Cardiovascular And Respiratory Systems Modeling

The parameter identification problem attempts to find parameter values that cause the solution of a predictive model to match data. In this work, parameters in cardiovascular and respiratory models are identified. This workÃ¢â'¬â"¢s main contribution is in its application of gradient based optimization techniques and insight into methods to identify parameters that can be estimated given subject specific data. The models presented in this paper are lumped compartment models of the cardiovascular and respiratory systems. Lumped compartment models treat the cardiovascular and respiratory systems as collections of interconnected compartments transporting blood and exchanging oxygen and carbon dioxide. Using these compartments, a system of ordinary differential equations (ODE) is generated that incorporates several physiological parameters representing vascular resistances, compliances, and tissue metabolic rates. The solution to this ODE system is used to predict cerebral blood flow, systemic arterial blood pressure, and expired carbon dioxide partial pressures, which are then compared to subject data. Minimizing the two-norm difference between between the result of the predictive model and the experimental data is a non-linear least squares problem. Although the least squares problem is overdetermined, the data do not contain enough information to determine all model parameters. A combination of sensitivity analysis, expert knowledge, and subset selection techniques reduce the number of model parameters estimated.

This book describes the basic, pathophysiologic, and clinical importance of the reciprocal relationships and interactions between the respiratory and cardiovascular systems, examining mechanical responses caused by lung volume and thoracic pressure. Emphasizes humoral and neurophysical interactions occurring in diseases that lead to cardiorespiratory failure. Covering pulmonary mechanics, respiratory muscle function, exercise physiology, and control of venous return and cardiac output, Respiratory-Circulatory Interactions in Health and Disease focuses on mechanisms of heart failure in respiratory disease details the central interactions in sudden infant death syndrome considers the control of tissue metabolism, the development of the sympathetic nervous system, mathematical modeling, and image analysis as a tool for investigating cardiocirculatory function examines the effects of muscle reflexes on respiration and circulation analyzes systemic inflammatory response and chronic obstructive lung disease discusses respiratory maneuvers to support failing circulation and ventilation addresses current controversies surrounding the balloon-tipped catheter debates using inhaled nitrous oxide to treat circulatory failure and more! Supplying a rational basis for understanding the ways in which the cardiovascular and respiratory systems interact in normal and abnormal situations, Respiratory-Circulatory Interactions in Health and Disease is a blue-ribbon reference for cardiologists; pulmonologists; physiologists; intensivists; cardiothoracic surgeons; anesthesiologists; asthmatologists; health care practitioners interested in chest, pulmonary, and thoracic medicine; and medical school students in these disciplines.

This volume synthesizes theoretical and practical aspects of both the mathematical and life science viewpoints needed for modeling of the cardiovascular-respiratory system specifically and physiological systems generally. Theoretical points include model design, model complexity and validation in the light of available data, as well as control theory approaches to feedback delay and Kalman filter applications to parameter identification. State of the art approaches using parameter sensitivity are discussed for enhancing model identifiability through joint analysis of model structure and data. Practical examples illustrate model development at various levels of complexity based on given physiological information. The sensitivity-based approaches for examining model identifiability are illustrated by means of specific modeling examples. The themes presented address the current problem of patient-specific model adaptation in the clinical setting, where data is typically limited.

