

# <u>Mathematical Modelling Of Immune Response In</u> <u>Infectious Diseases</u>

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#### **Mathematical Modelling Of Immune Response In Infectious Diseases:**

Mathematical Modelling of Immune Response in Infectious Diseases Guri I. Marchuk, 2013-04-17 Beginning his work on the monograph to be published in English this author tried to present more or less general notions of the possibilities of mathematics in the new and rapidly developing science of infectious immunology describing the processes of an organism's defence against antigen invasions. The results presented in this monograph are based on the construction and application of closed models of immune response to infections which makes it possible to approach problems of optimizing the treat ment of chronic and hypertoxic forms of diseases The author being a mathematician had creative long Iasting con tacts with immunologists geneticist biologists and clinicians As far back as 1976 it resulted in the organization of a special seminar in the Computing Center of Siberian Branch of the USSR Academy of Sci ences on mathematical models in immunology The seminar attracted the attention of a wide circle of leading specialists in various fields of science All these made it possible to approach from a more or less united stand point the construction of models of immune response the mathematical description of the models and interpretation of results Mathematical Modeling of the Immune System in Homeostasis, Infection and Disease Gennady Bocharov, Burkhard Ludewig, Andreas Meyerhans, Vitaly Volpert, 2020-02-24 The immune system provides the host organism with defense mechanisms against invading pathogens and tumor development and it plays an active role in tissue and organ regeneration Deviations from the normal physiological functioning of the immune system can lead to the development of diseases with various pathologies including autoimmune diseases and cancer Modern research in immunology is characterized by an unprecedented level of detail that has progressed towards viewing the immune system as numerous components that function together as a whole network Currently we are facing significant difficulties in analyzing the data being generated from high throughput technologies for understanding immune system dynamics and functions a problem known as the curse of dimensionality As the mainstream research in mathematical immunology is based on low resolution models a fundamental question is how complex the mathematical models should be To respond to this challenging issue we advocate a hypothesis driven approach to formulate and apply available mathematical modelling technologies for understanding the complexity of the immune system Moreover pure empirical analyses of immune system behavior and the system's response to external perturbations can only produce a static description of the individual components of the immune system and the interactions between them Shifting our view of the immune system from a static schematic perception to a dynamic multi level system is a daunting task It requires the development of appropriate mathematical methodologies for the holistic and quantitative analysis of multi level molecular and cellular networks Their coordinated behavior is dynamically controlled via distributed feedback and feedforward mechanisms which altogether orchestrate immune system functions The molecular regulatory loops inherent to the immune system that mediate cellular behaviors e g exhaustion suppression activation and tuning can be analyzed using mathematical categories such as multi

stability switches ultra sensitivity distributed system graph dynamics or hierarchical control GB is supported by the Russian Science Foundation grant 18 11 00171 AM is also supported by grants from the Spanish Ministry of Economy Industry and Competitiveness and FEDER grant no SAF2016 75505 R the Mar a de Maeztu Programme for Units of Excellence in R D Mathematical Immunology of Virus Infections MDM 2014 0370 and the Russian Science Foundation grant 18 11 00171 Gennady Bocharov, Vitaly Volpert, Burkhard Ludewig, Andreas Meyerhans, 2018-06-12 This monograph concisely but thoroughly introduces the reader to the field of mathematical immunology The book covers first basic principles of formulating a mathematical model and an outline on data driven parameter estimation and model selection The authors then introduce the modeling of experimental and human infections and provide the reader with helpful exercises The target audience primarily comprises researchers and graduate students in the field of mathematical biology who wish to be **Mathematical Modelling and Analysis of Infectious Diseases** concisely introduced into mathematical immunology Khalid Hattaf, Hemen Dutta, 2020-07-30 This book discusses significant research and study topics related to mathematical modelling and analysis of infectious diseases It includes several models and modelling approaches with different aims such as identifying and analysing causes of occurrence and re occurrence causes of spreading treatments and control strategies A valuable resource for researchers students educators scientists professionals and practitioners interested in gaining insights into various aspects of infectious diseases using mathematical modelling and mathematical analysis the book will also appeal to general readers wanting to understand the dynamics of various diseases and related issues Key Features Mathematical models that describe population prevalence or incidence of infectious diseases Mathematical tools and techniques to analyse data on the incidence of infectious diseases Early detection and risk estimate models of infectious diseases Mathematical models that describe the transmission of infectious diseases and analyse data Dynamical analysis and control strategies for infectious diseases Studies comparing the utility of particular models in describing infected diseases related issues such as Virus Dynamics : Mathematical Principles of Immunology and Virology Martin social health and economic Nowak, Robert M. May, 2000-11-23 This groundbreaking book describes the emerging field of theoretical immunology in particular the use of mathematical models to describe the spread of infectious diseases within patients It reveals fascinating insights into the dynamics of viral and other infections and the interactions between infectious agents and immune responses Structured around the examples of HIV AIDS and hepatitis B Nowak and May show how mathematical models can help researchers to understand the detailed dynamics of infection and the effects of antiviral therapy Models are developed to describe the dynamics of drug resistance immune responses viral evolution and mutation and to optimise the design of therapy and vaccines We know down to the tiniest details the molecular structure of the human immunodeficiency virus HIV Yet despite this tremendous accomplishment and despite other remarkable advances in our understanding of individual viruses and cells of the immune system we still have no agreed understanding of the ultimate course and variability of the

