zoans, and cellular slime molds are attempted, even though the adaptations are in some cases parallel and pregnant with theoretical implications. For a systematic account of animal coloniality it will still be necessary to consult the first volume of W. N. Beklemishev's *Principles of Comparative Anatomy of Invertebrates*. But even this review is overly brief and unnecessarily technical, leaving the need for a modern general synthesis of the subject largely unfilled.

EDWARD O. WILSON
Museum of Comparative Zoology Laboratories, Harvard University, Cambridge, Massachusetts

Neural Bases of Rhythmicity

Neurobiology of Invertebrates. Mechanisms of Rhythm Regulation. Proceedings of a symposium, Tihany, Hungary, 1971. J. SALÁNKI, Ed. Akadémiai Kiadó, Budapest, 1973. 494 pp., illus. $24.

In his introductory remarks to this satellite symposium of the 25th International Congress of Physiological Sciences Salánki notes that "rhythmicity and cyclic character is one of the rules of the living processes." The proceedings volume presents 33 papers examining aspects of rhythmicity at various levels of biological organization.

In line with the current emphasis on physiological analysis of arthropod and molluscan nervous systems, little attention is given to rhythmic phenomena in invertebrates other than crustaceans, gastropods, insects, and pelecypods.

Most of the papers may be cataloged under three topic categories: the cellular basis of pacemaker rhythmicity, the regulation of cardiac rhythms, and the generation of rhythmic behavior patterns.

Three papers examine the contributions of K^+ conductance changes and Na^+ pump activity to the generation of neuronal pacemaker activity. The reports of Carpenter and of Wachtel and Wilson respectively support the primary pacemaking role in *Aplysia* of K^+ conductance changes and of Na^+ pump activity. A synthesis of these contradictory results is suggested by Livengood and Kusano, who demonstrate in the crustacean cardiac ganglion that rhythmic pacemaker activity is most likely generated by a decrease in K^+ conductance and modulated by an electrogenic Na^+ pump.

Several papers deal with the role of neurotransmitters, neurohormones, and pharmacological agents in the regulation of cardiac rhythmicity. Among the most interesting are the three by Greenberg *et al.*, Miller, and Richter, who examine the cardioregulatory effects of extracts from neural tissues. A lively discussion erupts when Miller demonstrates the myogenic nature of cockroach heart rhythmicity.

Complete analysis of the neural generation of complex rhythmic behavior patterns requires quantitative study at two levels: detailed analysis of motor neuron activities that generate the behavior, and intracellular recording from the neuronal elements that participate in the generation of the motor neuron output. Elegant examples of the first type of study are provided in this book by Elsner's paper on grasshopper courtship and Wyman's statistical analysis of dipteran flight motor neurons. Reports of intracellular examination of neuronal interactions in the locust, presented by Hoyle, and in *Tritonia*, presented by Willows, provide new insight into the structure of the neuronal circuits which generate rhythmic motor outputs.

As Prosser notes in his concluding remarks, this symposium was characterized by the diversity of topics considered. Unfortunately it was also afflicted by a great disparity in the interest and quality of the work presented. Some papers are excellent, providing concise reviews of recent work with supporting experimental data. These are counterbalanced by several papers of poor quality which in terms of ideas, experimental design, and results presented should have been excluded from this volume.

A general characteristic of most papers in this symposium is insufficient breadth for the general reader in physiology or zoology and insufficient depth for the interested comparative neurophysiologist. While I cannot recommend the book to the general reader, about two-thirds of the papers do present work of sufficient interest to merit the attention of the neurobiologist. For the neurophysiologist interested in rhythmic phenomena the book contains a sufficient number of provocative discussions supported—in part—by experimental data to merit inclusion in his or her personal library.

CHARLES H. PAGE
Department of Zoology, Ohio University, Athens

Instruments and Their Use

The Encyclopedia of Microscopy and Microtechnique. PETER GRAY, Ed. Van Nostrand, Reinhold, New York, 1973. xii, 638 pp., illus. $32.50.

Microscopy is covered by five pages of contributors from Acanthocephala to zoom microscopes, in alphabetical order, and an index facilitates access to the material. The statement that this is not a second edition of Clark's *Encyclopedia of Microscopy* (1961) precludes comparison with that work. Gray has included useful information on stains and preparation methods from his earlier out-of-print books. This book is new and different.

Many of the biological entries give preparation technics and information useful to microscopists. Most entries have up-to-date reference lists. Some (automatic histology, fluorescence, Quantimet, reconstruction, stereo, zoom, and others) fail to indicate that more is known than is given in the entry itself. The illustrations vary from excellent to poor. Most of the entries should be usable for high school seniors and college freshmen; a few (holography, resolution) use simple mathematics.

Industrial microscopy is included: atmospheric, bakery products, clay, metals, sand, and so on. Microscopes receive less full treatment than preparation methods. For example, the account of polarized light microscopy is limited to crystallography and fails to indicate its usefulness in particle identification or biological applications. Resolution is discussed in several entries and one ten-page entry that fails to mention modern work of Charman, Osterberg, van Duijn, and others. It does compare optical and poor electron microscope pictures of diatom shells. Diatoms are not listed. Only the entry on photomicrography mentions accommodation of the eye with reference to depth of field and focus.