This dissertation, "The Applications of Computational Fluid Dynamics to the Cardiovascular System and the Respiratory System" by Yi, Fan, □□, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. Abstract: □The diseases of cardiovascular system and the respiratory system have been the second and third killers causing deaths in Hong Kong. In this stressful civilized world, the prevalence and incidence of these diseases increased prominently which arouse our concern on the theories behind the pathological conditions. This report will focus on the biofluid mechanics in the large artery and in the upper airway. Thoracic aortic dissection, characterized by the tearing in the middle layer of vessel wall, is a catastrophic vascular disorder. The wall of the newly formed channel, the false lumen, is weakened and prone to aortic events. Endovascular repair is a minimally invasive technique for treating dissection patients. The biomechanical factors and the length of endograft were studied by computational fluid dynamics. Two geometrical factors showed a significant impact on the backflow in the false lumen. A larger false lumen and a larger distal tear size greatly affected the extent of thrombosis in the false lumen. It made the false lumen under a higher risk of vessel rupture. The computational prediction also demonstrated a more stable hemodynamic condition in the model with a longer endograft. These results provide important information for the clinicians to propose the surgical procedures and to improve the design of endografts. Airway obstruction is a common breathing disorder but it is always underdiagnosed. Obstructive sleep apnea (OSA) and different dentofacial deformities are two pathological conditions in which the patients have the abnormal sizes of airways. Computational fluid dynamic was employed in both conditions with patient-specific models. In the part of OSA, pre- and post-operative models were studied. The dimensions and flow resistance of the upper airway showed a significant improvement after mandibular distraction. The percentage of stenosis and the flow resistance was reduced by 27.3% and 40.7% respectively. For the patients in three facial skeletal deformity groups, the cross-sectional area and the flow resistance were compared. The patients with Class II deformity had the smallest retroglossal and retroplatal dimensions as well as the greatest flow resistance. The results confirmed the effectiveness of mandibular distraction and also provide valuable implications for the clinicians on the treatment planning, particularly for the Class II subjects. DOI: 10.5353/th_b4775319 Subjects: Fluid dynamics - Mathematical models Cardiovascular system - Mechanical properties Respiratory system - Mechanical properties

Modelling, Simulation and Applications of Complex Systems

Engineering Approaches to Study Cardiovascular Physiology: Modeling, Estimation, and Signal Processing

World Congress on Medical Physics and Biomedical Engineering 2018
CoSMoS 2019, Penang, Malaysia, April 8-11, 2019
Energy, Information, Feedback, Adaptation, and Self-organization

With cardiovascular diseases being one of the main causes of death in the world, quantitative modeling, assessment and monitoring of the cardiovascular control system plays a critical role in bringing important breakthroughs to cardiovascular care. Quantification of cardiovascular physiology and its control dynamics from physiological recordings and by use of mathematical models and algorithms has been proved to be of important value in understanding the causes of cardiovascular diseases and assisting the prognostic or diagnostic process. Nowadays, development of new recording technologies (e.g., electrophysiology, imaging, ultrasound, etc) has enabled us to improve and expand acquisition of a wide spectrum of physiological measures related to cardiovascular control. An emerging challenge is to process and interpret such increasing amount of information by using state-of-the-art approaches in systems modeling, estimation and control, and signal processing, which would lead to further insightful scientific findings. In particular, multi-disciplinary engineering-empowered approaches of studying cardiovascular systems would greatly deepen our understanding of cardiovascular functions (e.g., heart rate variability, baroreflex sensitivity) and autonomic control, as it would also improve the knowledge about heart pathology, cardiovascular rehabilitation and therapy. Meanwhile, developing cardiovascular biomedical devices or heart-machine interface for either clinical monitoring or rehabilitation purpose is of greater and greater interest for both scientific advancement and potential medical benefits. This Research Topic will bring together established experts whose areas of research cover a wide range of studies and applications. Contributions include but are not limited to state-of-the-art modeling methodologies, algorithmic development in signal processing and estimation, as well as applications in cardiovascular rehabilitation, and clinical monitoring. The Research Topic will consider both invited reviews and original research.

Cardiovascular and Respiratory SystemsModeling, Analysis, and ControlSIAM

Cardiovascular, respiratory, and related conditions cause more than 40 percent of all deaths globally, and their substantial burden is rising, particularly in low- and middle-income countries (LMICs). Their burden extends well beyond health effects to include significant economic and societal consequences. Most of these conditions are related, share risk factors, and have common control measures at the clinical, population, and policy levels. Lives can be extended and improved when these diseases are prevented, detected, and managed. This volume summarizes current knowledge and presents evidence-based interventions that are effective, cost-effective, and scalable in LMICs.

This volume presents one of the clinical foundations of vasculopathies: the biological markers and risk factors associated with cardiovascular disease. A detailed biological and clinical framework is provided as a prerequisite for adequate modeling. Chapter 1 presents cardiovascular risk factors and markers, where the search for new criteria is aimed at improving early detection of chronic diseases. The subsequent chapters focus on hypertension, which involves the kidney among other organs as well as many agents, hyperglycemia and diabetes, hyperlipidemias and obesity, and behavior. The last of these risk factors includes altered circadian rhythm, tobacco and alcohol consumption, physical inactivity, and diet. The volumes in this series present all of the data needed at various length scales for a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanisms. Therefore, investigation of flows of blood and air in anatomical conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning in quantitative terms.

