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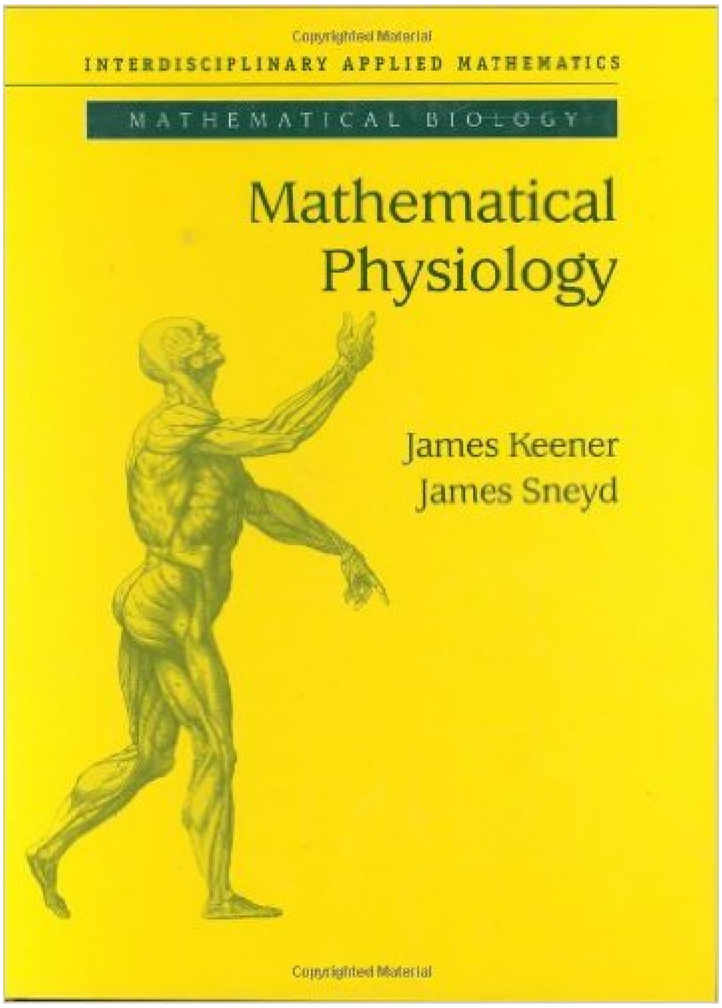
Mathematical Physiology (Interdisciplinary Applied Mathematics)



Synopsis

Mathematical Physiology provides an introduction into physiology using the tools and perspectives of mathematical modeling and analysis. It describes ways in which mathematical theory may be used to give insights into physiological questions and how physiological questions can in turn lead to new mathematical problems.The book is divided in two parts, the first dealing with the fundamental principles of cell physiology, and the second with the physiology of systems. In the first part, after an introduction to basic biochemistry and enzyme reactions, the authors discuss volume control, the membrane potential, ionic flow through channels, excitability, calcium dynamics, and electrical bursting. This first part concludes with spatial aspects such as synaptic transmission, gap junctions, the linear cable equation, nonlinear wave propagation in neurons, and calcium waves. In the second part, the human body is studied piece by piece, beginning with an introduction to electrocardiology, followed by the physiology of the circulatory system, blood muscle, hormones, and kindeys. Finally, the authors examine the digestive system and the visual system, ending with the inner ear. This book will be of interest to researchers, to graduate students and advanced undergraduate students in applied mathematics who wish to learn how to build and analyze mathematical models and become familiar with new areas of applications, as well as to physiologists interested in learning about theoretical approaches to their work. Mathematical Reviews, 2000: "This is neither a physiology book nor a mathematics book, but it is probably the best book ever written on the interdisciplinary field of mathematical physiology, i.e. mathematics applied to modelling physiological phenomena. The book is highly recommended to anybody interested in mathematical or theoretical physiology."

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Customer Reviews

This book is an excellent overview of the major research into the mathematics of physiological processes. The first part of the book covers cellular physiology beginning with a discussion of biochemical reactions in the first chapter. Some of the applications of dynamical systems are nicely illustrated here, especially bifurcation theory. Applications of the diffusion equation follow in the next chapter on cellular homeostasis. The Nernst-Planck electrodiffusion equation is discussed but not derived, and is solved in the constant field approximation. This is complicated somewthat in the next chapter on membrane ion channels, where the potential across the membrane is not assumed to have a constant gradient. There is a discussion of channel blocking drugs in the last section, but unfortunately it is too short. This is an important area of application, with the experimental validation of the mathematical results of upmost importance. The Hodgkin-Huxley and the FitzHugh-Nagumo equations dominate the next chapter on electrical signaling in cells. The phase space analysis of these models is discussed, along with an interesting treatment of the excitability of cardiac cells in the Appendix of the chapter. A very well-written treatment, along with helpful diagrams, of calcium dynamics is given in Chapter 5. The authors show how ignoring the fast variables and transients lead one to a solution of they dynamical problem of the receptor model. Phase space analysis is used extensively in the next chapter on electrical bursting, with emphasis on bursting in pancreatic beta-cells. An interesting discussion on the classification of bursting oscillations is given purely in terms of bifurcation theory.

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