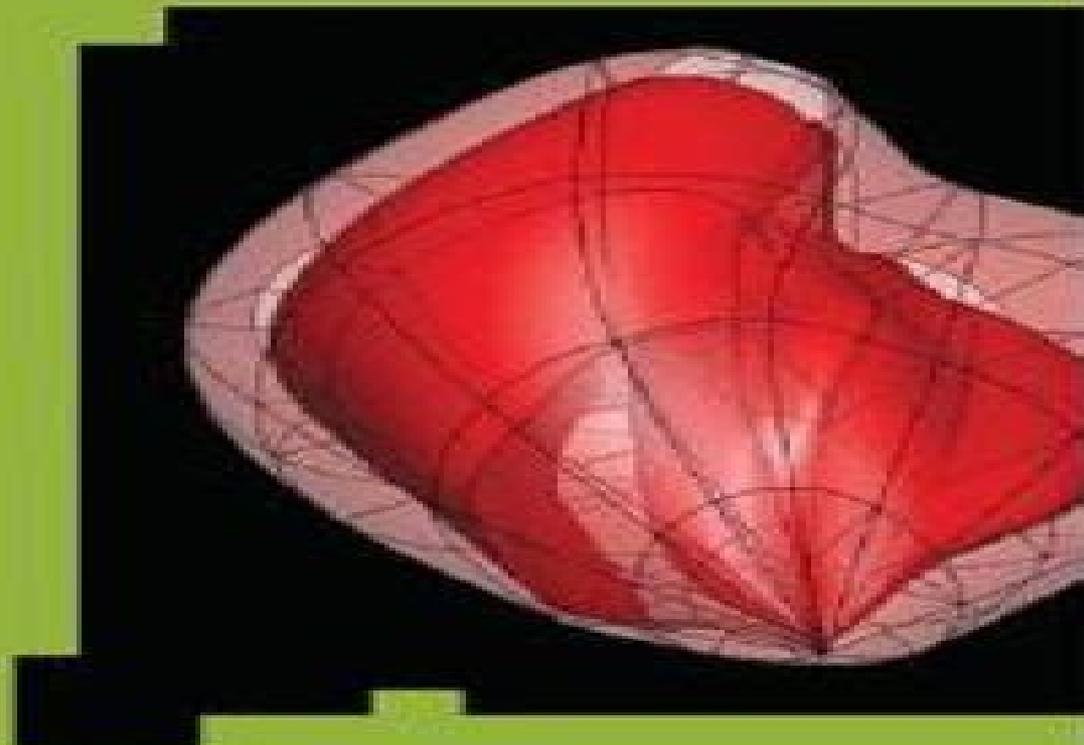


Andrew J. Pullan • Martin L. Buist • Leo K. Cheng



**MATHEMATICALLY MODELLING
THE ELECTRICAL ACTIVITY
OF THE HEART**

From Cell to Body Surface and Back Again

Mathematical Modelling Of Cardiac Electrical Activity

Trine Krogh-Madsen



Mathematical Modelling Of Cardiac Electrical Activity:

Mathematically Modelling The Electrical Activity Of The Heart: From Cell To Body Surface And Back Again Andrew Pullan, Martin L. Buist, Leo K. Cheng, 2005-09-07 This book on modelling the electrical activity of the heart is an attempt to describe continuum based modelling of cardiac electrical activity from the cell level to the body surface the forward problem and back again the inverse problem Background anatomy and physiology is covered briefly to provide a suitable context for understanding the detailed modelling that is presented herein The questions of what is mathematical modelling and why one would want to use mathematical modelling are addressed to give some perspective to the philosophy behind our approach Our view of mathematical modelling is broad it is not simply about obtaining a solution to a set of mathematical equations but includes some material on aspects such as experimental and clinical validation

Modeling and Simulating Cardiac Electrical Activity Trine Krogh-Madsen, David J. Christini, 2020-12-03 This book provides a thorough introduction to the topic of mathematical modeling of electrical activity in the heart from molecular details of ionic channel dynamics to clinically derived patient specific models It discusses how cellular ionic models are formulated introduces commonly used models and explains why there are so many different models available The chapters cover modeling of the intracellular calcium handling that underlies cellular contraction as well as modeling molecular level details of cardiac ion channels and specialized topics such as cardiomyocyte energetics and signalling pathways It is an excellent resource for experienced and specialized researchers in the field but also biological scientists with a limited background in mathematical modelling and computational methods Key Features Thorough introduction to the topic of mathematical modeling of electrical activity in the heart Focuses on use of experimental data in mathematical modeling and on explanations rather than equations In addition to being experts in the field the contributing authors are expert science communicators