The Applications of Computational Fluid Dynamics to the Cardiovascular System and the Respiratory System
Cardiovascular and Respiratory Systems
Modeling Respiratory Gas Dynamics in the Aviator's Breathing System
Mechanical Support for Heart Failure
Vasculopathies

A model of the human body which integrates the variables involved in temperature regulation and blood gas transport within the cardiovascular and respiratory systems is presented in this dissertation. It expands upon previous work developed by the author to model the competition between skin and muscles when both require increased blood flows during exercise and/or heat stress. First, a detailed study of the control relations used to predict skin blood flow was undertaken. Four other control relations employed in the model were also examined and modified as indicated by empirical results found in literature. Several important cases were then examined where changing environmental conditions have an effect upon the functioning of these systems of the body. The model was also revised to account for immersion in a water environment and exercise in the water.

The volumes in this authoritative series present a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. Volume 5 is devoted to cells, tissues, and organs of the cardiovascular and ventilatory systems with an emphasis on mechanotransduction-based regulation of flow. The blood vessel wall is a living tissue that quickly reacts to loads applied on it by the flowing blood. In any segment of a blood vessel, the endothelial and smooth muscle cells can sense unusual time variations in small-magnitude wall shear stress and large-amplitude wall stretch generated by abnormal hemodynamic stresses. These cells respond with a short-time scale (from seconds to hours) to adapt the vessel caliber. Since such adaptive cell activities can be described using mathematical models, a key objective of this volume is to identify the mesoscopic agents and nanoscopic mediators required to derive adequate mathematical models. The resulting biomathematical models and corresponding simulation software can be incorporated into platforms developed in virtual physiology for improved understanding and training.

This book discusses the latest progresses and developments on complex systems research and intends to give an exposure to prospective readers about the theoretical and practical aspects of mathematical modelling, numerical simulation and agent-based modelling frameworks. The main purpose of this book is to emphasize a unified approach to complex systems analysis, which goes beyond to examine complicated phenomena of numerous real-life systems; this is done by investigating a huge number of components that interact with each other at different (microscopic and macroscopic) scales; new insights and emergent collective behaviours can evolve from the interactions between individual components and also with their environments. These tools and concepts permit us to better understand the patterns of various real-life systems and help us to comprehend the mechanisms behind which distinct factors shaping some complex systems phenomena being influenced. This book is published in conjunction with the International Workshop on Complex Systems Modelling & Simulation 2019 (CoSMoS 2019): IoT & Big Data Integration. This international event was held at the Universiti Sains Malaysia Main Campus, Penang, Malaysia, from 8 to 11 April 2019. This book appeals to readers interested in complex systems research and other related areas such as mathematical modelling, numerical simulation and agent-based modelling frameworks. .

This book introduces mathematicians to real applications from physiology. Using mathematics to analyze physiological systems, the authors discuss models reflecting current research in cardiovascular and pulmonary physiology. In particular, they present models describing blood flow in the heart and the cardiovascular system, as well as the transport of oxygen and carbon dioxide through the respiratory system and a model for baroreceptor regulation. This is the only book available that analyzes up-to-date models of the physiological system at several levels of detail; both simple 'real-time' models that can be directly used in larger systems, and more detailed 'reference' models that show the underlying physiological mechanisms and provide parameters for and validation of simpler models. The book also covers two-dimensional modeling of the fluid dynamics in the heart and its ability to pump, and includes a discussion of modeling wave-propagation throughout the systemic arteries.

