

THE MATHEMATICAL MODELING OF METABOLIC AND ENDOCRINE SYSTEMS

**Model Formulation,
Identification, and
Validation**

**Ewart R. Carson,
Claudio Cobelli,
Ludwik Finkelstein**

**A Volume in the Wiley-Interscience Series on Biomedical
Engineering and Health Science Systems**

Mathematical Modeling Of Metabolic And Endocrine Systems

Andrew J. Clifford, Hans-Georg Müller



Mathematical Modeling Of Metabolic And Endocrine Systems:

The Mathematical Modeling of Metabolic and Endocrine Systems Ewart R. Carson, **The Mathematical Modeling of Metabolic and Endocrine Systems** Ewart R. Carson, Claudio Cobelli, Ludwik Finkelstein, 1983-02-25 Introduces the concepts methods and techniques of model formulation identification and validation as applicable to metabolic and endocrine processes Shows how modeling can be used to provide a concise description of complex dynamic processes to test hypotheses concerning physiological and biochemical structure and to estimate physiological quantities parameters that otherwise would not be directly accessible to measurement Includes numerous examples and case studies *Mathematical Modeling in Experimental Nutrition* Andrew J. Clifford, Hans-Georg Müller, 2013-11-21 Nutrients have been recognized as essential for maximum growth successful reproduction and infection prevention since the 1940s since that time the lion s share of nutrient research has focused on defining their role in these processes Around 1990 however a major shift began in the way that researchers viewed some nutrients particularly the vitamins This shift was motivated by the discovery that modest declines in vitamin nutritional status are associated with an increased risk of ill health and disease such as neural tube defects heart disease and cancer especially in those populations or individuals who are genetically predisposed In an effort to expand upon this new understanding of nutrient action nutritionists are increasingly turning their focus to the mathematical modeling of nutrient kinetic data The availability of suitably tagged isotope nutrients such as B carotene vitamin A folate among others sensitive analytical methods to trace them in humans mass spectrometry and accelerator mass spectrometry and powerful software capable of solving and manipulating differential equations efficiently and accurately has allowed researchers to construct mathematical models aimed at characterizing the dynamic and kinetic behavior of key nutrients in vivo in humans at an unparalleled level of detail **Dynamic Systems Biology Modeling and Simulation** Joseph DiStefano III, 2015-01-10 *Dynamic Systems Biology Modeling and Simulation* consolidates and unifies classical and contemporary multiscale methodologies for mathematical modeling and computer simulation of dynamic biological systems from molecular cellular organ system on up to population levels The book pedagogy is developed as a well annotated systematic tutorial with clearly spelled out and unified nomenclature derived from the author s own modeling efforts publications and teaching over half a century Ambiguities in some concepts and tools are clarified and others are rendered more accessible and practical The latter include novel qualitative theory and methodologies for recognizing dynamical signatures in data using structural multicompartmental and network models and graph theory and analyzing structural and measurement data models for quantification feasibility The level is basic to intermediate with much emphasis on biomodeling from real biodata for use in real applications Introductory coverage of core mathematical concepts such as linear and nonlinear differential and difference equations Laplace transforms linear algebra probability statistics and stochastics topics The pertinent biology biochemistry biophysics or pharmacology for modeling are provided to support understanding the

amalgam of math modeling with life sciences Strong emphasis on quantifying as well as building and analyzing biomodels includes methodology and computational tools for parameter identifiability and sensitivity analysis parameter estimation from real data model distinguishability and simplification and practical bioexperiment design and optimization Companion website provides solutions and program code for examples and exercises using Matlab Simulink VisSim SimBiology SAAMII AMIGO Copasi and SBML coded models A full set of PowerPoint slides are available from the author for teaching from his textbook He uses them to teach a 10 week quarter upper division course at UCLA which meets twice a week so there are 20 lectures They can easily be augmented or stretched for a 15 week semester course Importantly the slides are editable so they can be readily adapted to a lecturer's personal style and course content needs The lectures are based on excerpts from 12 of the first 13 chapters of DSBMS They are designed to highlight the key course material as a study guide and structure for students following the full text content The complete PowerPoint slide package 25 MB can be obtained by instructors or prospective instructors by emailing the author directly at joed.cs@ucla.edu

