the optimal internal filling of *p*H electrodes and with the adsorption of ions on electrode glasses. One sees on the one hand how temperature sensitivity can be minimized and on the other the origin of transient effects on electrode potential in response to changes of external solution. The importance of surface conductance, due to adsorbed ions, is stressed, and it appears that the ion selectivity of the outer layers of fixed groups may differ radically from the property of the glass as a whole. These adsorbed ions and the consequent ion selective channel give rise to the "tip potential," well known as an artifact to users of open microelectrodes. There is evidence that a trace of thorium salt in the fillant markedly lessens the source of uncertainty. Design details of electrodes for measuring intracellular *p*H and concentrations of K, Na, Cl, and Ca are to be found, together with discussion of sources of interference. Most contributions are from biologists who provide examples of the results obtained with their devices. We see that, in agreement with earlier data, the internal *p*H of nerve and muscle cells remains just over 7 when external *p*H is varied between 5 and 8; only carbon dioxide is effective in producing acidity. The activity coefficient of internal potassium is about 0.7, as predicted from solution data, but that of internal sodium is only about 0.4. A Russian group points out the similarity of this reduction to one obtained by incorporating the sodium salt with polyacrylamide. Intracellular chloride can be measured by a Ag-AgCl electrode situated internally at the base of a glass microelectrode into which cytoplasm moves by capillarity. A micro-*p*H-electrode has the *p*H-sensitive glass as a fine open capillary tube into which the sample is sucked; the outside of the capillary tube corresponds to the inside of the conventional bulb type. A microversion of an ion-exchanger fluid Ca electrode can be used to measure the concentration of the ion down to 0.1 m*M*, though care has to be taken to correct for interference from the other ions present. A microscale oxygen cathode is described. It was applied to show the depletion of oxygen at the core of a small (about 1 mm diameter) bundle of muscle fibers when they were made to contract. To minimize the depletion it is necessary to use a high oxygen tension, for example, with 98 percent O_2. A rate of 30 impulses a minute could be tolerated, but it is also important to interpose rest periods, because the oxygen at the core takes a minute or so to return to the resting level. Injection of substances into cells is discussed. Uncharged molecules can be introduced by ultrasonic vibration of a micropipette inserted in the cell; the technique has been used with fluorescent markers.

The methodology of using microelectrodes, including twin and concentric variants, is described. Particular chapters are devoted to the retina, cytoplasmic resistance, and heart muscle. The problem of extracting the membrane resistance from the input resistance when one is dealing with a syncytial structure is attacked by use of a number of alternative models of the cable analogue. Circuitry for voltage clamping and for neutralizing cross talk between channels fed from twin electrodes is useful to have for reference. A section describing the phenomenology in its own jargon of biological membranes may serve by contrast to direct attention to the use of model systems (such as Rudin and Müller's bilayers doped with ionophores). The electrodes and techniques described in this volume should help the biologist to obtain physicochemical data from his material. Where we can with models match the behavior of the living membrane, there is every hope of speedy progress in our understanding.

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Particle Theory in 1967

Fundamental Particle Physics. 1967 Tokyo Summer Lectures in Theoretical Physics. GYO TAKEDA and YASUA HARA, Eds. Syōkabō, Tokyo; Benjamin, New York, 1968. xii + 180 pp., illus. $8.50.

The Tokyo Summer Institute of Theoretical Physics has been held for about a week every summer since 1965 in Oiso, a famous beach site 40 miles west of Tokyo. The lecture notes have been edited by G. Takeda and his collaborators and published each year. The book under review is the third in the series and contains eight articles on theoretical particle physics. The topics and authors are: universality and symmetries of hadrons, P. G. O. Freund; chiral dynamics, Y. Yamaguchi; current algebras, S. M. Berman, T. D. Lee; *CPT* and weak interactions, T. D. Lee, K. Nishijima, M. Gourdin; and Regge poles, N. Nakanishi. Each of these articles is a short, comprehensive review of the author's own recent work. They are valuable for senior graduate students and research workers who intend to study the general ideas and developments in these specialized topics without engaging in the delicate technical details. Since the character of these articles is more or less the same, let me as an example review Yamaguchi's article with some detail.

One of the central activities in particle theory around 1967 was to describe the chiral invariance of hadronic interactions in terms of a phenomenological (or effective) Lagrangian from which various hadronic reaction amplitudes are calculated by a simple prescription based on the perturbation theory. One of the intentions was to obtain the results of current algebra (previous fashionable activity) with considerable economy. A simple, elegant approach due to Ohnuki and Yamaguchi is well described in this 18-page article. The article is self-contained and very comprehensive. Although many papers on this topic have been published since then, I think the basic ideas and techniques of the phenomenological Lagrangian approach are all here. The article would be appropriate for the person who wants to learn the basics of the approach rather than its whole development. For the latter, the current literature of the time must be read.

This judgment may be applied to most of the articles in the book. The book is also valuable historically as a synopsis of the activities in particle theory around 1967.

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Books Received

Abundant Nuclear Energy. Proceedings of a symposium, Gatlinburg, Tenn., August 1968. W. W. Grigorieff, Coordinator. Division of Technical Information, U.S. Atomic Energy Commission, Oak Ridge, Tenn., 1969 (available as CONF-680810 from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va.). vi + 354 pp., illus. Paper, $3. AEC Symposium Series, vol. 14.

Advances in Geophysics. Vol. 13. H. E. Landsberg and J. Van Mieghem, Eds. Academic Press, New York, 1969. x + 270 pp., illus. $14.50.

Advances in Physical Organic Chemistry. Vol. 7. V. Gold, Ed. Academic Press, New York, 1969. x + 354 pp., illus. $13.50.

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