Cardiovascular and Respiratory Bioengineering

Cardiovascular Complications of Respiratory Diseases

Current Solutions and New Technologies
The Fundamental Elements of Life and Society
Cell and Tissue Organization in the Circulatory and Ventilatory Systems

This presentation describes various aspects of the regulation of tissue oxygenation, including the roles of the circulatory system, respiratory system, and blood, the carrier of oxygen within these components of the cardiorespiratory system. The respiratory system takes oxygen from the atmosphere and transports it by diffusion from the air in the alveoli to the blood flowing through the pulmonary capillaries. The cardiovascular system then moves the oxygenated blood from the heart to the microcirculation of the various organs by convection, where oxygen is released from hemoglobin in the red blood cells and moves to the parenchymal cells of each tissue by diffusion. Oxygen that has diffused into cells is then utilized in the mitochondria to produce adenosine triphosphate (ATP), the energy currency of all cells. The mitochondria are able to produce ATP until the oxygen tension or PO2 on the cell surface falls to a critical level of about 4–5 mm Hg. Thus, in order to meet the energetic needs of cells, it is important to maintain a continuous supply of oxygen to the mitochondria at or above the critical PO2 . In order to accomplish this desired outcome, the cardiorespiratory system, including the blood, must be capable of regulation to ensure survival of all tissues under a wide range of circumstances. The purpose of this presentation is to provide basic information about the operation and regulation of the cardiovascular and respiratory systems, as well as the properties of the blood and parenchymal cells, so that a fundamental understanding of the regulation of tissue oxygenation is achieved.

Biodynamic Research Corporation (BRC) completed an SBIR Phase I project to study the feasibility of developing a model of the Aviator's Breathing System (ABS). The motivation for the project was the desire to develop a model which could simulate the cardiovascular and respiratory responses to altitude and acceleration stress encountered in high performance military aircraft. Software modules were developed and tested for simulation of: (1) the flows and pressures within the breathing gas delivery system; (2) the flows, pressures, and gas distribution within the lung; and (3) the steady-state flows and pressures within the cardiovascular system. Subprograms were also developed to compute altitude barometric pressure relationships as well as passenger cabin pressures in military aircraft. In addition to the software development, BRC reviewed and organized the Government furnished data from a series of manned rapid decompression known as the EONS Experiments. Aircrew breathing system, Rapid decompression, Lung mechanics, Respiratory physiology, mathematical model.

Mathematicalmodelingofhumanphysiopathologyisatremendouslyambitioustask. It encompasses the modeling of most diverse compartments such as the cardiovas- lar,respiratory,skeletalandnervoussystems,aswellasthemechanicalandbioch- ical interaction between blood ?ow 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 dif?cult task. It calls for the setting up of, for instance, interaction models for the integrated cardio-vascular 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 identi?cation and sensitivity analysis to parameter changes or data uncertainty – and many others.

The volumes in this authoritative series present a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanisms. Therefore, investigation of flows of blood and air in physiological conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning. Volumes 1 and 2 are devoted to cell organization and fate, as well as activities that are autoregulated and/or controlled by the cell environment. Volume 1 examined cellular features that allow adaptation to environmental conditions. Volume 2 begins with a survey of the cell types of the nervous and endocrine systems involved in the regulation of the vasculature and respiratory tract and growth factors. It then describes major cell events in the circulatory and ventilatory systems, such as cell growth, proliferation, migration, and death. Circadian cycles that drive rhythmic gene transcription are also covered.

Modeling and Simulation in Biomedical Engineering: Applications in Cardiorespiratory Physiology

A Two-circuit Model of the Cardio-respiratory System

Survey of research in modeling the human respiratory and cardiovascular systems

Investigation of the Human Respiratory Control System by Computer Modeling and System Identification Techniques

Disease Control Priorities, Third Edition (Volume 5)

Gathering the proceedings of the 12th CHAOS2019 International Conference, this book highlights recent developments in nonlinear, dynamical and complex systems. The conference was intended to provide an essential forum for Scientists and Engineers to exchange ideas, methods, and techniques in the field of Nonlinear Dynamics, Chaos, Fractals and their applications in General Science and the Engineering Sciences. The respective chapters address key methods, empirical data and computer techniques, as well as major theoretical advances in the applied nonlinear field. Beyond showcasing the state of the art, the book will help academic and industrial researchers alike apply chaotic theory in their studies.

