Book Reviews

Bioenergetics. Albert Szent-Györgyi. Academic Press, New York, 1957. x + 143 pp. Illus. + plates. $4.50.

Bioenergetics is the latest in a series of books in which Albert Szent-Györgyi has given us a lively running account of his efforts to understand the chemical and physical bases of life-processes.

The present work is about the utilization of energy by living things. It is based on an evaluation of our present knowledge of cellular chemistry, which no student of biochemistry can afford to forget. We know a great deal about how cells release energy from foodstuffs but very little about how this energy is put to use as work. What is more, "Dazzled by our successes we even forget to ask."

With characteristic directness, Szent-Györgyi dedicates his book to an attack on this area of ignorance, for he is convinced that "Such a schism between the known and the unknown suggests that some basic information is missing."

The problem is to discover how the energy that is associated with a chemical bond, and which has no influence beyond the limits of a given molecule, may be converted into a transferable, externally active form. To make matters easy for biologists, and to avoid "an argument with statistical mechanics," Szent-Györgyi adopts separate notations for the two types of energy, the symbol E^* representing the transferable form which accomplishes work. E^* is associated with an excited state of a solid system and represents energy transferable within such a solid. Biological macromolecules, especially proteins and nucleic acids, are solid-state systems capable of conducting E^* and delivering it to the point at which it may link up with a work process.

This proposition stated, Szent-Györgyi devotes several succeeding chapters to presentation of supporting evidence. The evidence is derived from relatively simple experiments on fluorescence and phosphorescence. Since excited states of the type denoted by E^* frequently decay by delayed emission of light, these phenomena are a source of rough information about systems capable of generating and transferring E^*. The evidence is suggestive rather than final. Nevertheless, the experimental facts provide Szent-Györgyi with a framework for some stimulating discussions of the problem of energy transfer in biological systems and the possible roles played by biologically important substances, especially water.

The remainder of the book is frankly speculative, dealing with possible relations between E^* and various aspects of normal and pathological biology. Szent-Györgyi's speculations are always worth reading.

This book is valuable because it is an eloquent plea that we give attention to the vital areas which modern biochemistry, which is so successful in other ways, appears to be unable to master. Biochemical analysis of cellular processes is based on the behavior of dilute homogeneous solutions. The conceptual framework is that of the chemist; its cornerstone is the chemical reaction between colliding molecules. What Szent-Györgyi tells us is that the reactive systems of the cell are not solutions but structurally organized solids and that the chemical events of life are more nearly related to solid-state physics than they are to solution chemistry.

A partisan of Szent-Györgyi's cause would wish that his appeal were more firmly founded on modern solid-state physics. This field is developing at a remarkable rate, but relatively little of recent knowledge about energy transport in solids is reflected in Szent-Györgyi's book.

This failing is not wholly Szent-Györgyi's responsibility. His first plea that biochemistry take heed of the solid state was made 16 years ago in an article in *Science* [**93**, 609 (1941)]. Six years later, in his essay on the continuum theory—which is essentially the same as his present proposal—Szent-Györgyi made some trenchant comments on the impact of this previous article. "In the course of my career as a biochemist I was more and more depressed by the feeling of complete failure, not being able to explain a single reaction. Much relieved by the new theory of matter (*i.e.*, energy levels in solid semiconductors), I gave vent to my joy in an article in *Science* entitled 'Towards a New Biochemistry?' By this rather ambitious title I wanted to emphasize that the application of this new theory to living systems might mean a new period in biochemistry. The reaction to this article was rather amazing: There was none at all" (in *Muscular Contractions*, Academic Press, New York, p. 97).

If Szent-Györgyi's first call had been heeded by biochemists and other investigators, the intervening 16 years might have seen a vigorous application of solid-state physics to the problem of biology, and we would now be able to substitute fact for speculation.

The readability of this book is somewhat marred by printing defects.

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Educating Gifted Children. Robert F. DeHaan and Robert J. Havighurst. University of Chicago Press, Chicago, Ill., 1957. ix + 276 pp. $5.

Educating Gifted Children is one more book in the considerable number which have appeared in recent years evidencing the mounting interest in superior youngsters and awareness of the importance of finding them and nurturing their potentialities. As is set forth in this volume, there is a responsibility for helping gifted children not alone for their sake and for that of the community; the international situation makes it urgent that this country find its best young people and give them such training and opportunities as will bring them to maximal fruition.

The treatment is systematic and broad, and it aims at practicality. Thus, the third chapter, on screening children for ability, considers tests of various types and also ways of systematizing the observation of teachers, parents, and other children in locating exceptional talents of various sorts—as in science, the fine arts, and music. A following chapter, on screening programs in action, describes ways of setting up such programs in a school or school system, with a chapter next following on administrative aspects of an educational program for gifted children.

Other chapters deal with the long-standing controversy between enrichment and acceleration (why not, the authors wisely and diplomatically say, some of both?); with motivation of the gifted; with values of special grouping and ways of serving the gifted child in the classroom; and with the development of creativity and special talents. Unusual breadth is evidenced by chap-

ters on community factors and resources in the education of the gifted and on the gifted child in the family.

As has already been implied, the consideration is of youngsters in the elementary and secondary schools rather than students in college, although integration of the work of secondary school and college is touched on. There is much illustrative material, there are appendixes listing tests useful in locating superior children and organizations interested in them, and there is a classified annotated bibliography.

