of coverage is uneven. However, this is probably due more to the imbalance in available material than superficiality on the part of the author.

The principal conclusions that emerge from this book are: (i) All organs are capable of repair. Repair is achieved through cell proliferation, enlargement, differentiation, movement, recognition, and death, as well as through the synthesis of intercellular materials. The extent to which each of these tools is used, if at all, is determined largely by the organ in question. Since these tools are also the ones used in development, the study of tissue repair may shed light on the mechanisms bringing about embryogenesis. (ii) Except for a few organs such as the skin, we have a very poor description of tissue repair. (iii) Modern molecular biology has still to make its impact on the problems of damage-induced growth. It is time for such investigation to begin.

This book also allows us to evaluate the impact of two other experimental approaches to the problem of tissue repair which have been used to a considerable extent. The first is histochemistry and the second electron microscopy. In the reviewer's opinion it is clear that histochemistry has contributed very little of fundamental importance to our understanding of damage-induced growth. Electron microscopy has been valuable in filling in important details, for example, in cell identification.

The author presents ideas and interpretations that I disagree with, and I suspect that other readers may find themselves disagreeing with him on specific points, or points of view. I would have preferred a more balanced discussion of the role of stimulators and inhibitors in the control of damage-induced growth. I think there should have been a summary at the end of the book attempting a synthesis of the problem of tissue repair in the various organs studied and its relationship to the problem of growth control. But no matter what one finds to disagree with, it will be secondary to the overall feeling of gratefulness to the author for bringing together and organizing such a vast array of facts.

This book is not only useful for the developmental and cell biologist, surgeon, or pathologist, but it is of value for anyone who wishes to get a good overall understanding of the current status of the biological bases of tissue repair.

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Cybernetic Biology

Neurological Control Systems. Studies in Bioengineering. LAWRENCE STARK. Plenum, New York, 1968. xx + 428 pp., illus. $17.50.

Stark has thought considerably and deeply about the topics of his book, yet I find it less stimulating than I expected. Part of the problem undoubtedly arises because the book is fundamentally a collection of edited reprints, arranged in a sort of phylogenetic order of subject. This leads to redundancy and some obscurity in the text, where much is taken for granted. There are few biologists who can read about "Wiener kernels" with any insight, and the others would find Stark's explanation of the relevant techniques for signal analysis inadequate. To an engineer, perhaps, the profusion of Bode plots means more and is even possibly exciting.

I find it hard to understand the exact rationale for some of the experiments described, although I am sympathetic to the applications of systems theory to problems of biological organization. For example, in the first section of the book the light responses of photoreceptor neurons in the crayfish are described in some detail. In particular the impulse patterns from the two photoreceptors in the sixth abdominal segment were recorded and compared under conditions of *constant illumination*. No, or in some cases small, correlations were found between the two pulse trains. I cannot understand, however, why correlation should be expected except under conditions of changing illumination—which, indeed, are the conditions that evoke a behavioral response from the animal. The data are then used to restrict the description of the neural code used by the crayfish—an extrapolation which must be invalid.

Autobiography has a new vogue in scientific literature. Stark's book is often autobiographical and therefore idiosyncratic, so that it unfortunately invites comparison with others of the genre, for example, K. S. Cole's brilliant and exciting *Membranes, Ions and Impulses.* The strongly autobiographical approach is probably successful only when the author can look back at continuous work in a field that has already shown enduring achievements, such as the description of the action potential by the Hodgkin-Huxley equations. I do not think that that stage has been reached by work on the human operator, to whom most of the book is devoted; he has been described, inevitably in limited, essentially linear regions. So although there is much that is interesting and useful to be found in the details of the human operator that Stark presents, there is nothing that is new in the book and little that is novel in the synthesis.

The book is full of data which are undoubtedly needed by theorists of muscular control systems but which by themselves are unsatisfactory for less committed students. The conclusions drawn and the discursive sections themselves are often redundant although individually interesting. This is not so much a book as a compendium, not a closed account but a progress report. In other words, all the details, but not the essence, are readily available. This is not to decry the worth of the book: the details and not the essence are often overwhelmingly important. Interpretations of news are better avoided; the living is more interesting, though less explicable, than the dead.

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Enzymology

Flavins and Flavoproteins. Proceedings of the second conference, Nagoya, Japan, 1967. KUNIO YAGI, Ed. University of Tokyo Press, Tokyo; University Park Press, Baltimore, 1969. xii + 286 pp., illus. $17.50.

Immediately preceding the 1967 International Congress of Biochemistry in Tokyo, a group of experts working with flavin nucleotides and flavoproteins assembled in Nagoya to assess the current status of their field. Their experimental findings (up to date as of that moment), their conclusions and speculations, and even their disagreements are all faithfully recorded in this volume, which will serve as a standard work on this specialized subject.

Although such books as this one reach limited audiences, their importance as part of the foundation for a larger discipline (enzymology, in this case) cannot be overemphasized. The continuity of the symposia upon which these reference works are based is now in jeopardy owing to the travel restrictions being imposed by granting agencies, and this should be a matter of concern for all scientists.

