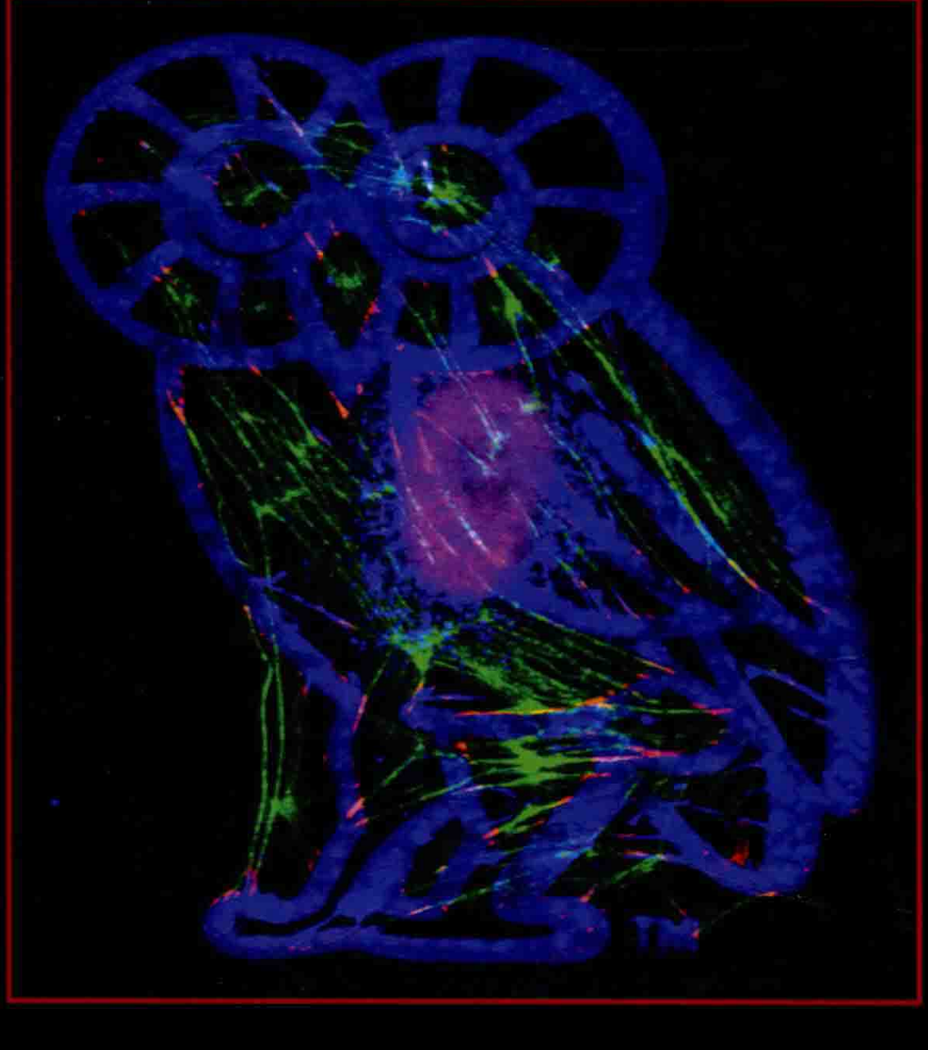
Methods in Cell Biology • Volume 119

Micropatterning in Cell Biology

Part A



Edited by

Matthieu Piel and Manuel Théry

Methods in Cell Biology

Micropatterning in Cell Biology Part A

Volume 119

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Methods in Cell Biology

Micropatterning in Cell Biology
Part A

Volume 119

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Preface

Micropatterning refers generally to techniques which provide an experimental control over the chemical, physical, or geometrical properties of materials at the micron or submicron scale, and are thus used to produce spatial patterns of these properties. These techniques, which were often originally designed for application in microelectronics, have spread over most areas of science, including biology. They have proved particularly useful for cell biology, bridging the gap between the Petri-dish and complex 3D assays and tissues. At the level of single cells, many environmental parameters are entangled and assessing their individual contribution to cell physiology and behavior is often difficult. Micropatterned cell-culture substrates allow to specifically design tools to quantitatively control the cell microenvironment *in vitro* and to assess the effect of individual parameters, with devices which are almost as easy to handle as a regular Petri dish. Historically, printing of cell adhesion molecules, such as collagen or fibronectin, have allowed producing cell culture substrates on which cells have a well-defined shape and adhesion geometry. Such substrates have been crucial to demonstrate the role of cell shape, cell spreading area and of geometrical parameters of cell adhesion on cell survival, proliferation, differentiation, and polarity. The fabrication of micropatterned substrates initially required special expertise in surface chemistry and sophisticated devices, but their success lead to the development of much simpler methods accessible to almost any regular biology lab (see Chapters 1–6 for printing of proteins on various types of substrates, including printing of multiple proteins and of gradients). Efforts have also been made to make the process cheaper and more versatile (see maskless techniques in Chapters 7–11). Micropatterning now covers a large number of cell biology applications, from stem cell culture and differentiation (see e.g., Chapters 2 and 13) to printing of purified proteins or other biomolecules for *in vitro* assays (see Chapters 15 and 1–4 of vol. 120). Moreover, the size of the features which can be printed is now down to tens of nanometers (see Chapters 12–14). Current micropatterning techniques have developed further to implement the quantitative control of other aspects of the cell microenvironment such as 3D geometry (see Chapters 7–15 of vol. 121) and mechanical properties (see Chapters 16 of vol. 120, 3 and 6 of vol. 121). Importantly, some of these tools do not only allow building microcontrolled environments for cultured cells, but are also measurement tools, giving access to crucial parameters such as forces (see Chapters 13 of vol. 120 and 1, 2, 4 of vol. 121). Although the technical basis for most micropatterning methods is very generic, clever variations and adaptation are enough to produce tools for very specific applications, such as the study of collective cell behavior (see Chapter 15 of vol. 120), imaging of yeast cells from the tip (Chapter 14 of vol. 120), or local application of forces on individual cells (Chapter 12 of vol. 120). The latest evolutions of micropatterning are meant to implement temporal control of the micropatterned features (see Chapters 5–11 of vol. 120), to reach full spatio-temporal control of the cell microenvironment.

