight in the interpretation of astronomical observations are apparent throughout. It is easy to see why he has, for over a decade, been a leader in the field.

One particular passage in the book deserves to be ranged alongside that classic quotation from John Donne that sets the theme for Hemingway's *For Whom the Bell Tolls*. After carefully tracing the sequences of nuclear transformations and element synthesis that occur in stars as they evolve from the hydrogen-burning main-sequence and red-giant stages through helium-burning stages and beyond, Fowler concludes: " . . . all the elements heavier than helium, and perhaps the helium too, have been synthesized in stars . . . your bodies consist for the most part of these heavier elements. Thus . . . you and your neighbor and I, each one of us and all of us, are truly and literally a little bit of stardust." Statements such as this convey to the layman how it is that men can dedicate their lives to research in astrophysics.

ICKO IBEN, JR.
Department of Physics, Massachusetts Institute of Technology, Cambridge

Growth Symposium

Major Problems in Developmental Biology. The 25th symposium of the Society for Developmental Biology, Haverford, Pa., June 1966. MICHAEL LOCKE, Ed. Academic Press, New York, 1967. 420 pp., illus. $16.

This volume, the latest of the "Growth Symposia," marks the silver jubilee of this splendid series. It provides an occasion for a backward look, and in the opening paper Jane Oppenheimer recounts the origins and something of the achievements of the symposia, putting them into a background of contemporary discoveries. It provides an occasion, too, for a wider span of topics than has recently been usual. A substantial sample of those major problems of animal development which seem due soon for solution come up for discussion under various guises.

Preeminent among these is the determination of tissue types. Molecular genetics has blown the fog away from this towering problem and suddenly it seems to be approachable. The developmental biologist, since he is in no danger of distracting the biochemist from the search for gene repressors (given a stimulating discussion here by Koshland and Kirtley), can with a clear conscience continue his harping on some of the complexities of the business. Of these the involvement of cell heredity, or at least cell population heredity, is one of the most interesting. It has seldom been more beautifully displayed than in the work of Hadorn, which he discusses here, on the prolonged replication in culture of the state of determination in *Drosophila* imaginal disks. Cell heredity is of course part of the cancer problem too. Malignant transformation has attractions as at least an analogue of differentiation, and vice versa, and it is interesting that more than a tenth of the book is concerned with the cancer cell, in papers by Ebert and Kaighn and by Rubin. It is refreshing to have Rubin's uninhibited airing of the idea that the cell surface may be an organ of heredity.

Twenty-five years ago the inside of a cell was such a mystery that the only approachable problems of determination seemed to be those concerned with the signals between embryonic cells that switched determination on. Whether these are really a softer option seems doubtful now. We are faced with problems whose outlines we cannot even make out when we read of the laying down of the intricate patterns of differentiation described here by Ursprung and by Waddington; or, in Jacobson's article, of the onset of the polarities of embryonic rudiments, a problem which the modern highly refined analysis of retinal development revives from earlier days.

The Growth Symposia have always put botanical and zoological contributions side by side, and in this volume there is a most lucid account by Lang of the (to a zoologist) usually impossibly confusing subject of plant hormones. But one has the impression that the two cultures are still apart, even though they share, with stimulating variations, the problems of determination. Perhaps it is because they have less in common when it comes to morphogenetic mechanisms. Morphogenetic cell death, here discussed by Saunders and Fallon, and especially morphogenetic cell movement, given a masterly review by Trinkaus, are predominantly animal mechanisms. Indeed, the pride of the animal kingdom, the ordered complexity of its nervous systems, depends largely on the extreme subtlety of the behavior of moving axon tips during development. There is no more striking example of this than the regeneration of the anamniote optic nerve that Jacobson describes. But though animals by their exploitation of cell movement may have gained a nervous system, the vegetable world has not had to pay the corresponding penalty of cancer.

One cannot leave this volume without recording the great debt of gratitude that the community of developmental biologists owes to those who have organized the Growth Symposia; for a quarter of a century they have spent much imagination and skill in our service.

MICHAEL ABERCROMBIE
Department of Zoology, University College, London, England

Sulfur Chemistry

The Chemistry of Organic Sulfur Compounds. Vol. 2. NORMAN KHARASCH and CAL Y. MEYERS, Eds. Pergamon, New York, 1966. 473 pp., illus. $21.

The second volume of this work consists of 15 chapters, most of which seem to have been written shortly after publication of the first volume in 1961. To bridge this time gap, some of the authors contribute short addenda to the appendix, and the editors themselves list in the appendix reviews of organic sulfur chemistry and provide a collection of brief summaries of selected primary publications from the period 1961–1965. Regrettably the material of the appendix (30 pages) is not indexed.