Modelling Methodology for Physiology and Medicine Ewart Carson, Claudio Cobelli, 2000-12-31 *Modelling Methodology for Physiology and Medicine* offers a unique approach and an unprecedented range of coverage of the state of the art advanced modelling methodology that is widely applicable to physiology and medicine The book opens with a clear and integrated treatment of advanced methodology for developing mathematical models of physiology and medical systems Readers are then shown how to apply this methodology beneficially to real world problems in physiology and medicine such as circulation and respiration Builds upon and enhances the readers existing knowledge of modelling methodology and practice Editors are internationally renowned leaders in their respective fields

Biomedical Engineering Handbook 2 Joseph D. Bronzino, 2000-02-15 Modeling Ruminant Digestion and Metabolism R.L. Baldwin, 1995-05-31 Role of ruminants in human food production Why an animal scientist would choose to model animal systems Basic organization of this book Modeling principles and terminology Classification of models Objectives in modeling The modeling process I objective statements block diagrams equation forms and parameterization Steps in modeling Setting the modeling objective Block diagrams Formulation of mathematical statements Development of numerical inputs The modeling process II solution algorithms model evaluations and parameter estimation Model solution algorithms Evaluation of management and research models Evaluation and use of analytical models for parameter estimation Decision support software Animal energetic models Thermodynamic concepts in nutrition Historical development of bases for feeding system models Energy requirements for maintenance and production Equations used to estimate maintenance and costs of production Components of maintenance Protein and amino acid models Current protein and amino acid systems Analytic models of amino acid and protein metabolism Dynamic modeling Biology and algebraic models of ruminant digestion The rumen microbes and their metabolism Balance models of ruminant digestion An analytical model of rumen digestion Microbial growth elements Biology and algebraic models of growth Classical equations for growth

Nutritional models of growth Concepts of the basic biology of growth used in mechanistic models Biology of lactation Decent evolution of feeding systems for lactating dairy cattle An analytical model of nutrient transactions during lactation Dynamic models of ruminant digestion Early dynamic models Current dynamic models Dynamic models of ruminant adipose tissue metabolism Evolution of steady state balance model Radioisotope tracer elements Dynamic models of ruminant mammary metabolism Development of model inputs and initial parameters Descriptions of a model of mammary gland metabolism Dynamic models of liver and viscera metabolism Overall structure and notation Mechanistic dynamic models of growth Beef growth models Sheep growth and metabolism model Lactation Background on MOLL Y CSL The program MOLL Y CSL Evaluation and use of a growth and lactation model Behavioral analyses Sensitivity analyses Bioeconomic analysis

Pathophysiology of Plasma Protein Metabolism Giulian Mariani, 2012-12-06 This book represents a factual account of the proceedings of an international symposium on the pathophysiology of plasma protein metabolism which was organised in October 1982 by the Plasma Protein and Immunology Division of the C N R Institute of Clinical Physiology at the University of Pisa Italy Several of the contributors are former members of the International Study Group on Plasma Protein Metabolism the last meeting of which was held in Turin Italy in 1974 under the auspices of the scientific organisation of the same institute The symposium took the form of a series of lectures with the main objective of providing a positive contribution to the state of the art of several topics related to the kinetic and pathophysiological factors regulating the synthesis distribution and degradation of plasma proteins The first four chapters form a group each one considering a special aspect of the kinetics of turnover and distribution of plasma proteins in general particular attention is paid to the recent advances in the field of kinetic modelling the choice of the best models and the optimisation of the experimental designs The next seven chapters consider the regulation of synthesis distribution and catabolism of various classes of plasma proteins including albumin immunoglobulins complement fractions and acute phase proteins The remaining chapters deal with metabolic studies of various plasma proteins including tumour markers coagulation proteins and lipoproteins in different disease states such as malignancies coagulative disorders malnutrition and the extensive group of atherosclerotic cardiovascular diseases *The Future of Predictive Safety Evaluation* D.V. Parke, J. Marks, 2012-12-06 A N WORDEN D V PARKE AND J MARKS THE BACKGROUND There is nothing new about the fact that chemical substances derived either from natural products or by synthetic means can give rise to toxicity in animals and human beings and that they must be subjected to controls The earliest writings speak of such toxicity and from the times of ancient Egypt and in the Old Testament controls have existed 1 In the Middle Ages Paracelsus 1493 1541 noted that All things are poisons for there is nothing without poisonous qualities It is only the dose which makes a thing a poison and hence he stressed the importance of dose relative to toxic reactions 2 Most of the early controls concentrated on substances that were to be deliberately administered to the human subject in the form of medicines Legislation for many centuries was mainly concerned with regulating the activities of apothecaries and