Together, the volumes in this series present all of the data needed at various length scales for a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanism. Therefore, investigation of flows of blood and air in anatomical conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning in quantitative terms. The present volume focuses on macroscopic aspects of the cardiovascular and respiratory systems in pathological conditions, i.e., diseases of the cardiac pump, blood vessels, and airways, as well as their treatments. Only diseases that have a mechanical origin or are associated with mechanical disorders are covered. Local flow

disturbances can trigger pathophysiological processes or, conversely, result from diseases of conduit walls or their environment. The ability to model these phenomena is essential to the development and manufacturing of medical devices, which incorporate a stage of numerical tests in addition to experimental procedures.

THEORY AND PRACTICE OF MODELING AND SIMULATING HUMAN PHYSIOLOGY Written by a coinventor of the Human Patient Simulator (HPS) and past president of the Society in Europe for Simulation Applied to Medicine (SESAM), Modeling and Simulation in Biomedical Engineering: Applications in Cardiorespiratory Physiology is a compact and consistent introduction to this expanding field. The book divides the modeling and simulation process into five manageable steps--requirements, conceptual models, mathematical models, software implementation, and simulation results and validation. A framework and a basic set of deterministic, continuous-time models for the cardiorespiratory system are provided. This timely resource also addresses advanced topics, including sensitivity analysis and setting model requirements as part of an encompassing simulation and simulator design. Practical examples provide you with the skills to evaluate and adapt existing physiologic models or create new ones for specific applications. Coverage includes: Signals and systems Model requirements Conceptual models Mathematical models Software implementation Simulation results and model validation Cardiorespiratory system model Circulation Respiration Physiologic control Sensitivity analysis of a cardiovascular model Design of model-driven acute care training simulators “Uniquely qualified to author such a text, van Meurs is one of the original developers of CAE Healthcare’s Human Patient Simulator (HPS). ...His understanding of mathematics, human physiology, pharmacology, control systems, and systems engineering, combined with a conversational writing style, results in a readable text. ...The ample illustrations and tables also break up the text and make reading the book easier on the eyes. ...concise yet in conversational style, with real-life examples. This book is highly recommended for coursework in physiologic modeling and for all who are interested in simulator design and development. The book pulls all these topics together under one cover and is an important contribution to biomedical literature.” --IEEE Pulse, January 2014 “This book is written by a professional engineer who is unique in that he seems to have a natural understanding of 3 key areas as follows: the hardware involved with simulators, human physiology, and mathematical modeling. Willem van Meurs is one of the inventors of the model-driven human patient simulator (HPS), and so, he is very qualified to write this book. The book is written in a clear way, using the first person throughout, in a conversational manner, with a style that involves posing questions and answering them in subsequent text. ...The book starts with a very useful introduction and background chapter, setting out the scene for the rest of the book. ...I have used his book in enhancing my own talks and understanding human patient simulation and can strongly recommend it.” --Simulation in Healthcare December, 2012 Reviewed by Mark A. Tooley, Ph.D., Department of Medical Physics and Bioengineering, Royal United Hospital, Combe Park, Bath, UK.

The aim of this book is to spread and make easier the use of comprehensive modelling for research, educational and clinical applications. Flexible and modular numerical, physical and hybrid models developed to assess patho-physiology of cardiovascular and respiratory systems are the subject of the book. The models discussed in the book are effective and easy to use tools to simulate circulatory and respiratory systems, their interactions and their mechanical support. The models can be applied to analyse data, predict the trend of selected variables not routinely measured and to identify critical variables to be monitored. Spreading of comprehensive modelling can offer to physicians and engineers powerful tools to analyse complex phenomena and interactions involving circulatory and respiratory systems along with their mechanical assistance. The complexity of the circulatory and respiratory systems makes their analysis very difficult or sometimes impossible in clinical environment.

Development of a Coupled Model of the Cardiorespiratory and Thermoregulatory Systems
12th Chaotic Modeling and Simulation International Conference
Behavioral, Chemical, Environmental, and Genetic Factors
Modeling Respiratory Gas Dynamics in the Aviator's Breathing System. Volume 2. Appendices
Respiratory-Circulatory Interactions in Health and Disease

The volumes in this authoritative series present a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanisms. Therefore, investigation of flows of blood and air in physiological conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning. The present volume is devoted to cellular events that allow adaptation to environmental conditions, particularly mechanotransduction. It begins with cell organization and a survey of cell types in the vasculature and respiratory tract. It then addresses cell structure and functions, especially in interactions with adjoining cells and matrix.