The most comprehensive and generally useful discussions are those on Polyfluoroalkyl Derivatives (R. E. Banks and R. N. Haszeldine), The Chemistry of the 1,2-Dithiole Ring (N. Lozac'h and J. Vialle), Mechanisms of Raney Nickel Desulfurization (W. A. Bonner and R. A. Grimm), Oxidation of Disulfides, with Special Reference to Cystine (W. E. Savige and J. A. Maclaren),

Thiohydantoins (J. T. Edward), Thiophosgene (H. Tilles), Recent Aspects of Olefin Sulfide Chemistry (L. Goodman and E. J. Reist), Desulfonylation Reactions (J. L. Kice), and the two chapters on the homolytic addition reactions of thiols to multiple C-C bonds (A. A. Oswald, T. J. Wallace, and K. Griesbaum). The discussion of the chemistry of olefin sulfides should have included their oxidation reactions even though the successful preparation of episulfoxides and episulfones is very recent (1966). The statement that episulfones cannot be isolated is misleading in view of the accessibility of these structures via the reaction of diazoalkanes and sulfur dioxide. Also, it is unfortunate that the discussion of the stereochemistry of the co-oxidation of thiophenol and indene does not clarify the fact that the reaction is not *trans* stereospecific in view of the reported isolation of appreciable yields of *cis*-2-phenylsulfinyl-1-indanol. The chapter on thiophosgene could have been enriched by a detailed account of a recommended procedure for the generation of this useful reagent in the laboratory. Less comprehensive, but thorough, discussions centered primarily around personal research are contributed by A. Fava (Isomerization of Organic Thiocyanates) and O. Gawron (On the Reaction of Cyanide with Cystine and Cystine Peptides). The chapter on Electron Correlation and Bond Properties in Some Selected Sulfur Compounds (H. A. Bent) presents an excellent review of generally recognized relationships between the electronic states of atoms and the physical properties of the resulting bonds, an extension of this discussion to cover sulfur bonds, and an original treatment of the tangent sphere model, anticoincidence, and the Hellman-Feynman theorem as applied to the bonds in certain sulfur compounds.

Two chapters of this book are disappointing. The discussion of The Alkaline Decomposition of Aliphatic Disulfides (J. P. Danehy) is inconclusive and is based on admittedly incomplete studies. No attempt is made to explain the zeroth-order dependence on cystine in its alkaline decomposition. The chapter by W. Drenth entitled Properties of 1-Alkynyl Thioethers is essentially a repetition of the discussion of four personal studies (with Loewenstein, Hogeveen, Stamhuis, and Hekkert) and is highly speculative.

The proofreading of the book could have been more careful. Errors, omissions, and other flaws were noted on 36 pages. But in spite of its shortcomings the volume is an indispensable addition to the library of the ever-expanding field of organic sulfur compounds.

H. HARRY SZMANT
Puerto Rico Nuclear Center, University of Puerto Rico, Río Piedras

Papers on Elementary Particles

High Energy Physics. Vol. 1. E. H. S. BURHOP, Ed. Academic Press, New York, 1967. 511 pp., illus. $22.

The present volume is the first of three intended to provide a comprehensive and up-to-date account of elementary particle physics. It is a prime example of the misguided practice of combining under one cover unrelated essays by experts in various specialties. Although the authors have produced useful articles, the long delay (nearly two years) required to produce this expensive and beautiful book inevitably decreases the impact and interest of their essays. As the editor admits, "the content of each volume has been determined by the order in which the articles came to hand rather than by the natural order suggested by the rational development of the subject."

Because of this I shall discuss the contributions separately. The introductory article by V. F. Weisskopf gives a qualitative survey of elementary particle physics. This paper is a reprint from an earlier issue of *Science* [**149**, 1181 (1965)]. It has the decided virtue of recalling an earlier day when particle physics was considered as a single subject which could be understood, however imperfectly, by one person. It is a fine essay for the nonspecialist who wonders why physicists care. There follows a closely packed, 170-page article by G. Breit and R. D. Haracz on nucleon-nucleon scattering. Every expert in this field will have to consult this definitive work on the extensive phase-shift analyses by the Yale group, at least to make sure his papers are cited in the extensive (13 pages) reference section. The discussion of theory is inadequate, and in general the nonspecialist will tire while hunting for the main accomplishments and problems of the subject. The excellent article by J. Hamilton on pion-nucleon scattering rarely loses sight of the physical content of the mathematics. This paper, which is an amplified version of lectures that have appeared previously, in several places, shows successfully how experimental data may be understood by means of plausible approximations based on dispersion relation techniques. The selection of material and references is eclectic and is largely confined to the contributions of Hamilton and co-workers. T. A. Griffy and L. I. Schiff present a discussion of electromagnetic form factors. The treatment is similar to that of Drell and Zachariasen's *Electromagnetic Structure of Nucleons* (Oxford University Press, 1961), with changes to accommodate the steady progress in this area. (For example, the Dirac-Pauli form factors have given way to the Barnes-Sachs form factors. More accurate theories of the deuteron now permit a better determination of the neutron form factor.) Unfortunately the utility of this contribution suffers from the long time between manuscript completion and publication. Many important recent advances could not be included. In the final contribution, P. T. Matthews provides a lucid treatment of various unitary symmetry schemes. His discussion of SU(3) is fairly standard, but the unified exposition of theories dealing with "relativistic SU(6)" is really outstanding. This part evokes memories of the great gold rush of 1964–65. It is a pity that Matthews's article was not widely available during the great controversy surrounding this subject. Much has happened in this area since the review was written, but his discussion is less dated than might be expected. The mathematical appendix is very useful.

The publishers have not done the readers or authors a favor by the publication of this book. The excuse given, that "it is now extremely difficult to envisage a work both comprehensive and up-to-date, written by a single author," is disproved by Gasiorowicz's recent *Elementary Particle Physics* (Wiley), which is simultaneously comprehensive, organized, and very much up to date. The reviewer hopes that his colleagues will learn that their specialized essays will be read sooner, by more people, if they publish in the review journals.

PETER A. CARRUTHERS
Department of Physics, Cornell University, Ithaca, New York