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# SPECIAL ISSUE

# ACTIVE TISSUE MODELING: FROM SINGLE MUSCLE CELLS TO MUSCULAR CONTRACTION

***Guest Editors***

***Markus Böl & Ellen Kuhl***

## PREFACE

All living creatures share a common architectural feature: the cell. This functional unit is the fundamental building block of life. Muscle cells are classified as smooth, skeletal, and cardiac: Smooth muscles control the movements of internal organs; skeletal muscles generate the locomotion of creatures (King et al., 2012; Kober et al., 2012; Simms et al., 2012; Yucesoy and Huijing, 2012); and cardiac muscles create the pump function of the heart (Böl et al., 2012; Chapelle et al., 2012). Muscle cells undergo and control a variety of intra- and extracellular events with distinct mechanical characteristics to perform various functions. Although these events are relatively well understood on a macroscopic phenomenological scale, the understanding of their microscopic behavior remains an active area of research. To obtain a holistic understanding of active muscle force creation, current research focuses on characterizing active muscle tissue *across* the scales, i.e., on informing the larger scales with kinematic, dynamic, constitutive, and static quantities measured at the small scales.

The objective of this special issue is to bridge the gap between the subcellular, cellular, tissue, and organ-level modeling of movement of living systems with a particular focus on the modeling of active muscle contraction. Over the past decades, computational modeling has become an indispensable tool to supplement active muscle experiments to enhance our understanding of smooth, skeletal, and cardiac muscle. Computational modeling of active force generation may increase success rates of clinical interventions and therapeutic effectiveness, which is of great socioeconomical interest.

The modeling of active biological tissues is conceptually challenging because they typically undergo large deformations and may display incompressibility, heterogeneity, anisotropy, viscosity, damage, plasticity, and growth, paired with the fascinating ability to create active force. Yet, many of these aspects are neglected in today's muscle models. To advance our understanding of active contraction across the scales, this special issue brings together expertise in life science, engineering, and medicine, theoretically (Chapelle et al., 2012; Simms et al., 2012), computationally [BLANK] (Kober et al., 2012; Yucesoy and Huijing, 2012), and experimentally (Böl et al., 2012; King et al., 2012). We hope you enjoy studying the individual contributions while gaining deeper insight into the current state of active tissue modeling.

*Markus Böl*
Department of Mechanical Engineering,
TU Braunschweig, Germany

*Ellen Kuhl*
Departments of Mechanical Engineering, Bioengineering, and Cardiothoracic,
Surgery, Stanford University, USA

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## REFERENCES

Böl, M., Abilez, O. J., Assar, A. N., Zarins, C. K., and Kuhl, E., *In vitro/in silico* characterization of active and passive stresses in cardiac muscle, *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 171–188, 2012.

Chapelle, D., Le Tallec, P., Moireau, P., and Sorine, M., An Energy-preserving muscle tissue model: Formulation and compatible discretizations, *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 189–211, 2012.

King, M. A., Lewis, M. G. C., and Yeadon, M. R., Is it necessary to include biarticular effects within joint torque representations of knee flexion and knee extension? *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 117–130, 2012.

Kober, C., Berg, B. I., Sturmat, M., Rieger, J., Gallo, L., Böl, M., Mack, M., Zeilhofer, H. F., and Sader, R., Macroscopic muscular modeling based on *in vivo* 4D-radiology, *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 131–142, 2012.

Simms, C. K., Van Loocke, M., and Lyons, C. G., Skeletal muscle in compression: Modelling approaches for the passive muscle bulk, *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 143–154, 2012.

Yucesoy, C. A. and Huijing, P. A., Specifically tailored use of the finite element method to study muscular mechanics within the context of fascial integrity: The linked fiber-matrix mesh model, *Int. J. Multiscale Comput. Eng*., vol. **10**, no. 2, pp. 155–170, 2012.