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Mathematical Modelling of the Human Cardiovascular System Alfio Quarteroni, Luca Dede', Andrea Manzoni, Christian Vergara, 2019-05-09 Addresses the mathematical and numerical modelling of the human cardiovascular system from patient data to clinical applications

Mathematical Modelling of Cardiac Electrical Activity Within a Heterogeneous Bidomain Framework Thushka Maharaj, 2008 An Introduction to Mathematical Modeling in

Physiology, Cell Biology, and Immunology James Sneyd, American Mathematical Society, In many respects biology is the new frontier for applied mathematicians This book demonstrates the important role mathematics plays in the study of some biological problems It introduces mathematicians to the biological sciences and provides enough mathematics for bioscientists to appreciate the utility of the modelling approach The book presents a number of diverse topics such as neurophysiology cell biology immunology and human genetics It examines how research is done what mathematics is used what the outstanding questions are and how to enter the field Also given is a brief historical survey of each topic putting current research into perspective The book is suitable for mathematicians and biologists interested in mathematical methods in biology Dynamical Systems, PDEs and Networks for Biomedical Applications: Mathematical Modeling, Analysis and Simulations André H. Erhardt, Krasimira Tsaneva-Atanasova, Glenn Terje Lines, Erik Andreas Martens, 2023-02-15

Complex Systems in Biomedicine A. Quarteroni, L. Formaggia, A. Veneziani, 2007-03-20

Mathematical modeling of human physiopathology is a tremendously ambitious task It encompasses the modeling of most diverse compartments such as the cardiovascular respiratory skeletal and nervous systems as well as the mechanical and biochemical interaction between blood flow and arterial walls and electrocardiac processes and electric conduction in biological tissues Mathematical models can be set up to simulate both vasculogenesis the aggregation and organization of endothelial cells dispersed in a given environment and angiogenesis the formation of new vessels sprouting from an existing vessel that are relevant to the formation of vascular networks and in particular to the description of tumor growth The integration of models aimed at simulating the cooperation and interrelation of different systems is an even more difficult task It calls for the setting up of for instance interaction models for the integrated cardiovascular system and the interplay between the central circulation and peripheral compartments models for the mid to long range cardiovascular adjustments to pathological conditions e.g. to account for surgical interventions congenital malformations or tumor growth models for integration among circulation tissue perfusion biochemical and thermal regulation models for parameter identification and sensitivity analysis to parameter changes or data uncertainty and many others *Finite Element Modeling of Cardiac Activation Dynamics* Jack Moss Rogers, 1993 Modeling and Simulating Cardiac Electrical Activity Trine Krogh-Madsen, 2020-12-03 This book provides a thorough introduction to the topic of mathematical modeling of electrical activity in the heart from molecular details of ionic channel dynamics to clinically derived patient specific models It discusses how cellular ionic models are formulated introduces commonly used models and explains why there are so many different models available The chapters cover modeling of the intracellular calcium handling that underlies cellular contraction as well as modeling molecular level details of cardiac ion channels and specialized topics such as cardiomyocyte energetics and signalling pathways It is an excellent resource for experienced and specialized researchers in the field but also biological scientists with a limited background in mathematical modelling and computational methods Key Features Thorough introduction to the topic of

mathematical modeling of electrical activity in the heart Focuses on use of experimental data in mathematical modeling and on explanations rather than equations In addition to being experts in the field the contributing authors are expert science communicators *Computing the Electrical Activity in the Heart* Joakim Sundnes, Glenn Terje Lines, Xing Cai, Bjørn Frederik Nielsen, Kent-Andre Mardal, Aslak Tveito, 2007-06-26 The heart is a fantastic machine during a normal lifetime it beats about 2.5 billion times and pumps 200 000 tons of blood through an enormous system of vessels extending 160 000 kilometres throughout the body For centuries man has tried to understand how the heart works but there remain many unsolved problems problems that have captured the attention of thousands of researchers worldwide There is for example a huge amount of research being devoted to the analysis of single heart cells Other areas of research include trying to understand how it works as a complete muscle and how blood flows through the heart The entire process is extremely complex The history of bioelectricity can be traced back to the late eighteenth century and the experiments of Luigi Galvani A century later in 1887 Augustus Waller managed to measure the electrical signal generated by the heart at the surface of the body 142 His dog Jimmy earned a place in history by being the first to have his heart measured in this way see Figure 1.1 In 1903 Willem Einthoven developed the first commercial device for recording electrocardiograms ECGs see Figure 1.2 *Spatial Estimation of the 12-lead Electrocardiogram Using Linear Least-squares Modeling Techniques* Julie Ann Scherer, 1994