The formal papers (23 in number) in this symposium fall into three groups, and, indeed, it might have been preferable if they had been published in this

manner. The first group covers certain chemical aspects of flavin nucleotides: semiquinone formation by irradiation of flavoproteins, photochemical reduction of free and enzyme-bound flavins, and products obtained by anaerobic photolysis of riboflavin. One could also include in this group the stimulating contribution by Kosower on pyridinyl radicals.

Mitochondrial enzymes traditionally have been the subject of much argument. It is not surprising, therefore, to find a certain amount of controversy surrounding the papers in the second group, covering mitochondrial flavoproteins and related topics. Previous debates over whose mitochondrial DPNH dehydrogenase was the most "physiological" have now largely been placed by such questions as: At what point in the respiratory chain does rotenone exert its inhibitory effect? What is the nature of the "occult" thiol group in the reduced diphosphopyridine nucleotide (DPNH) dehydrogenase chain? Does the DPNH chain contain more than one flavoprotein? What are the structural differences between the various nonheme iron entities in the mitochondrial electron-transport chain?

The wealth of information available about the chemistry of flavin nucleotides, and the fact that many flavoproteins have been isolated in essentially homogeneous form, might suggest that very little remains unknown about the mechanism of these enzymes. Such is not the case, however, as is evidenced by papers in the final group. Although it is clear that a "minimal" flavoprotein should operate by a two-step mechanism in which reducing power is transferred from substrate to flavin to acceptor, the actual situation encountered in the various flavoproteins is far more complex. Thus, interaction of a substrate with the enzyme-bound flavin can result in formation of the flavin semiquinone, the fully reduced flavin, a charge-transfer complex between the substrate and the flavin, or a group-transfer complex in which the substrate is bonded covalently to the flavin. Similar possibilities exist during interaction of the flavin with the electron acceptor (which, for expediency, is often a nonphysiological oxidant). Further complications arise when the enzyme contains more than one flavin nucleotide or other oxido-reduction groups (such as metals, thiol groups, hemes). It is hardly surprising to note, for example, that both red and blue radicals can be generated from the same enzyme (see discussion, pp. 250–51).

In addition to providing specific information about the mechanism of various flavoproteins, this book is of value in illustrating how the techniques of absorption spectrophotometry (especially when used over short time intervals), electron paramagnetic resonance, and optical rotatory dispersion can be utilized to study complex mechanisms. It is a definitive work both for specialists in this field and for biochemists and chemists in general who may wish to obtain some insight into one of the more rapidly developing areas in the study of enzyme reaction mechanisms.

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A Species in Trouble

Ecology and Behaviour of the Black Rhinoceros (Diceros bicornis L.). A Field Study. RUDOLF SCHENKEL and LOTTE SCHENKEL-HULLIGER. Parey, Hamburg, 1969. 104 pp., illus. Paper, DM 28. Mammalia Depicta.

The authors have conducted a thorough investigation of the black rhinoceros in several East African national parks over a period of almost three years. The reasons for these studies were the apparent ecological changes taking place in the rhino's habitat, an increasing elephant population being one of the major problems. Rhinos and elephants normally coexist; however, serious competition for food and water often occurs. Relationships with other ungulates, as well as predators, showed no special problems.

Black rhinos were found to lead a nomadic life, and did not have individual territories. The same mud wallows, watering and sleeping places, and other areas were used by many different rhinos. Population counts of adults and young were made by both ground and aerial studies. Observations of single animals showed how far they would stray from water, and also how long they could do without it. Feeding habits were watched by following individual rhinos along their daily routes. Specimens of food plants were collected for identification, the result being a large list of bushes and shrubs. Several sick or dying rhinos were shot and examined for possible identification of diseases and parasites and in order to note the general condition of the animals.

Social reaction and mating behavior are well covered. The information obtained is very important, for the breeding of the rhinoceros in zoos is a must. Premating fights, which so often occur in closely confined captive rhinos, were found to be minor or to consist of nothing more than threatening gestures. The authors also found little or no horn rubbing in wild rhinos. Zoo specimens rub their horns to blunt stumps, as compared to the wild rhino's long sharp ones. This could be the result of boredom in the captive rhino.

This work clearly shows that the black rhinoceros is in serious trouble. It seems that even the national parks may be too small to save this beast from extinction. The principal problem is organized poaching, which must be stopped if the species is to survive. To make matters worse, the bush country, which is the rhino's home, is fast becoming dry grassland as a result of drought, brush fires, and the destruction of trees and shrubs, which are the rhino's food, by elephants. To conserve the species in its few remaining strongholds, the authors suggest ecological investigations of these regions over a number of years. These would include analysis of the rhino and elephant populations along with changes in topography and vegetation. Strict control of the elephant herds is also advocated. This could raise the question of which is to survive, the elephant or the black rhino.

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Microscopic Anatomy

Comparative Vertebrate Histology. DONALD I. PATT and GAIL R. PATT. Harper and Row, New York, 1969. x + 438 pp., illus. $14.95.

Two major problems must be solved in the production of a book such as this one. First, because the illustrations are crucial to the exposition, some way must be found to include a large number while keeping the price within textbook limits. Second, a mass of scattered and often contradictory observations must be pruned into a logical and useful exposition. In this volume these problems have been dealt with in an ade-