The volumes in this authoritative series present a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to phenomenological models of nano- and microscopic events in a corrector scheme of regulated mechanisms when the vessel lumen caliber varies markedly. Therefore, investigation of flows of blood and air in physiological conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning. Volume 4 is devoted to major sets of intracellular mediators that transmit signals upon stimulation of cell-surface

receptors. Activation of signaling effectors triggers the release of substances stored in cellular organelles and/or gene transcription and protein synthesis. Complex stages of cell signaling can be studied using proper mathematical models, once the role of each component is carefully handled. Volume 4 also reviews various categories of cytosolic and/or nuclear mediators and illustrates some major signal transduction pathways, such as NFkappaB axis, oxygen sensing, and mechanotransduction.

This book provides a comprehensive overview of mechanical circulatory support of the failing heart in adults and children. The book uniquely combines engineering knowledge and the clinician's perspective into a single resource, while also providing insights into current and future development of mechanical circulatory support technology, such as ventricular assist devices, the total artificial heart and catheter-based technologies for heart failure. Topics featured in this book include: The history of mechanical circulatory device development. Fundamentals of hemodynamics support. Clinical management of mechanical circulatory devices. Surgical implantation techniques. Current limitations of device therapies in advanced heart failure. Advanced and novel devices in the development pipeline. Opportunities for advancement in the field. Mechanical Support for Heart Failure: Current Solutions and New Technologies is a must-have resource for not only physicians, residents, fellows, and medical students in cardiology and cardiac surgery, but also clinical and basic researchers in biomedical engineering with an interest in mechanical circulatory support, heart failure, and new technological applications in medicine.

This book (vol. 1) presents the proceedings of the IUPESM World Congress on Biomedical Engineering and Medical Physics, a triennially organized joint meeting of medical physicists, biomedical engineers and adjoining health care professionals. Besides the purely scientific and technological topics, the 2018 Congress will also focus on other aspects of professional involvement in health care, such as education and training, accreditation and certification, health technology assessment and patient safety. The IUPESM meeting is an important forum for medical physicists and biomedical engineers in medicine and healthcare learn and share knowledge, and discuss the latest research outcomes and technological advancements as well as new ideas in both medical physics and biomedical engineering field.

Comprehensive Models of Cardiovascular and Respiratory Systems
Model of the Cardiovascular and Respiratory System for Rate Responsive Pacemaker Controller Design
June 3-8, 2018, Prague, Czech Republic (Vol.1)
Applications to the Cardiovascular and Respiratory Systems
Cardiovascular and Respiratory Systems Modeling, Analysis, and Control

This unique book offers a comprehensive and integrated introduction to the five fundamental elements of life and society: energy, information, feedback, adaptation, and self-organization. It is divided into two parts. Part I is concerned with energy (definition, history, energy types, energy sources, environmental impact); thermodynamics (laws, entropy definitions, energy, branches of thermodynamics, entropy interpretations, arrow of time); information (communication and transmission, modulation–demodulation, coding–decoding, information theory, information technology, information science, information systems); feedback control (history, classical methodologies, modern methodologies); adaptation (definition, mechanisms, measurement, complex adaptive systems, complexity, emergence); and self-organization (definitions/opinions, self-organized criticality, cybernetics, self-organization in complex adaptive systems, examples in nature). In turn, Part II studies the roles, impacts, and applications of the five above-mentioned elements in life and society, namely energy (biochemical energy pathways, energy flows through food chains, evolution of energy resources, energy and economy); information (information in biology, biocomputation, information technology in office automation, power generation/distribution, manufacturing, business, transportation), feedback (temperature, water, sugar and hydrogen ion regulation, autocatalysis, biological modeling, control of hard/technological and soft/managerial systems), adaptation and self-organization (ecosystems, climate change, stock market, knowledge management, man-made self-organized controllers, traffic lights control).

Eleven chapters, written by experts in their respective fields, on topics ranging from control of the Navier-Stokes equations to nondestructive evaluation - all of which are modeled by distributed parameter systems.

