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Book review

Bioelectrochemistry
G.S. Wilson (editor), Volume 9 of *Encyclopedia of Electrochemistry*, A. Bard, M. Stratmann (editors), Wiley-VCH, Weinheim, 2002, ISBN 3-527-30401-0, X + 662 pages, € 352.90

In life sciences the importance of bioelectrochemistry for solving problems in living beings connected with charges, electron transfer, fields, and theoretical explanations increases. Apart from historical developments (see the overview by P. Bianco, but he forgot to mention the basic textbooks by Heyrovsky-Kuta, Zuman, Brezina-Zuman, and Krjukova et al.) the term bioelectrochemistry became popular by the Journal *Bioelectrochemistry and Bioenergetics* founded by G. Milazzo in 1972.

The 17 chapters cover modern methods, analytical or organic electrochemistry and bioelectrochemistry per se, in particular Chapters 2, 3, 4, 8, 12/9, 14, and 16. Of highest interest are the real-time determinations of single cell electrochemical properties (Chapter 2) by miniaturization of sensors, which makes it possible to measure even single-molecule properties in volumes as small as 20 fl. Only the rotation technique of single cells worked out by Fuhr and Giemsa is missing. A novel branch of bioelectrochemistry is bioelectronics (Chapter 3) starting with signal transduction in neural systems. As a first step it was for instance possible to determine strychnine concentrations in cultures of embryonic mice spinal cord by means of a neural network biosensor designed for measurement of smell ("electronic nose"). The oxidation of NAD(P)H in many different systems is described in detail (rate constants, sensitivity, etc.) as well as the mediated catalysis of NAD(P) + reduction from a thermodynamic point of view (Chapter 4). Of particular interest is the role of NO (Chapter 7) in several diseases, such as hypertension, hyperglycemia, arteriosclerosis, Parkinson's and Alzheimer's disease. Hence the concentration of NO in single cells and its release will be measured by a porphyrin-sensor on carbon fibers. Moreover, a challenging task is the in vivo determination in the beating heart simultaneously with the ECG-signal, and also in the functioning brain in competition with radicals during necrosis. Scanning electrochemical microscopy (SECM, Chapter 8) for applications in biological systems (enzymes, antigen-antibodies, cells and tissues) requires measurements of picoamp currents, which may be amplified by means of ELISA techniques. Electron transfer occurring in a small space is analyzed even for single-molecule reactions. Another application of SECM is the monitoring of ion transport processes through voltage gated channels in membranes.

Besides the complicated electrochemical electrode reactions of nucleic acids and their components many of their interactions with small molecules have been detected (Chapter 12/7) and applications for various phenomena such as hybridization, covalently bound indicators, point mutations, strand breaks, damage and cleavage have been studied (Chapter 12/9), especially in the polarographic laboratory of E. Palecek. In spite of the extraordinary amount of references several structural changes of DNA upon adsorption at the surface of the dropping mercury electrode (DME) and the mechanism of electron exchange are not yet fully understood, e.g., fast unwinding of the double helix or loosening only—that is still the question! On the other hand, the helix-coil relaxation after a temperature jump to 90 °C was recorded for the first time by an increase of an a.c. polarographic peak at the DME [J. Chim. Phys. 65 (1968) 54]. The photodynamic cancer therapy is an effective adjuvant method and the degradation of DNA, e.g. by guanine oxidation, was determined polarographically [Stud. Biophys. (Berlin) 3 (1967) 133]. However, the quantitative determination of the cooperative anthracycline-DNA binding, which was already presented in "Anthracycline and Anthracendione-Based Anticancer Agents" (Ed. Lown, Elsevier 1988, p. 245), is missing in the description of DNA interactions (Chapter 12/7.1.3). Anyway, nucleic acids are still fascinating molecules in biology as well as in electrochemistry.

Based on the pioneering work of R. Adams on the neurochemical activity and release of dopamine in the brain (Chapter 14), carbon-fiber electrodes were developed which allow a high spatial resolution when implanted near viable axonal terminals. Last not least the electrochemical characterization of cell membranes (Chapter 16) including potentiometry, patch-clamp techniques, impedance spectroscopy, charge transfer processes by incorporated molecules such as valinomycin, and even photoelectric effects (e.g. photosynthesis) belongs indispensably to the field of bioelectrochemistry. Whereas some of the contributions not mentioned here would be more appropriate for Volume 8 or 10 of the Encyclopedia, I am missing at least an introduction to two modern fields of bioelectrochemistry, namely, electroporation of membranes used, e.g., in genetics (the word electroporation is just mentioned on page 553) and the influence of ELF alternating fields on proliferation, apoptosis induction, and metabolism, a field with increasing importance for

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future life sciences. Nevertheless, this volume presents many examples of connections between electrochemistry and biology suitable for elucidating processes and mechanisms in life sciences.

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