physicians The Royal College of Physicians for example was originally established to control the activities of physicians within London Among the controls which it exerted was that over the use of medicinal substances Such controls were however poor based as they were on hearsay evidence of toxicity For many centuries no means existed for the accurate determination of toxicity

Introduction to Modeling in Physiology and Medicine Claudio Cobelli, Ewart Carson, 2019-08-01 Introduction to Modeling in Physiology and Medicine Second Edition develops a clear understanding of the fundamental principles of good modeling methodology Sections show how to create valid mathematical models that are fit for a range of purposes These models are supported by detailed explanation extensive case studies examples and applications This updated edition includes clearer guidance on the mathematical prerequisites needed to achieve the maximum benefit from the material a greater detail regarding basic approaches to modeling and discussions on non linear and stochastic modeling The range of case study material has been substantially extended with examples drawn from recent research experience Key examples include a cellular model of insulin secretion and its extension to the whole body level a model of insulin action during a meal oral glucose tolerance test a large scale simulation model of type 1 diabetes and its use in in silico clinical trials and drug trials Covers the underlying principles of good quantitative modeling methodology with applied biomedical engineering and bioscience examples to ensure relevance to students current research and clinical practice Includes modeling data modeling systems linear and non linear systems model identification parametric and non parametric models and model validation Presents clear step by step working plus examples and extensive case studies that relate concepts to real world applications Provides end of chapter exercises and assignments to reinforce learning

Endogenous and Exogenous Regulation and Control of Physiological Systems Robert B. Northrop, 2020-11-26 From a biomedical engineering perspective this book takes an analytic quantitative approach to describing the basic components of physiological regulators and control systems PRCs In Endogenous and Exogenous Regulation and Control of Physiological Systems the author provides grounding in the classical methods of designing linear and nonlinear systems He also offers state of the art material on the potential of PRCs to treat immune system ailments most notably AIDS and cancer The book focuses on certain wet physiological regulators such as those using endocrine hormones as parametric control substances Endogenous and Exogenous Regulation and Control of Physiological Systems includes simulations that illustrate model validations and the putative control of cancer and HIV proliferation It explores novel untried immunotherapies on the cutting edge of PRC treatment and explores the latest technologies

Recent Advances in Information Technology Waldemar Wójcik, Jan Sikora, 2017-10-24 Information Technology is applicable in all areas of life As a result computer science is essential to imagine the modern world Recent advances in information technology represents only a small part of today's computing applications which were the subject of international cooperation between Kazakh Ukrainian and Polish scientists A wide range of issues and topics is addressed from game theory to advanced control issues Application of new

computational models and their security problems The integro differential game approach Application of information technology for automated translation from inflected languages to sign language Mathematical problems of complex systems investigation under uncertainties Recent advances in information technology is of interest to academics and engineers and to professionals involved in information technology and its applications Identification and System Parameter Estimation