This Monograph provides an update on cardiovascular disease complications and treatment implications for respiratory diseases, based on current scientific evidence and considered from an epidemiological, pathophysiological and clinical point of view. This book also discusses the future challenges when studying the complex relationship between these two groups of disorders.

Cardiovascular and Respiratory Bioengineering focuses on computational tools and modeling techniques in cardiovascular and respiratory systems that help develop bioengineered solutions. The book demonstrates how these technologies can be utilized in order to tackle diseases and medical issues. It provides practical guidance on how a bioengineering or medical problem can be modeled, along with which computational models can be used. Topics include computer modeling of Purkinje fibers with different electrical potential applied, modeling of cardiomyopathies caused by sarcomeric gene mutations, altered sarcomere function, perturbations in intracellular ion homeostasis, impaired myocardial energetics at reduced costs, and more. The book also discusses blood flow through deformable blood vessels in human aorta, abdominal aortic aneurysm, carotid artery, coronary artery and plaque formation, along with content on stent deployment modeling and stent design and optimization techniques. Features practical applications of cardiovascular and respiratory technology to counteract diseases Includes detailed steps for the modeling of cardiovascular and respiratory systems Explores a range of different modeling methods, including computational modeling, predictive modeling and multi-scale modeling Covers biological processes and biomechanics relevant to cardiovascular and respiratory

bioengineering
Mathematical Modeling and Validation in Physiology
Tissue Functioning and Remodeling in the Circulatory and Ventilatory Systems
Anatomy and Physiology of the Circulatory and Ventilatory Systems
Modeling, Analysis, and Control
Modeling the human cardiovascular respiratory control system with two state delays : an application to congestive heart failure

The volumes in this authoritative series present a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to and remove carbon dioxide from the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanisms when the vessel lumen caliber varies markedly. Therefore, investigation of flows of blood and air in physiological conduits requires an understanding of the biology, chemistry, and physics of these systems together with the mathematical tools to describe their functioning. Volume 3 is devoted to the set of mediators of the cell surface, especially ion and molecular carriers and catalytic receptors that, once liganded and activated, initiate signal transduction pathways. Intracellular cascades of chemical reactions trigger the release of substances stored in cellular organelles and/or gene transcription and protein synthesis. Primary mediators are included in models of regulated cellular processes, but multiple secondary signaling components are discarded to allow simple, representative modeling and to manage their inverse problems.

Together, the volumes in this series present all of the data needed at various length scales for a multidisciplinary approach to modeling and simulation of flows in the cardiovascular and ventilatory systems, especially multiscale modeling and coupled simulations. The cardiovascular and respiratory systems are tightly coupled, as their primary function is to supply oxygen to, and remove carbon dioxide from, the body's cells. Because physiological conduits have deformable and reactive walls, macroscopic flow behavior and prediction must be coupled to nano- and microscopic events in a corrector scheme of regulated mechanism. Therefore, investigation of flows of blood and air in physiological conduits requires an understanding of the biology, chemistry, and physics of these systems, together with the mathematical tools to describe their

functioning in quantitative terms. The present volume focuses on macroscopic aspects of the cardiovascular and respiratory systems in normal conditions, i.e., anatomy and physiology, as well as the acquisition and processing of medical images and physiological signals.
Cardiovascular and Respiratory Systems: Modeling, Analysis, and Control uses a principle-based modeling approach and analysis of feedback control regulation to elucidate the physiological relationships. Models are arranged around specific questions or conditions, such as exercise or sleep transition, and are generally based on physiological mechanisms rather than on formal descriptions of input-output behavior. The authors ask open questions relevant to medical and clinical applications and clarify underlying themes of physiological control organization. Current problems, key issues, developing trends, and unresolved questions are highlighted. Researchers and graduate students in mathematical biology and biomedical engineering will find this book useful. It will also appeal to researchers in the physiological and life sciences who are interested in mathematical modeling.
Complex Systems in Biomedicine
Signaling at the Cell Surface in the Circulatory and Ventilatory Systems

A Study of the Human Cardiovascular-respiratory System Using Hybrid Computer Modeling
Regulation of Tissue Oxygenation, Second Edition