

Preface

This volume focuses on one of the most innovative and exciting topics in biomedical engineering, and in biomechanics in particular: the new research domain of cellular and biomolecular mechanics, which practically only exists as a defined sub-field of biomechanics for the last 10 years or so.

Several factors contributed to our ability as biomechanists to now look at mechanical processes at the cellular and subcellular scales. First, there are the vast advances made in the field of microscopy, including fluorescence microscopy with specific staining of cellular and subcellular structures (some of which can be stained while cells are kept alive), as well as confocal microscopy which allows looking at cells in three-dimensions (3D). Second, there has been huge progress with mechanical testing methods at the cellular and subcellular levels, which today, other than classical cytoindentation and pipette aspiration, now include atomic force microscopy as well as magnetic and optical tweezers. Third, the progress in computational modeling, supported by the ever-increasing computer power, presently allows complex simulations that consider chemo- and mechano-communication between hundreds and thousands of cells, or calculation of mechanical loads within and around individual cells, where these cannot be measured directly. The abilities to observe living cells at high spatial and temporal resolutions and in 3D, to measure their mechanical properties or even mechanical properties of their components, and to model their behavior in computer simulations altogether allowed the major breakthroughs described in this book, in regard to basic cell science as well as applications in understanding disease processes or enabling design of better tissue engineering constructs. Accordingly, chapters in the book fall under the following categories: fundamental concepts and basic research, experimental methods in cell mechanics, computational modeling methods and applications, and the mechanobiology of cancer. Cancer in particular has been chosen as a paradigm for a disease that demonstrates the kind of progress allowed by cell mechanics research in understanding pathophysiological processes that not long ago were thought to have nothing in common with mechanics, whereas now, mechanics emerges as a key factor in the cell scale processes during the cascade of the disease

The research groups who contributed to this book, from 7 different countries - mostly in the USA and Europe - are all very well known internationally for their fundamental contributions to the field of cellular mechanics, and the book as a whole therefore represents the state-of-the-art of research in cell mechanics. The book also nicely demonstrates how cell mechanics research interacts with other recent scientific breakthroughs, including nanotechnology, tissue engineering and multiscale computation. Faculty and students with interest in these fields should find this book an excellent source of information indicating where cellular and biomolecular mechanics research brought us so far, and what are some of the open questions that wait to be answered.

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