Book Reviews

Protozoans

The Biology of Amoeba. KWANG W. JEON, Ed. Academic Press, New York, 1973. xviii, 628 pp., illus. $34. Cell Biology.

Because amoebae are so extensively used in teaching and research a volume reviewing their basic biology is a welcome addition to the literature. The present compendium consists of 21 chapters on the biology of the "large free-living amoebae," and the author list is studded with names of individuals well known as specialists to anyone even slightly acquainted with the original literature. Each chapter provides an effective general background to its subject, and chapters on related subjects are somewhat coordinated to decrease overlap. History, taxonomy, morphology, fine structure, behavior, ameboid movement, endocytosis, effects of chemical and physical agents, and biochemical and physiological studies are covered.

Amoebae have been especially important for studies on effects of enucleation, renucleation, nuclear-cytoplasmic relationships, ameboid movement, and endocytosis, and as examples of cells. Amoebae have served these purposes well because the large size of some species makes microsurgery easy, permitting enucleation and renucleation with nuclei from other strains or species, and fusion of individuals or parts of individuals treated in different ways or of different species. Thereby, information not easily obtained with other types of cells has become available. An example is the interesting finding that both proteins and RNA move out of, and into, the nucleus of an amoeba. Much new information on ameboid movement is presented, but there is still not complete agreement as to its mechanism. However, some fascinating new data are presented on the molecular biology of ameboid movement. Among the curious historical facts is that amoebae escaped the watchful eye of Leeuwenhoek and were first described by Rösel von Rosenhof in 1755. A good review is presented of the classification of amoebae, with the provocative information that *Pelomyxa palustris* lacks mitochondria, endoplasmic reticulum, Golgi-like bodies, and cilia-like bodies (the "9+2 organelle"), suggesting that it is something less than a true eukaryote; although it has a nucleus it forms no mitotic apparatus of spindle fibers during division. One almost wants to seek the next step down—an amoeba without a true nucleus, though none has been described. An absorbing account is given of the possible genealogy of amoebae and their evolution.

The Biology of Amoeba has some minor defects: some chapters are largely catalogs and do not make effective use of the information presented; references at the ends of the chapters lack titles, a sacrifice to economy, but one that makes the bibliography of little interest to peruse by itself; glossy paper makes for good reproductions of photographs but presents some difficulty in reading. Although there are some other shortcomings, by and large *The Biology of Amoeba* accomplishes its objective of presenting clearly the large mass of old and new information (emphasis is on the last ten years, with much unpublished work included). The book is well designed, with attractive format and excellent illustrations, including some striking scanning electron micrographs. The volume will thus be of great value to any student or research worker who may wish to use amoebae or compare them with the cells he is studying.

ARTHUR C. GIESE
Department of Biological Sciences,
Stanford University,
Stanford, California

NGF

Nerve Growth Factor and Its Antiserum. A symposium, London, Apr. 1971. ELEANOR ZAIMIS and JULIE KNIGHT, Eds. Athlone, London, 1972. xii, 274 pp., illus. £7.50.

"The discovery, about 20 years ago, that 'more than 90 per cent of the population of sympathetic nerve cells can be increased up to sixfold, or, conversely, wiped out, by supplying a protein or its antiserum to newborn animals,' was so extraordinary," Zaimis remarks in her introduction to this book, "that for many years it was viewed by a great number of scientists, at least in Great Britain, with some disbelief. In 1964, however, we were able, with Professor Levi-Montalcini's advice and using her antiserum, to demonstrate to the Physiological Society the first immunosympathectomized rats produced in this country. . . . Scientists all over the world have not only confirmed the results of Professor Levi-Montalcini and those of her colleagues but have also produced a number of additional and striking observations on the nerve growth factor (NGF) and its antiserum."

The book contains 12 papers on chemical and biological properties of NGF, 8 on NGF-antiserum effects, and 3 on technical problems in the assay of NGF and its antiserum. Purification and chemical characterization of NGF are reviewed by several leading research groups: C. A. Vernon *et al.* of University College London, E. M. Shooter *et al.* of Stanford University, and R. Levi-Montalcini and the Angelettis of Washington University and the Consiglio Nazionale delle Ricerche in Rome. The first two groups of authors consider NGF to involve a complex group of related proteins, but the third maintains that a single protein accounts for the nerve-growth-promoting activity of mouse submaxillary gland (which has been a principal source of NGF). The complete amino acid sequence of this "2.5S NGF" protein has recently been determined by R. H. Angeletti *et al.* The active NGF molecule appears to be "a dimer of molecular weight 26,518, composed of two identical subunits of molecular weight 13,259," and Levi-Montalcini notes that "elucidation of its primary and secondary structure . . . [should soon make it possible] to identify the biologically active group of this small protein molecule and its mechanism of action at the molecular level. The NGF compares favorably with hormones such as insulin and the growth hormone in one important respect; its field of action is much more specific and its target sensory and sympathetic nerve cells . . . have distinct and unique differentiative characteristics which enable us to detect the successive morphological stages of the growth response" (see also Frazier, Angeletti, and Bradshaw, *Science* **176**, 482 [1972]). In view of the serious differences which

evidently existed among participants at this symposium regarding interpretation of these and other properties of NGF, it would have been useful to emphasize some of these issues by including the discussions, or a summary of them, in the volume.