,1979 **Computational Models of Risks to Infrastructure** D. Skanata,D.M. Byrd,2007-08-08 Deals with programs of infrastructure risk This title focuses on following issues such as the state of the art and practice gaps between the arts and practices ways to bridge the gaps and future research directions *Biomedical Engineering Fundamentals* Joseph D. Bronzino,Donald R. Peterson,2006-04-14 Over the last century medicine has come out of theblack bag and emerged as one of the most dynamic and advanced fields of development in science and technology Today biomedical engineering plays a critical role in patient diagnosis care and rehabilitation As such the field encompasses a wide range of disciplines from biology and physiolog *Nonlinear Dynamic Modeling of Physiological Systems* Professor Vasilis Z. Marmarelis,2004-09-03 The study of nonlinearities in physiology has been hindered by the lack of effective ways to obtain nonlinear dynamic models from stimulus response data in a practical context A considerable body of knowledge has accumulated over the last thirty years in this area of research This book summarizes that progress and details the most recent methodologies that offer practical solutions to this daunting problem Implementation and application are discussed and examples are provided using both synthetic and actual experimental data This essential study of nonlinearities in physiology apprises researchers and students of the latest findings and techniques in the field **Positron Emission Tomography** Dale L. Bailey,David W. Townsend,Peter E. Valk,Michael N. Maisey,2006-07-06 Essential for students science and medical graduates who want to understand the basic science of Positron Emission Tomography PET this book describes the physics chemistry technology and overview of the clinical uses behind the science of PET and the imaging techniques it uses In recent years PET has moved from high end research imaging tool used by the highly specialized to an essential component of clinical evaluation in the clinic especially in cancer management Previously being the realm of scientists this book explains PET instrumentation radiochemistry PET data acquisition and image formation integration of structural and functional images radiation dosimetry and protection and applications in dedicated areas such as drug development oncology and gene expression imaging The technologist the science engineering or chemistry graduate seeking further detailed information about PET or the medical advanced trainee wishing to gain insight into the basic science of PET will find this book invaluable This book is primarily repackaged content from the Basic Science section of the big Valk book on PET It contains new completely revised and unchanged chapters covering the basic sciences section of the main book total 18 chapters 2 new chapters 1 16 8 completely revised chapters 4 5 8 13 14 15 17 18 3 minor corrections chapters 2 6 11 5 unchanged chapters 3 7 9 10 12

Mathematics in Biology and Medicine Vincenzo Capasso,Enea Grosso,Stefano L. Paveri-Fontana,2013-03-13

Modelling in Medicine and Biology VI Mauro Ursino, 2005 Featuring contributions from the Sixth International Conference on Modelling in Medicine and Biology this volume covers a broad spectrum of topics including the application of computers to simulate biomedical phenomena It will be of interest both to medical and physical scientists and engineers and to professionals working in medical enterprises actively involved in this field Areas highlighted include Simulation of Physiological Processes Computational Fluid Dynamics in Biomedicine Orthopaedics and Bone Mechanics Simulations in Surgery Design and Simulation of Artificial Organs Computers and Expert Systems in Medicine Advanced Technology in Dentistry Gait and Motion Analysis Cardiovascular System Virtual Reality in Medicine Biomechanics and Neural Systems

Molecular, Cellular, and Tissue Engineering Joseph D. Bronzino, Donald R. Peterson, 2018-10-08 Known as the bible of biomedical engineering The Biomedical Engineering Handbook Fourth Edition sets the standard against which all other references of this nature are measured As such it has served as a major resource for both skilled professionals and novices to biomedical engineering Molecular Cellular and Tissue Engineering the fourth volume of the handbook presents material from respected scientists with diverse backgrounds in molecular biology transport phenomena physiological modeling tissue engineering stem cells drug delivery systems artificial organs and personalized medicine More than three dozen specific topics are examined including DNA vaccines biomimetic systems cardiovascular dynamics biomaterial scaffolds cell mechanobiology synthetic biomaterials pluripotent stem cells hematopoietic stem cells mesenchymal stem cells nanobiomaterials for tissue engineering biomedical imaging of engineered tissues gene therapy noninvasive targeted protein and peptide drug delivery cardiac valve prostheses blood substitutes artificial skin molecular diagnostics in personalized medicine and bioethics

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