pathogenesis of AIDS Gaps in our understanding like these impede our efforts towards developing effective therapies and preventive vaccines Martin Nowak and Robert M May describe the emerging field of theoretical immunology in this accessible and well written text Using mathematical modelling techniques the authors set out their ideas about how populations of viruses and populations of immune system cells may interact in various circumstances and how infectious diseases spread within patients They explain how this approach to understanding infectious diseases can reveal insights into the dynamics of viral and other infections and the interactions between infectious agents and immune responses The book is structured around the examples of HIV AIDS and Hepatitis B virus although the approaches described will be more widely applicable The authors use mathematical tools to uncover the detailed dynamics of the infection and the effects of antiviral therapy Models are developed to describe the emergence of drug resistance and the dynamics of immune responses viral evolution and mutation The practical implications of this work for optimisation of the design of therapy and vaccines are discussed The book concludes with a glance towards the future of this fascinating and potentially highly useful field of study an excellent introduction to a field that has the potential to advance substantially our understanding of the complex interplay Mathematical Models in Immunology Gurii Ivanovich Marchuk, 1983 between virus and host Nature and Control of Infectious Diseases in the Host Esteban A. Hernandez-Vargas, 2019-02-19 Modeling and Control of Infectious Diseases in the Host With MATLAB and R provides a holistic understanding of health and disease by presenting topics on quantitative decision making that influence the development of drugs The book presents modeling advances in different viral infections dissecting detailed contributions of key players along with their respective interactions By combining tailored in vivo experiments and mathematical modeling approaches the book clarifies the relative contributions of different underlying mechanisms within hosts of the most lethal viral infections including HIV influenza and Ebola Illustrative examples for Handbook on Immunosenescence parameter fitting modeling and control applications are explained using MATLAB and R Tamas Fulop, Claudio Franceschi, Katsuiki Hirokawa, Graham Pawelec, 2009-02-27 Immunosenescence is an imprecise term used to describe deleterious age associated changes to immune parameters observed in all mammals studied so far It represents a rapidly progressing science in the aging field with a vertiginous volume of new data knowledge and concepts concerning these changes We are poised to be in a position to translate these accumulated data into the clinical setting via better understanding of the contribution of immunosenescence to age associated pathologies and their prevention by appropriate interventions This authoritative handbook seeks to encompass the current state of our knowledge on the multitude of those changes to immunity related to aging with contributions from experts in the research and clinical areas This book therefore considers methods and models for studying immunosenescence cellular immunosenescence of T cells B cells neutrophils antigen presenting cells NK NKT and stem cells genetics mechanisms including receptors and signal transduction mitochondria proteasome cytokines neuro endocrine immune networks inflammation thymus clinical relevance

in disease states including infections autoimmunity cancer metabolic syndrome neurodegenerative diseases frailty and osteoporosis modulation by nutrition lipids vaccination and the question can interventions to influence immunosenescence be realistically proposed based on our current state of knowledge **Environmental Radiation Effects on Mammals** Olga A. Smirnova, 2016-10-14 Dr Smirnova's updated text is devoted to the theoretical studies of radiation effects on mammals It summarizes 35 years of results the author obtained from analyzing dose rate equivalents for the Galactic Cosmic Rays GCR and for Solar Particles Events SPE This edition also includes two new chapters on skin epidermal epithelium and risk assessment for myeloid leukemia as well as extended revisions addressing the radiation effects on the blood forming system Mathematical models are used to explain the effects of both acute and chronic irradiation on the dynamics of vital body systems like the hematopoietic system the development of autoimmune diseases and the mortality dynamics in homogeneous and nonhomogeneous mammalian populations The proposed methodology of these studies the models themselves and the obtained results are of a great theoretical significance and can find wide practical use Functional Differential Equations and Applications Alexander Domoshnitsky, Alexander Rasin, Seshadev Padhi, 2022-02-02 This book discusses delay and integro differential equations from the point of view of the theory of functional differential equations. This book is a collection of selected papers presented at the international conference of Functional Differential Equations and Applications FDEA 2019 7th in the series held at Ariel University Israel from August 22 27 2019 Topics covered in the book include classical properties of functional differential equations as oscillation non oscillation representation of solutions sign properties of Green's matrices comparison of solutions stability control analysis of boundary value problems and applications. The primary audience for this book includes specialists on ordinary partial and functional differential equations engineers and doctors dealing with modeling and researchers in areas of mathematics and engineering

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