New Advances in Gastrointestinal Motility Research L. K. Cheng, A. J. Pullan, G. Farrugia, 2013-06-01 Research into gastrointestinal motility has received renewed interest in part due to recent advances in the techniques for measuring the structure and function of gastrointestinal cells tissue and organs The integration of this wealth of data into biophysically based computation models can aid in interpretation of experimental and clinical measurements and the refinement of measurement techniques The contents of this book span multiple scales from cell tissue organ to whole body and is divided into four broad sections covering i gastrointestinal cellular activity and tissue structure ii techniques for measuring analyzing and visualizing high resolution extra cellular recordings iii methods for sensing gastroelectrical activity using non invasive bio electro magnetic fields and for modulating the underlying gastric electrical activity and finally iv methods for assessing manometric and videographic motility patterns and the application of these data for predicting the flow and mixing behavior of luminal contents by using computational fluid dynamic techniques This book aims to provide both an overview of historical and existing research techniques as well as to highlight future directions and challenges for the community as a whole It will be suitable for clinicians to understand the cellular and biophysical underpinnings of gastric emptying gastroenterologists surgeons bioengineers and all scientists with interests in gastrointestinal motility research **Mathematical Approaches to Cardiac Arrhythmias** José Jalife, 1990 *A Model for the Mapping of Cardiac Events Onto the Electrocardiogram (ECG) in the Case of Coronary Artery Disease* Abraham Tat Chang Wong, 1980 **A Discrete-Event Simulation Model of Myocardial Electrical Activity: Mathematical Electrophysiology**, 1994 This work unit was opened to provide a channel

for in house work on mathematical modeling and computer simulation of the electrocardiogram ECG and its underlying electrophysiology This work was intended to complement work being done in contracted efforts aimed at model based enhancement of ECG diagnostic criteria for detection of coronary artery disease in USAF aircrew members Both the contract and in house efforts have been terminated due to funding constraints and organizational shifts in research focus In this technical paper we report on the development of a simulation model of the depolarization and repolarization processes in the ventricles which was to be used as a cardiac electrical source model in simulations of the ECG as well as attempt to provide some commentary regarding the relation of these efforts to broader contexts

Pacemaker Activity and Intercellular Communication Jan D. Huizinga, 1995-02-06 The book focuses on enhancing our understanding of pacemaker systems and associated mechanisms of intercellular communication Three different physiological systems are compared the cardiac system the cells of the pancreas and the gastrointestinal tract Experts in all three areas highlight the parallels and comparisons among the systems Emphasis is placed on finding precise characteristics of all cell types involved in pacemaker activity The interpretation of data on single isolated cells in light of tissue function receives thorough discussion Ion channel characteristics involved in the generation of action potential and pacemaker components are described in detail A fascinating but largely unexplored area is touched upon the electrical and metabolic coupling of different cell types A most valuable feature is that most investigators have explored a variety of techniques to examine cell function patch clamp studies intracellular voltage recording intracellular calcium measurements gap junction conductance measurements dye spread techniques and more Various aspects of the molecular biology of gap junction and ion channels are explored

Computer Techniques in Clinical Medicine Peter W. Macfarlane, 1985 *Bioelectricity and Biomagnetism* Ramesh M. Gulrajani, 1998-10-30 Many vital medical techniques are based on fundamental bioelectric and biomagnetic phenomena electrocardiographs and cardiac pacemakers are two examples This book examines the fundamental science underlying these techniques

Journal of Mathematical Biology, 1990 Publishes papers in which mathematics is used to understand biological phenomena and mathematical papers which answer questions arising from models of biological phenomena

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