Matthieu Piel and Manuel Théry

Biography

A Tribute to Co-Editor Paul Matsudaira

After more than 20 years a co-Editor of Methods in Cell Biology, Paul Matsudaira is stepping down. Paul joined the series in 1991 and has been highly instrumental in the continuation and, importantly, the successful expansion of the Methods series between then and now. In the earliest days of Methods in Cell Biology, which began in 1964, founding editor David Prescott (University of Colorado, Boulder), oversaw publication of the first 20 volumes. Those were also the formative years of modern cell biology and initially David published only one volume every two years, then one volume a year, and eventually 2-3 volumes during the last few years that he was editor. The structure of the series and the breadth of cell biology then was quite different than now, in that David not only was the editor of the series, but because cell biology was still a small discipline, he could organize each volume by himself. David stepped down as series editor in 1978 and oversight of the series was assumed by the American Society for Cell Biology through an Advisory Board, chaired by Keith R. Porter. The ASCB Advisory Board Committee guided publication of 6 volumes through Volume 26 with each volume organized by a different editor; a new model for the series. Still the series output remained relatively low at $\sim$ 2 volumes per year. I was appointed editor by the ASCB Advisory Committee in 1986, and continued as the sole editor until 1991. At that time it became clear that the field of cell biology and the methodology for studying cells and their functions were expanding at a galloping pace, so Paul Matsudaira joined me as a co-editor in 1991 to foster development and expansion of the series so as to keep pace with the expansion of cell biology. The expansion of Methods in Cell Biology and our efforts to keep ahead of new developments in cell biology were extremely successful, thanks in large part to Paul's insights, interest in and knowledge of cutting end methods and emerging disciplines within cell biology. Close to 120 volumes have been published in the Methods in Cell Biology series with the rate of publication now at 6 volumes per year, the recent addition of another co-editor, Phong Tran, and a rich pipeline of future volumes. Early on Paul and I implemented a unique program of theme-focused methods that has proven highly valuable to the cell biology research community, which has included groups of volumes such as volum groups focusing on model organisms in cell biology and on all aspects of microscopy. The theme volumes approach is unique to Methods in Cell Biology and is a mainstay of the series. It helps the series stand out as the place where students and researchers can go to learn, for example, what is the best organism to use to study a specific question, or what is the best kind of microscopy to use for a particular question and how to do it. Specifically with Paul's input, Methods in Cell Biology has expanded greatly keeping pace with developments in cell biology, with modern methods focusing on the more biophysical and quantitative aspects of cell biology, including, just to mention a few, volumes on atomic force microscopy, cell mechanics, laser tweezers, and computational methods.

