

Preface

Multiscale modeling (MSM) has been a fundamental theoretical modeling approach in several engineering disciplines including for example materials engineering and fluid mechanics for many years, but the capacities of MSM have increased tremendously over the past several years with the exponential growth in computer power. In biomechanics and biomedical engineering, a multiscale model typically represents several hierarchies in the structures of organs and tissues, possibly down to cellular or even molecular scales, and there are links for exchange of information between these different hierarchical scales. For example, in a problem involving tissue loading, e.g., in musculoskeletal biomechanics there will be different model scales to describe how loads are transferred between organs, and then at the levels of tissue structures, and eventually at the level of cellular structures such that it would be possible to connect between continuum-scale mechanical loads and loads at the scale of individual cells. Moreover, with the recent progress that was made in computational and systems biology it is now possible to, e.g., assess the effects of such potential cell-level loads on their biological function, such as viability, synthesis of biomolecules, and events in a cell's life cycle. One particularly interesting problem that is often being addressed by means of MSM is how mechanotransduction eventually shapes tissue function, since it is now possible to connect computationally between phenomena that take place at a cell-scale and those that affect whole-tissue behavior, and incorporate in the modeling not only mechanics but also transport, thermodynamics, and biochemistry.

The frontier of MSM methods and techniques in bioengineering research today is described in this volume through contributions of internationally leading groups in this field, from the UK, France, The Netherlands, Italy, Ireland, New Zealand, and the United States. Biomedical engineers, medical physicists, applied mathematicians, and computer scientists who are interested in the state-of-science and current challenges in MSM should find this book very useful. Likewise, medical researchers in fields such as orthopedics, cardiology and vascular surgery, oncology and cancer research, respiration and pulmonary medicine, infections and

wound healing, and others who wish to be updated about the technologies and latest achievements in this exciting arena of research are also potential readers. Faculty and graduate students as well as medical practitioners will be able to use this volume for learning about the latest achievements and great promises that MSM brings in to biomedical research.

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