Preface

Biophysical approaches have recently been taking an increasingly prominent place in the cell biology toolbox. Historically, physics, and specifically mechanics, has been tightly intertwined with biology since the early days of cell and developmental biology. Throughout the twentieth century, embryologists have been using glass capillaries, needles, and deformable plates to probe and perturb the mechanical properties of cells. With the expansion of optical microscopy techniques in cell biology, these approaches have been complemented with optical perturbation and quantitative imaging. In this volume, we cover a variety of biophysical methods allowing for the quantification and perturbation of the organization, dynamics, and mechanics of structures at the subcellular, cellular, and tissue scales. Far from being exhaustive, the chapters presented here intend to cover various aspects of the cell biophysics toolbox and to highlight recent developments in the field. Many of the methods rely on custom-made software that is either available online or can be obtained from the authors upon request. This highlights the growing need for flexible and adaptable computer software in cell biology. Computational approaches go hand in hand with an increasing use of modeling in cell biology. While physical models are often too context-specific to lend themselves to a method chapter on modeling itself, many of the methods presented here, particularly those dealing with the measurement of cellular mechanics, rely on a model for the extraction of physical quantities from quantitative data. Such cross talk between quantitative experiments and modeling is becoming increasingly central to modern cell biology.

The first nine chapters present different aspects of how high-end **optical techniques** can be used for quantitative cell and developmental biology. These include methods for single-molecule imaging of dynamic processes in live cells (Chapters 1–3), and quantitative methods for characterizing the organization, morphology, and dynamics of intracellular structures, such as cytoskeletal or mitochondrial networks (Chapters 4–6). The following two chapters describe the application of novel superresolution imaging techniques for high-throughput screening (Chapter 7) and imaging of cellular structures in vivo, in the *Drosophila* embryo (Chapter 8). Finally, Chapter 9 presents the implementation and various applications of digital holographic microscopy for the measurement of the cellular refractive index. The following 10 chapters present methods for the **measurement of cellular mechanical properties**. Chapter 10 describes the development and implementation of FRET sensors for the measurement of tension at the molecular level. Chapters 11–13 focus on measurements of cellular physical properties using deformable plates (Chapter 11) and atomic force microscopy (Chapters 12 and 13). Chapter 14 presents a pipette-based method for probing cell–cell adhesion. Chapters 15–17 describe the implementation of different traction force microscopy methods for mapping forces exerted by cells on substrates. Chapters 18 and 19 present methods for the quantification of cellular strains and stresses from quantitative imaging of cell aggregates. Finally, Chapter 20 presents a method using oil droplets as probes to measure cell-generated stresses. Besides methods for measuring dynamics and mechanics, recent years have seen an increasing use of biophysical techniques to **perturb and manipulate cell behavior**. Chapters 21 and 22 describe techniques for controlled perturbation of plasma membrane mechanics and integrity. Chapters 23 and 24 present examples of how microfabrication can be used to study specific cell biology questions. Note that a recent Methods in Cell Biology volume extensively describes various applications of micropatterning in cell biology (Methods in Cell Biology, volumes 119, 120, and 121 edited by Matthieu Piel and Manuel Théry). Finally, Chapters 25 and 26 describe easy to implement methods for the quantification of global cell dynamics.

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