Throughout his career, Paul has been and continues to be a highly innovative experimentalist and teacher. Paul started his research career in cell biology while an undergraduate student working for cell biologist and pioneering electron microscopist Thomas Schroeder at the University of Washington Friday Harbor Laboratrories, which is where I first met him. He obtained his PhD degree at Dartmouth College with cell biologist David Burgess. in 1981 he became a postdoctoral fellow with Klaus Weber at the Max Planck Institute for Biophysical Chemistry in Goettingen, Germany, and subsequently took on a second postdoc with Alan Weeds at the MRC Laboratory of Molecular Biology in the UK, before joining the faculty of MIT. He was Professor of Biology and Biological Engineering at the Whitehead Institute at MIT until 1999 and during his tenure at the Whitehead and MIT he initiated and directed a number of innovative teaching and research programs. In 1999, he joined the National University of Singapore (NUS) as Professor of Biological Sciences and Head of the Department of Biological Sciences and launched the Centre for Bio-Imaging Sciences. Paul has had a long-standing interest in advancing cell biology through development of novel methods. For example, he published the book "A Practical Guide to Protein and Peptide Purification for Micro Sequencing (Academic Press/Elsevier) in 1993 when the methodology for micro sequencing of proteins was in its infancy. It is entirely appropriate for me to say that Paul has always been ahead of the curve in pioneering the newest methods for advancing research and knowledge in cell biology. Paul is also well known as an accomplished teacher. Paul is not leaving science but rather is continuing to expand his leadership role in cell biology and biophysics at NUS. I have greatly enjoyed working together with Paul on the Methods in Cell Biology Series during these many years, and consider him a close friend. I wish him well in his future endeavors and can say easily that I will miss working with him on the Methods series, but that I still look forward to many fine dinners with excellent food, wine and of course, our families.

Leslie Wilson
Santa Barbara, CA

I was asked by Les Wilson to assist him as Co-Editor of Methods in Cell Biology, effectively stepping into the shoes of Paul Matsudaira, who had held this position for more than twenty years.

At a dinner at the ASCB 2012 meeting, I met with both Paul and Les, and Elsevier publishers Zoe Kruze and Lisa Tickner, to discuss future directions for MCB. I learned a lot from these seasoned individuals, and in particular from Paul concerning the anticipation of important methodologies.

I look forward to working with the MCB team. Indeed, Paul has left quite large shoes to fill. I wish Paul well in his future endeavors.

Phong Tran
Paris

It has been my pleasure to co-edit Methods in Cell Biology and with Les Wilson for the past twenty-three years. The editorship began in 1991 with volume 34, Vectorial Transport of Proteins into and across Membranes, edited by Alan Tartakoff. Since then we have nurtured and developed within MCB several subseries of volumes on microscopy, biophysical methods, model cells/organelles/tissues/organisms, and model processes. Many volumes are classics not only in cell biology but also in developmental biology and biophysics. We thought that the molecular biology and biochemical problems studied in the 80's would become cell biological problems in the 90's and in the following decades, that biophysical tools would be needed to study cells and tissues. Looking back at the past eighty-five volumes, I have a deep sense of satisfaction that MCB volumes have arrived at the right place, at the right time.

Les and I have been a team since 1975 when I was a technician for Tom Schroeder (volume 27, Echinoderm Gametes and Embryos, 1986) at the University of Washington Friday Harbor Labs. Les would spend the summer at Friday Harbor along with Joe Bryan, Jim Spudich, Dave Burgess, Ellis Ridgeway, and Ray Rappaport. From them, I learned to isolate the mitotic apparatus from sea urchin eggs (pre-recombinant DNA), film cell dynamics (pre-video) with the DIC microscope (single molecule microscopy), and investigate the ultrastructure of the dividing sea urchin egg (pre-cryoTEM). I was exposed to a variety of techniques and learned methods in cell biology from the best. But little did I know that these summers would lead to a career-long partnership and friendship with Les in bringing timely methods to a generation of cell biologists. Now, it is time for Phong Tran and the next generation to continue this tradition.

MCB has been a team effort. Phyllis Moses brought me to MCB when it was published by Academic Press and sponsored by the ASCB. Afterwards, we have worked with many editors at AP and Elsevier but we shaped the current vision of MCB with the support of Graham Lees and Jasna Markovac. We were fortunate to expand the impact of MCB through the resources of Elsevier and our current editor, Zoe Kruze, and publisher, Lisa Tickner. It's been a pleasure to have worked with all of them.

Paul Matsudaira

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