

useful background to the many reactions involved and reviews much of the earlier literature. The sections on the sources of pulsed radiation and experimental techniques are the weakest part of the book. The basic principles behind the experimental techniques are chiefly ignored, particularly the special design of the optical systems needed in this field. This is basically a matter of using a very intense light source, getting as much as possible concentrated in the irradiation cell and then getting it down a rather lengthy light path out through a protective radiation maze and eventually through a monochromator on to a photocell. The fourth chapter describes the methods for identifying the transient products and determining the reaction rates and, because it is a series of résumés of the recent literature, lacks an overall cohesion. A very comprehensive summary of published experiments, however, is contained in two extensive tables. Table 15 lists the relative rate constants for the reactions of OH, H and the hydrated electron with more than 200 pairs of solutes, and Table 16 the absolute rate constants for the radicals with more than 500 solutes. The book provides a useful introduction to pulse radiolysis and will be a useful reference for those working in the field.

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PHYSICAL METHODS IN BIOLOGY

Magnetic Resonance in Biological Systems

Edited by A. Ehrenberg, B. G. Malmström and T. Vänngård. (Proceedings of the Second International Conference held at the Wenner-Gren Centre, Stockholm, June 1966.) (Wenner-Gren Centre International Symposium Series, Vol. 9.) Pp. viii + 431. (Oxford, London and New York: Pergamon Press, Ltd., 1967.) 140s. net.

A VALID reason for publication of the proceedings of a meeting in book form is to convey the results of ensuing discussions. Unfortunately, in this book any such discussion has been omitted.

The forty-nine original research papers presented deal with the applications of highly sophisticated techniques of magnetic resonance, namely, NMR, EPR and Mössbauer spectroscopy, to "sub-molecular" biology, as Hugo Theorell defines it in his opening address. There are also introductory papers on electron nuclear double resonance (ENDOR) and nuclear electron double resonance. The biological systems range from nucleic acids to paramagnetic metal complexes.

It is possible to highlight only a few of the topics covered. NMR is used to gain information about the structure of peptides, to measure fast reaction rates and to determine binding positions in metal complexes. EPR is used to probe the structure of heme and non-heme iron proteins, copper-containing enzymes, metal flavoproteins and single crystals of proteins. Flow techniques of EPR and their applications to the kinetics of flavin redox systems and to the conformation of labile free radicals are described.

The technique of spin-labelling in which a stable organic free radical is attached to a molecule of biological interest and used as a probe is introduced in a paper by McConnell. The technique is also applicable to NMR as shown by Sternlicht *et al.* Here use is made of the perturbation of a protein spectrum caused by the unpaired spin of the bound radical.

The group of papers dealing with Mössbauer spectroscopy is introduced by a paper briefly describing the theory and instrumentation and some applications of the method to ferredoxins. In practice the method is limited to molecules containing iron-57.

This is a specialist book containing a wealth of information, while the introductory papers are of wider interest. The book could, however, have been improved if

more papers had contained concise summaries or abstracts.

The volume is well produced and contains a good subject index, but the high price reminds one, unfortunately, of the business interest in these publications.

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BIOLOGICAL CLOCKS

The Physiological Clock

By Erwin Bünning. Revised second edition. (Heidelberg Science Library.) Pp. 167. (London: Longmans, Green and Co., Ltd.; New York: Springer-Verlag, 1967.) 24s. paperback.

WE do some things only or especially at certain times of the day or the year. At night, flowers close up, leaves droop, some animals become active, others torpid. Marine animals and plants fit their activities to the tides and to the phases of the Moon. We have known for some years that most of these rhythmical activities persist for a time when the environmental rhythms are eliminated and it is clearly advantageous to organisms to be able to predict, say, the dawn or the full Moon. Some animals navigate by means of the Sun or the stars; some plants and animals regulate their seasonal activities by detecting the length of the night. For both these purposes chronometers are needed. Professor Bünning's book deals with what we know about the nature of the clock and how organisms use it. His examples are drawn from plants, man and other animals. His method is to present the problems and then the experiments that bear on their solution, and in many ways the book is a model for what a biological monograph should be. An enormous amount of experimental data is presented within a short space, much of it in text figures, and clearly a lot of thought has gone into the arrangement of the work and the elimination of specialist jargon in order to interest all biologists. The design of experiments is stressed especially because, in this field, many false conclusions have been reached in the past because of the complexity of an organism's response to its environment.

The first edition of the book was published in German in 1958 and a first English edition, based on the second German edition and printed in Germany, appeared in 1964. The second English edition is a revised version of this. There are a few more pages, more small print and fewer diagrams. Some errors of fact have been corrected. This edition retains Professor Bünning's preference for relaxation oscillation as the mechanism of the clock as opposed to harmonic oscillation. Arguments on the other side are presented, but half-heartedly. Similarly the argument that the circadian rhythm may be a beat phenomenon is dismissed more readily than some of us would like. In a monograph by such an authority, such personal preferences are what we want, but I should like it to be more obvious that not everyone agrees.

In a book of this excellence it is a pity to have to complain about presentation, but undoubtedly the author does not do himself full justice because of this. The book is not easy to read. This is due partly to the English style in spite of, or perhaps because of, the battery of experts who have helped the author with the translation. It is also partly due to the poor printing. There are many spelling and grammatical errors carried over from the old edition and new ones have appeared, although this edition is printed in America. The archaic "afore mentioned" [*sic*] has replaced "above mentioned" and words are now often hyphenated at the wrong places.

However, all students of biology should make the effort to read the book if they have not already read an earlier edition.

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