

Studies in Mechanobiology,
Tissue Engineering and Biomaterials 10

Liesbet Geris *Editor*

Computational Modeling in Tissue Engineering

Computational Modeling In Tissue Engineering Studies In Mechanobiology Tissue Engineering And Biomaterials

**J. Miguel Oliveira, Rui L. Reis, Sandra
Pina**



Computational Modeling In Tissue Engineering Studies In Mechanobiology Tissue Engineering And Biomaterials:

Computational Modeling in Tissue Engineering Liesbet Geris, 2012-10-30 One of the major challenges in tissue engineering is the translation of biological knowledge on complex cell and tissue behavior into a predictive and robust engineering process Mastering this complexity is an essential step towards clinical applications of tissue engineering This volume discusses computational modeling tools that allow studying the biological complexity in a more quantitative way More specifically computational tools can help in i quantifying and optimizing the tissue engineering product e g by adapting scaffold design to optimize micro environmental signals or by adapting selection criteria to improve homogeneity of the selected cell population ii quantifying and optimizing the tissue engineering process e g by adapting bioreactor design to improve quality and quantity of the final product and iii assessing the influence of the in vivo environment on the behavior of the tissue engineering product e g by investigating vascular ingrowth The book presents examples of each of the above mentioned areas of computational modeling The underlying tissue engineering applications will vary from blood vessels over trachea to cartilage and bone For the chapters describing examples of the first two areas the main focus is on the optimization of mechanical signals mass transport and fluid flow encountered by the cells in scaffolds and bioreactors as well as on the optimization of the cell population itself In the chapters describing modeling contributions in the third area the focus will shift towards the biology the complex interactions between biology and the micro environmental signals and the ways in which modeling might be able to assist in investigating and mastering this complexity The chapters cover issues related to multiscale multiphysics model building training and validation but also discuss recent advances in scientific computing techniques that are needed to implement these models as well as new tools that can be used to experimentally validate the computational results

Biomaterials for Bone Tissue Engineering José A. Sanz-Herrera, 2020-05-27 Bone tissue engineering aims to develop artificial bone substitutes that partially or totally restore the natural regeneration capability of bone tissue lost under circumstances of injury significant defects or diseases such as osteoporosis In this context biomaterials are the keystone of the methodology Biomaterials for bone tissue engineering have evolved from biocompatible materials that mimic the physical and chemical environment of bone tissue to a new generation of materials that actively interacts with the physiological environment accelerating bone tissue growth Mathematical modelling and simulation are important tools in the overall methodology This book presents an overview of the current investigations and recent contributions in the field of bone tissue engineering It includes several successful examples of multidisciplinary collaboration in this transversal area of research The book is intended for students researchers and professionals of a number of disciplines such as engineering mathematics physics chemistry biomedicine biology and veterinary The book is composed of an editorial section and 16 original research papers authored by leading researchers of this discipline from different laboratories across the world

Uncertainty in Biology Liesbet Geris, David Gomez-Cabrero, 2015-10-26 Computational

modeling allows to reduce refine and replace animal experimentation as well as to translate findings obtained in these experiments to the human background However these biomedical problems are inherently complex with a myriad of influencing factors which strongly complicates the model building and validation process This book wants to address four main issues related to the building and validation of computational models of biomedical processes 1 Modeling establishment under uncertainty 2 Model selection and parameter fitting 3 Sensitivity analysis and model adaptation 4 Model predictions under uncertainty In each of the abovementioned areas the book discusses a number of key techniques by means of a general theoretical description followed by one or more practical examples This book is intended for graduate students and researchers active in the field of computational modeling of biomedical processes who seek to acquaint themselves with the different ways in which to study the parameter space of their model as well as its overall behavior

Multiscale Modelling in Biomedical Engineering Dimitrios I. Fotiadis, Antonis I. Sakellarios, Vassiliki T. Potsika, 2023-05-05 Multiscale Modelling in Biomedical Engineering Discover how multiscale modeling can enhance patient treatment and outcomes In Multiscale Modelling in Biomedical Engineering an accomplished team of biomedical professionals delivers a robust treatment of the foundation and background of a general computational methodology for multi scale modeling The authors demonstrate how this methodology can be applied to various fields of biomedicine with a particular focus on orthopedics and cardiovascular medicine The book begins with a description of the relationship between multiscale modeling and systems biology before moving on to proceed systematically upwards in hierarchical levels from the molecular to the cellular tissue and organ level It then examines multiscale modeling applications in specific functional areas like mechanotransduction musculoskeletal and cardiovascular systems Multiscale Modelling in Biomedical Engineering offers readers experiments and exercises to illustrate and implement the concepts contained within Readers will also benefit from the inclusion of A thorough introduction to systems biology and multi scale modeling including a survey of various multi scale methods and approaches and analyses of their application in systems biology Comprehensive explorations of biomedical imaging and nanoscale modeling at the molecular cell tissue and organ levels Practical discussions of the mechanotransduction perspective including recent progress and likely future challenges In depth examinations of risk prediction in patients using big data analytics and data mining Perfect for undergraduate and graduate students of bioengineering biomechanics biomedical engineering and medicine Multiscale Modelling in Biomedical Engineering will also earn a place in the libraries of industry professional and researchers seeking a one stop reference to the basic engineering principles of biological systems

Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System Z Jin, Junyan Li, Zhenxian Chen, 2020-09-29 Computational Modelling of Biomechanics and Biotribology in the Musculoskeletal System Biomaterials and Tissues Second Edition reviews how a wide range of materials are modeled and applied Chapters cover basic concepts for modeling of biomechanics and biotribology the fundamentals of computational modeling of biomechanics

in the musculoskeletal system finite element modeling in the musculoskeletal system computational modeling from a cells and tissues perspective and computational modeling of the biomechanics and biotribology interactions looking at complex joint structures This book is a comprehensive resource for professionals in the biomedical market materials scientists and biomechanical engineers and academics in related fields This important new edition provides an up to date overview of the most recent research and developments involving hydroxyapatite as a key material in medicine and its application including new content on novel technologies biomorphic hydroxyapatite and more Provides detailed introductory coverage of modeling of cells and tissues modeling of biomaterials and interfaces biomechanics and biotribology Discusses applications of modeling for joint replacements and applications of computational modeling in tissue engineering Offers a holistic perspective from cells and small ligaments to complex joint interactions

Multiscale Cell-Biomaterials Interplay in Musculoskeletal Tissue Engineering and Regenerative Medicine J. Miguel Oliveira,Rui L. Reis,Sandra Pina,2023-11-28 Multiscale Cell Biomaterials Interplay in Musculoskeletal Tissue Engineering and Regenerative Medicine addresses the key concepts involved in the interactions between cells and biomaterials in the musculoskeletal tissue engineering and regenerative medicine field The updated developments and challenges of the mechanisms mechanobiology and structure function properties of those interactions as well as emerging technologies underlying tissue engineered scaffolding are carefully discussed Lastly cell engineering and cell based therapies growth factors drugs properties vascularization immunomodulation are also outlined Given the large number of musculoskeletal disorders and related injuries that can affect muscles bones and joints and lead to severe complications of the neuromuscular system it is imperative to develop new treatment strategies to delay or repair associated diseases and to promote optimal long term health Presents the fundamentals of the complex interplay of cells with biomaterials in musculoskeletal tissue engineering Includes coverage of stem cells and cell based therapies in vitro and in vivo models nanotechnology bioprinting computational modeling regulatory and clinical translation and much more Written by global leaders in the field

Multi-scale Extracellular Matrix Mechanics and Mechanobiology Yanhang Zhang,2019-07-12 This book describes the current state of knowledge in the field of multi scale ECM mechanics and mechanobiology with a focus on experimental and modelling studies in biomechanical characterization advanced optical microscopy and imaging as well as computational modeling This book also discusses the scale dependency of ECM mechanics translation of mechanical forces from tissue to cellular level and advances and challenges in improving our understanding of cellular mechanotransduction in the context of living tissues and organisms

Soft Tissue Biomechanical Modeling for Computer Assisted Surgery Yohan Payan,2012-04-27 This volume focuses on the biomechanical modeling of biological tissues in the context of Computer Assisted Surgery CAS More specifically deformable soft tissues are addressed since they are the subject of the most recent developments in this field The pioneering works on this CAS topic date from the 1980 s with applications in orthopaedics and biomechanical models of bones More

recently however biomechanical models of soft tissues have been proposed since most of the human body is made of soft organs that can be deformed by the surgical gesture Such models are much more complicated to handle since the tissues can be subject to large deformations non linear geometrical framework as well as complex stress strain relationships non linear mechanical framework Part 1 of the volume presents biomechanical models that have been developed in a CAS context and used during surgery This is particularly new since most of the soft tissues models already proposed concern Computer Assisted Planning with a pre operative use of the models Then the volume addresses the two key issues raised for an intra operative use of soft tissues models namely Part 2 how to estimate the in vivo mechanical behavior of the tissues i e what are the values of the mechanical parameters that can deliver realistic patient specific behavior and Part 3 how to build a modeling platform that provides generic real time or at least interactive time numerical simulations

Multiscale

Computer Modeling in Biomechanics and Biomedical Engineering Amit Gefen, 2014-07-08 This book reviews the state of the art in multiscale computer modeling in terms of both accomplishments and challenges The information in the book is particularly useful for biomedical engineers medical physicists and researchers in systems biology mathematical biology micro biomechanics and biomaterials who are interested in how to bridge between traditional biomedical engineering work at the organ and tissue scales and the newer arenas of cellular and molecular bioengineering

Computer Methods in

Biomechanics and Biomedical Engineering II Wafa Skalli, Sébastien Laporte, Aurélie Benoit, 2024-04-23 This book gathers selected extended and revised contributions to the 18th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering held on May 3 5 2023 at Arts Et Métiers Institute Of Technology in Paris France They highlight cutting edge advances in computational modelling in biomedical engineering discusses new developments on imaging and visualization as well as solutions for applying them in the clinical practice All in all this book offers a timely snapshot of the latest research and current challenges at the interface between biomedical engineering computational biomechanics and biological imaging It also aims at fostering future cross disciplinary collaborations

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