The dramatic selective growth-stimulating effects of NGF on sensory and sympathetic nerve cells of chick and mouse embryos (as well as on mature sympathetic neurons) are well reviewed by Levi-Montalcini and P. U. Angeletti; recent studies of ultrastructure and metabolic effects of NGF on these target cells are included. Zaimis's demonstration of similar selective hypertrophy of sympathetic ganglia (and adrenal medulla) in kittens and rats after one to two weeks of daily NGF injections in the neonatal period should provide valuable biological preparations for analyses of "the role of the sympathetic nervous system and the way in which structures innervated by it can be affected by drugs." L. Papadaki provides a detailed electron micrographic study of the NGF-hypertrophied sympathetic ganglion cells in Zaimis's kitten and rat experiments, and E. Nicolescu *et al.* demonstrate increased fluorescence attributed to catecholamines in heart, spleen, and other organs in these same NGF-treated kittens and rats. M. G. Larrabee reviews a series of interesting metabolic studies (carried out with L. M. Partlow) on NGF-stimulated chick embryo sensory and sympathetic ganglia, in vitro and in vivo.

N. R. Saunders provides a critical review of earlier claims by Scott and Liu (1963, 1964) that NGF promoted regeneration of spinal cord neurons in kittens, and concludes that "these experiments do not appear to provide convincing evidence that NGF can effect the outgrowth of spinal neurons after damage." He also describes his own attempts to detect NGF effects on regeneration of peripheral sensory nerves after crush lesions in rats and rabbits. The results were negative (although the superior cervical ganglia of the NGF-treated animals did show expected enlargement). Levi-Montalcini had already reported that although "sensory ganglia . . . dissected out from a large number of mammalian foetuses respond to NGF *in vitro*, . . . during postnatal life, mammalian spinal ganglia show no growth response when treated either *in vivo* or *in vitro* with NGF." The experiments by Scott and Saunders were based on the hope that introduction of high concentrations of NGF might nevertheless produce physiologically significant enhancement of adult sensory neuron regeneration. Although these attempts have been discouraging, recent studies by Björklund and Stenevi (*Science* **175**, 1251 [1972]) demonstrate that "a single intraventricular injection of NGF . . . has a potent stimulatory effect on the regenerative sprouting and growth of severed central noradrenaline axons." No growth-stimulating effects had been detected, however, on *intact* central nervous system neurons during Levi-Montalcini's studies in chick embryos and neonatal mice. It will therefore be of great interest to determine whether NGF may indeed, as proposed by Björklund and Stenevi, "play a role in . . . the normal development, maturation, and growth of certain central [catecholamine] neuron systems, . . . similar to that in peripheral, sympathetic neurons." Perhaps these questions will soon be clarified by further applications of sensitive fluorescence histochemistry techniques as well as by systematic analyses with CNS tissue cultures.

The chapters on NGF-antiserum cover a wide range of biochemical, physiological, and behavioral alterations which occur in animals during and after experimental immunosympathectomy. Larrabee describes metabolic and electrophysiologic deficits which develop in sympathetic glanglia during the first few days after a single injection of NGF-antiserum in 7- to 10-day-old mice. Zaimis provides a valuable review of the usefulness of immunosympathectomized animals in cardiovascular research, but limitations in this experimental method have been noted by L. Iverson in his recent review of a related book, *Immunosympathectomy*, edited by G. Steiner and E. Schönbaum (*Science*, 12 Jan. 1973, p. 171). The latter book provides an excellent extension of the Zaimis and Knight volume, especially in regard to NGF-antiserum.

The chapters on technical problems in the assay of NGF and its antiserum include valuable data and advice by D. C. Edwards, F. L. Pearce, and I. A. Hendry. Serious pitfalls in the bioassay of NGF by standard serial dilution are emphasized by Pearce, who shows that reversible adsorption of NGF on glass pipettes can easily lead to absurd errors in estimation of potency (and may account for some of the conflicting data already in the literature, for example Shenkein *et al.*, *Science* **159**, 640 [1968]). A new radioimmunoassay procedure developed by Hendry *et al.* avoids these dilution problems as well as the subjective errors involved in the usual bioassay, where the magnitude of nerve fiber outgrowth is estimated by microscopic observation. The new immunoassay is also 20-fold more sensitive than the bioassay. Angeletti *et al.* also utilize a microcomplement fixation assay to demonstrate the presence of significant amounts of NGF in membrane-bound particles isolated from a microsomal fraction of heart, kidney, and spleen tissues. This new technique should facilitate "recognition and characterization of the receptor sites at which this unique [NGF] molecule binds . . . [which] would be of the utmost importance in clarifying its mechanism of action."

In general, then, the book provides a useful review of current trends in NGF research. The references cited at the ends of chapters are adequate for those seeking further details in technique or data. An author index would have been helpful in this regard. No serious attempt has been made to integrate the diverse chapters, but most readers will probably find chapter 5, by Levi-Montalcini and Angeletti, an excellent introduction from which to proceed to more specific topics in this exciting area of developmental neurobiology.

STANLEY M. CRAIN
Department of Physiology and
Rose F. Kennedy
Center for Research in Mental
Retardation and Human Development,
Albert Einstein College of Medicine,
Bronx, New York

Developmental System

The Biology of Imaginal Disks. H. URSPRUNG and R. NÖTHIGER, Eds. Springer-Verlag, New York, 1972. xviii, 172 pp., illus. $14.60. Results and Problems in Cell Differentiation, vol. 5.

Within a maggot or a caterpillar there are sacs of presumptive adult cells, called imaginal disks, that depend on the larva for nutrition, waste disposal, and gas exchange. During metamorphosis larval cells die, but these embryonic adult cells are transformed into a fly or a moth.

This volume, consisting of six reviews of imaginal disk biology, is dedicated to the distinguished Swiss developmental geneticist Ernst Hadorn. In most of the book, emphasis is placed on data