

Preface

One of the current challenges in medicine and engineering is related to the application of computational methods to clinical medicine. The virtual environment can be used to study biological systems at different scales and under multi-physics conditions. Based on the tremendous advances in medical imaging, modern CAD systems, and high-performance computing, engineering can provide help in understanding biological processes but also implant designs. This enables the possibility to enhance medical decision processes in many areas of clinical medicine. The computational tools and methods can be applied to predict performance of medical devices in virtual patients. Physical and animal testing procedures can be reduced by use of virtual prototyping of medical devices.

In this book, scientists from different areas of medicine, engineering, and natural sciences have contributed to the above research areas and ideas. The book will focus on function, production, initialization, and complications of different types of implants and related topics.

The contributions start with theoretical and numerical investigations that are related to modeling biological materials like the papers “[RVE Procedure for Estimating the Elastic Properties of Inhomogeneous Microstructures Such as Bone Tissue](#)” by Blöß and Welsch and “[A Gradient-Enhanced Continuum Damage Model for Residually Stressed Fibre-Reinforced Materials at Finite Strains](#)” by Waffenschmidt et al. A more application-oriented work “[A Mechanically Stimulated Fracture Healing Model Using a Finite Element Framework](#)” is provided by Sapotnick and Nackenhorst that builds a bridge to the work “[The Customized Artificial Hip Cup: Design and Manufacturing of an Innovative Prosthesis](#)” by Betancur Escobar et al. New stents are modeled in the paper “[On the Role of Phase Change in Modelling Drug-Eluting Stents](#)” by Bozsak et al. The paper “[Development of Magnesium Alloy Scaffolds to Support Biological Myocardial Grafts: A Finite Element Investigation](#)” by Weidling et al. deals with the development of new degenerative implants. The contributions “[Finite Element Analysis of Transcatheter Aortic Valve Implantation in the Presence of Aortic Leaflet Calcifications](#)” by Dimasi et al., “[Repair of Mitral Valve Prolapse Through ePTFE Neochordae: A Finite Element Approach From CMR](#)” by Sturla et al. and

“An Extended Computational Framework to Study Arterial Vasomotion and Its Links to Vascular Disease” by Boileau et al. are related to virtual models for the vascular system. Models that describe the behavior of the cochlea are provided in “Development of a Model of the Electrically Stimulated Cochlea” by Nogueira et al. Finally, models and investigations of infections due to implantation are discussed in “Implant Related Infections” by Abraham and “Animal Test Models for Implant-Associated Inflammation and Infections” by Rais et al.

All contributions show the state of the art in modeling and numerical simulation of systems in biotechnology and thus provide an extensive overview of this subject.

Hannover, May 2014

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Biomedical Technology

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2015, VIII, 187 p. 92 illus., 53 illus. in color., Hardcover

ISBN: 978-3-319-10980-0