Of recent active methods, stereology and, in a limited way, microspectrophotometric methods are recognized. I am amazed that interference microscopy (except for a listing under another topic) and the considerable developments and trends toward automated microscopy are not included. The item on blood fails to mention instruments developed for automatic blood counts, nor does the item on chromosomes mention computer methods for typing and analysis. The only entry along these lines is Quantimet, which lacks refer-

ences. The entry "automated histology equipment and techniques" describes only one commercial product, yet others exist, including automatic specimen preparation and microscopy developed in England. The use of cryostats would seem to be worth more than the mere mention it gets in this entry.

The following subjects are not in the index: cinemicroscopy, deep field microscope, EOLM, integrating microscope, leptoscope, light section microscope, phosphorescence microscope, optical staining, Schlieren, television, TICAS, time-lapse, and ultrasonic microscopes, or stroboscopic analysis. Students have asked recently about these and other such subjects.

Gray's book will be of most use to college biologists and biomedical technicians for the material on specimen preparation methods and technics. Entries with reference lists are useful guides to more detailed information. The book is an encyclopedia on a small scale: Selected Topics might be a more descriptive title, because much microscopy and not a few microscopes are omitted. Within its limitations it is a useful work that does fill a need among the many recent specialized books on microscopy.

OSCAR W. RICHARDS
Pacific University,
Forest Grove, Oregon

Biochemical Tools

Immobilized Enzymes. OSKAR ZABORSKY. CRC Press (Chemical Rubber Co.), Cleveland, Ohio, 1973. xiv, 176 pp., illus. $26.50.

Immobilized enzymes are a subject of extraordinary activity in both academic and industrial circles. This book is primarily an exhaustive (through 1971) review of the literature of this rapidly growing field. It is not, however, simply a compilation of facts and reports. An attempt has been made to introduce some order and to systematize the divergent aspects of the field by definition of terms and categorization of the various topics. Thus the book should be very helpful to established workers in the field as well as to newcomers and the simply curious.

There have been numerous recent reviews on this topic, but few if any are as comprehensive as this and probably none emphasizes methodology more strongly. Partly because of a concern for leaving no major stones unturned, most aspects of the subject are not presented in great detail. This book rather summarizes, quite lucidly, the state of the art. The reader is referred to the original literature for details.

The book presents rather complete tables listing the enzymes that have been immobilized, and these are organized according to code numbers established by the International Union of Biochemistry Commission on Enzyme Nomenclature. A chapter summarizing the various chemical methodologies available for the covalent immobilization of enzymes to various supports is particularly useful. The use of multifunctional (bifunctional) reagents for the intermolecular cross-linking of enzymes, adsorptive methods of enzyme immobilization with reference to the examination of continuous catalytic processes, entrapment of enzymes within the interstitial spaces of cross-linked polymers, and immobilization of enzymes within microcapsules or semipermeable membranes are discussed separately in a systematic and succinct manner. The principal emphasis is on the general principles involved.

Immobilized enzymes are of importance in research on fundamental problems in biochemistry, and the potential value of these materials to the chemical, pharmaceutical, and medical industries is just now beginning to be realized. Enzyme reactors and a variety of immobilized enzymes can, for example, be used for the large-scale chemical processing or synthesis of substrates and foodstuffs (for example, sugars), for analytical purposes, in the therapy of metabolic disorders (for example, through enzyme replacement and removal of poisons), as continuous sources of fuel, and in selective separation procedures. Some of these are discussed by Zaborsky briefly and clearly, and the exciting future which these uses promise comes through well. A subject which is closely related to immobilized enzymes (or enzyme engineering), affinity chromatography (or separations based on biospecific adsorption), is barely mentioned, for the author has tried to limit the subject matter quite strictly to *enzyme* immobilization, especially as it relates to the continuous catalytic process.

Considerable progress must yet occur in the understanding and technology of enzyme immobilization and polymers with biological specificity before the potential theoretical and practical value of these special tools can be realized. The treatise by Zaborsky should help to focus attention, delineate problems, suggest new directions, and summarize the foundations upon which new advances will have to build.

PEDRO CUATRECASAS
Department of Pharmacology and Experimental Therapeutics and
Department of Medicine,
Johns Hopkins University School of Medicine, Baltimore, Maryland

Metabolic Diseases

Lysosomes and Storage Diseases. H. G. HERS and F. VAN HOOF, Eds. Academic Press, New York, 1973. xxii, 666 pp., illus. $45.

According to accepted dogmas, lysosomal storage disorders are defined by the presence of abnormal deposits within a membrane-bound vacuole and severe deficiency of a specific lysosomal enzyme which is involved in the cleavage of a specific chemical bond in the stored material. This publication attempts to summarize current knowledge of these diseases and their relationship to lysosomes.

Much of the material on the individual diseases has been covered in various books and review articles by these authors or by others. In general, each chapter of the present book includes the clinical description of a disease, its characteristic pathology, the nature of the specific biochemical abnormality, and finally the genetics of and attempts at therapy for the disorder or both.

Four general groups of diseases are covered: (i) The sphingolipidoses, including G_{M1} and G_{M2} gangliosidoses, Fabry's disease, Gaucher's disease, Krabbe's disease, metachromatic leukodystrophy, and Niemann-Picks disease. A lipidosis, Wolman's disease, that is not a sphingolipidosis is also included. (ii) Polysaccharide disorders, namely, the glycogen storage diseases, the mucopolysaccharidoses, and the mucolipidoses. (iii) Mannosidosis, which does not conveniently fall into either of these classes and has been used as an example of a glycoprotein storage disease. Fucosidosis, also covered, at this time must remain unclassified since both glycopeptides and glycolipids containing fucose are present in excessive quantities in the tissues of these patients. (iv) A final category of pathological conditions