

Microelectrode Techniques

The Plymouth Workshop Handbook

Edited by

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Preface

First edition

The use of microelectrodes as a means of probing the physiological properties of cells has grown enormously since the pioneering work of Ling & Gerard and Hodgkin & Nastuk. Microelectrodes are now used in many areas of biological sciences, to determine not only the membrane properties of cells with voltage clamp techniques, but also to measure the intracellular free ion concentrations of important inorganic ions, to study the overall architecture of cells by injection of markers, to determine the direct connections between cells and, with the advent of the patch clamp approach, to examine membrane properties at the level of single ion channels.

In 1983 a number of us working in the biological sciences became aware of an acute shortage of young research workers with adequate training in such modern electrophysiological techniques. This shortfall was apparent across a wide range of biological sciences as techniques that were originally the province of membrane physiologists interested in excitable cells spread into such diverse areas as developmental biology and plant sciences. Despite such widespread application, opportunities for training were few and diminishing as reduced financial resources bit into University and Research Council funding. Our concern led us to launch a postgraduate Workshop, designed to provide intensive practical and theoretical training in Microelectrode Techniques for Cell Physiology.

It was decided to hold the Workshop at the Laboratory of the Marine Biological Association, Plymouth. The Laboratory has a distinguished record in providing facilities for membrane physiologists to carry out their research and our suggestion was received with enthusiasm by the Director of the Laboratory, Professor Sir Eric Denton FRS, and the Council of the Marine Biological Association. The Natural Environment Research Council, which provides a Grant in Aid to the Laboratory, gave full support to the Director. Generous financial assistance was offered by The Physiological Society, The Nuffield Foundation and the Company of Biologists. The Science and Engineering Research Council, the Medical Research Council and NERC all agreed to support a number of their research students and the Physiological Society, through its Dale Fund, was prepared to give grants to assist those offered places.

The first Workshop took place in April 1984; the demand was very high – 85 applications for 14 places – fully justifying our concerns about the lack of suitable training. Two further Workshops have followed, each drawing more than 50

applicants from all over the United Kingdom, Europe and the rest of the World, including the United States. We hope that it will become as established and prestigious as those at Woods Hole and Cold Spring Harbor. The Research Councils have continued to support their students and the Physiological Society has continued to give grants to assist those offered places through its Dale and Rushton Funds. The Laboratory of the Marine Biological Association at Plymouth has been a generous and supportive host, providing a wealth of marine preparations for our experiments. The Staff of the Laboratory have received our annual invasion with good humour and much practical support. We are especially grateful to the late Dr J. P. Gilpin-Brown, the Bursar of the Laboratory, who has looked after our accounts.

Each Workshop has held firm to the principle of intensive experimental work, together with theoretical sessions, provided by the resident staff and a number of visitors. Each of them is distinguished in their own field and has heavy teaching responsibilities in their own University. The success of the Workshop is a direct consequence of their enthusiasm, dedication and willingness to give up precious research time in order to train others. Each year valuable technical help has been provided by research students or assistants from the laboratories of some of the staff. Our original sponsors have been joined by Smith, Kline & French, Linton Instrumentation and the Sandoz Institute for Medical Research. We have also been fortunate in the number of companies who have generously loaned equipment for use during the Workshop.

This book is the Workshop Handbook. Like the Workshop itself, it is a cooperative venture. All the authors have taught on the Workshop and it has benefitted from the criticisms of the 1986 participants. Three of our number, Peter Gray, Nick Standen and Michael Whitaker have acted as editors of the various contributions and Judy Lewis and Carole Wright, secretaries at the University of Leicester, took our ill-prepared manuscripts and turned them into documents fit for the Press. Our publishers are the Company of Biologists. They, together with the Physiological Society, the Nuffield Foundation and the Research Councils, deserve much credit for making it possible for our tentative plans to materialize into the fully-fledged Workshop. We hope that other groups of scientists will be encouraged by our success and that the Microelectrode Techniques Workshop will prove to be the fore-runner of many other similar ventures.

Anne Warner
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Second edition

This second edition of 'Microelectrode Techniques' has arisen from the need to extend the set of lecture notes, which is essentially the purpose of this Handbook, to cover techniques that are currently taught on the Workshop but were not in the first edition. In particular, optical techniques – quantitative fluorescence microscopy for ion concentration measurements and flash photolysis – which are often used in conjunction with microelectrode and patch clamp methods nowadays are given a practical treatment in the style of the first edition. The electrophysiological techniques are extended to include channel reconstitution and recording in lipid bilayers and patch clamp recording from cells in tissue slices. The techniques described in the first edition have been updated, notably the chapter on computer analysis, and expanded or rewritten to take account of feedback from the workshop itself and from readers. The aim is to provide an introduction to each technique and its instrumentation, and to extend that to cover the ideas and techniques of analysis and particular aspects of current practice.

The Handbook originates with the Plymouth Workshop and the authors of the second edition are current or past teachers. An updated list of teachers, who keep the Workshops running, is given below.

The Workshop enjoys the continued support and hospitality of the Marine Biological Association of the UK at their laboratories on Citadel Hill, Plymouth. Direct financial support is received from the Medical Research Council, the Science and Engineering Research Council (or its successor), the Company of Biologists and the Physiological Society. There are several Companies listed below who generously loan equipment each year.

David Ogden
National Institute for Medical Research, London.

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