To me it seems unfortunate that there is no mention of Lehman's monumental work on age of achievement and of his finding that best creative work tends to be done early in the young adult years. In view of the increasingly long preparation now required in scientific and other fields, that finding adds urgency to efforts to facilitate the progress of able young people into careers. But, in total, the volume is exceptionally broad in treatment, in the sources on which it draws, and in the variety and practical nature of the suggestions of ways in which schools may find and foster the talents of the gifted.

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Plant Virus Serology. R. E. F. Matthews. Cambridge University Press, New York, 1957. xi + 128 pp. Illus. $5.

This excellent little volume is a manual of laboratory methods in plant virology. Aside from the condensed account in Bawden's general textbook, it seems in fact to be the only existing description of plant virus serology.

There are 11 chapters: "Introduction," "Types of serological test," "Routine testing for virus infection," "Serological tests for determining relationships among plant viruses," "The precipitin reaction," "The antibody content of sera," "Methods of estimating virus concentration," "The cross absorption procedure," "Precipitation in mixed systems," and "The applicability of serological techniques." The first chapter is a general introduction and assumes no knowledge of serology on the part of the reader. The nature of subsequent chapters is well indicated by their titles. To avoid any possible misunderstanding, however, it may be remarked that the antibodies used are animal (rabbit) antibodies.

In addition to the quantitative nitrogen methods introduced into serology by Heidelberger and Kendall, the author makes much use of quantitative timing of the precipitin reaction, including the optimal proportions method introduced by Dean and Webb and modifications of this method suggested by Hooker and Boyd, and by Boyd, little used in this country. The author's interpretation of the beta optimum is somewhat different from that of the latter authors but not necessarily incorrect. These relatively little known methods, plus a serological chromatographic method attributable to Matthews, are evidently of great value, especially for estimating small amounts of virus.

The book is well illustrated by six plates and 12 text figures. There are a bibliography of more than 100 titles, a subject index, and an author index.

WILLIAM C. BOYD

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Development of Vertebrates. Emil Witschi. Saunders, Philadelphia, Pa., 1956. xvi + 588 pp. Illus. $8.50.

This textbook of embryology is based on a new and original plan, incorporating a considerable amount of material on experimental embryology, developmental physiology (especially metabolism), and the endocrinology of reproduction. Such a plan results in a far more complete and well-rounded elucidation of developmental processes than was possible in the older textbooks based on a strictly morphological approach. The author's research experience in the fields of experimental embryology and endocrinology has, of course, eminently qualified him to prepare this new type of presentation. The clarity of the writing and the excellence of the illustrations make the book a pleasure to read, and these features will be appreciated by the college students who will use it. Since students majoring in zoology or in premedical work (for whom the book is intended) may eventually enter fields of biological or medical research, rather than medical practice, this approach provides a valuable stimulus to the coming generation of research workers in the biological sciences.

A great deal of material is covered in the 588 pages; basic concepts are outlined (10 pages), and there are general sections on maturation of the gametes (33 pages), fertilization (11 pages), and cleavage and gastrulation (13 pages) as well as longer and more specialized sections on the development of fishes (24 pages), amphibians (118 pages), birds (146 pages), and mammals, including man (179 pages). Experimental material is incorporated in the sections on each form, and there are separate chapters dealing with the developmental physiology of each group. The conclusions, which are based on the experimental work, are well documented. There is an adequate bibliography (12 pages) of the more important recent and older references.

The relative emphasis on the various topics (indicated, in part, by the amount of space devoted to each) has been carefully considered and, in my opinion, correctly placed. In addition, the book has been kept sufficiently concise for use in a one-semester course by a rigid systematizing of the descriptive materials contained in the representative life-histories. As the author states in the introduction (page vi), the book aims to contribute toward "a realization, by the student, that development is a natural process which is open to scientific analysis by research methods not essentially different from those of the inorganic sciences."

The excellent, well-labeled illustrations utilize a variety of techniques, from photographs to line drawings, and are beautifully reproduced. Many of these figures have not been published before.

In short, the book is a usable and useful addition to the available textbooks of modern embryology.

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The Genus Achlya: Morphology and Taxonomy. University of Michigan studies, scientific series. vol. XX. Terry W. Johnson, Jr. University of Michigan Press, Ann Arbor; Cumberlege, Oxford University Press, London, 1956. 180 pp. Illus. $4.50.

This short monograph deals with the largest genus of a family of aquatic Phycomycetes, the Saprolegniaceae, or "water molds." Taxonomically the entire family is a difficult one—extreme variability of vegetative and asexual structures leaves only the slightly less variable sexual organs and features as taxonomic criteria—in which the largest component genus certainly contains its full share of puzzling relationships and uncertainties. The author is clearly aware of these difficulties and limitations, uncomplainingly accepts them as completely unavoidable, and proceeds about the treatment of the group with admirable firmness and discrimination and with an equally admirable lack of pomposity: on page 74 he actually reduces *Achlya michiganensis* Johnson to synonomy. A great deal of effort obviously went into securing collections from widely scattered sources, particularly cultures or preserved samples, or both, of original materials from previous authors in the group; these materials, together with Terry Johnson's own numerous collections, constitute an extensive basis