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Written as a set of tutorial reviews on both experimental facts and theoretical modelling, this volume is intended as an introduction and modern reference in the field for graduate students and researchers in biophysics, biochemistry and applied mathematics.

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"This book presents cutting-edge research in the field of computational and systems biology, presenting studies ranging from the atomic/molecular level to the genomic level and covering a wide spectrum of important biological problems and applications"--Provided by publisher.

Over the last two decades, the recognition that astrocytes - the predominant type of cortical glial cells - could sense neighboring neuronal activity and release neuroactive agents, has been instrumental in the uncovering of many roles that these cells could play in brain processing and the storage of information. These findings initiated a conceptual revolution that leads to rethinking how brain communication works since they imply that information travels and is processed not just in the neuronal circuitry but in an expanded neuron-glial network. On the other hand the physiological need for astrocyte signaling in brain information processing and the modes of action of these cells in computational tasks remain largely undefined. This is due, to a large extent, both to the lack of conclusive experimental evidence, and to a substantial lack of a theoretical framework to address modeling and characterization of the many possible astrocyte functions. This book that we propose aims at filling this gap, providing the first systematic computational approach to the complex, wide subject of neuron-glia interactions. The organization of the book is unique insofar as it considers a selection of “ hot topics ” in glia research that ideally brings together both the novelty of the recent experimental findings in the field and the modelling challenge that they bear. A chapter written by experimentalists, possibly in collaboration with theoreticians, will introduce each topic. The aim of this chapter, that we foresee less technical in its style than in conventional reviews, will be to provide a review as clear as possible, of what is “ established ” and what remains speculative (i.e. the open questions). Each topic will then be presented in its possible different aspects, by 2-3 chapters by theoreticians. These chapters will be edited in order to provide a “ priming ” reference for modeling neuron-glia interactions, suitable both for the graduate student and the professional researcher.

Developmental biologists have been driven to investigate growth factor signaling in embryos in order to understand the regulatory mechanisms underlying a given developmental process. Thus, it is critical to explore the technical methods and experimental designs for growth factor signaling in embryos. Focusing on specific pathways or pathway components, Analysis of Growth Factor Signaling in Embryos provides the methods and guidelines for experimental design to study major aspects of cell signaling in vertebrate embryos. The

book covers a broad range of topics in signaling and a variety of current model organisms. Section I explores specific signaling pathways or pathway components. In this section, some chapters highlight the biochemistry of signaling pathways during development, which is often distinctive from that observed in cell culture systems. Section II discusses ionic regulatory mechanisms and the two chapters in Section III examine ways of investigating gene regulation in response to extracellular signals. Finally, Section IV addresses emerging strategies that facilitate integrated analyses of cell signaling in vivo in embryonic systems. Featuring contributions from expert researchers, Analysis of Growth Factor Signaling in Embryos will provide a foundation for further explorations of the cellular regulatory mechanisms governing vertebrate embryonic development.

Oscillations in cytoplasmic calcium concentration are a crucial control mechanism in almost every cell type. Two important classes of oscillation are of particular interest: solitary and periodic waves. Both types of waves are commonly observed in physical experiments and found in mathematical models of calcium dynamics and other excitable systems. In this thesis, we try to understand these two classes of wave solutions. We first investigate wave solutions of the canonical excitable model, the FitzHugh-Nagumo (FHN) equations. We analyze the FHN equations using geometric singular perturbation theory and numerical integration, and find some new codimension-two organizing centres of the overall dynamics. Many analytical results about the FHN model in its classical form have already been established. We devise a transformation to change the form of the FHN equations we study into the classical form to make use of the results. This enables us to show how basic features of the bifurcation structure of the FHN equations arise from the singular limit. We then study waves of a representative calcium model. We analyze the dynamics of the calcium model in the singular limit, and show how homoclinic and Hopf bifurcations of the full system arise as perturbations of singular homoclinic and Hopf bifurcations. We compare the wave solutions in the FHN model and the calcium model, and show that the dynamics of the two models differ in some respects (most importantly, in the way in which diffusion enters the equations). We conclude that the FHN model should not uniformly be used as a prototypical model for calcium dynamics. Motivated by phenomena seen in the FHN and calcium models, we then investigate reduction techniques for excitable systems, including the quasi-steady state approximation and geometric singular perturbation theory, and show that criticality of Hopf bifurcations may be changed when applying these reduction methods to slow-fast biophysical systems. This suggests that great care should be taken when using reduction techniques such as these, to ensure that spurious conclusions about the dynamics of a model are not drawn from the dynamics of a reduced version of the model. Finally, we describe the class of numerical algorithms used to compute features of the detailed bifurcation sets for the FHN and calcium models, and show how these were used to locate a non-structurally stable heteroclinic connection between periodic orbits in a calcium model; this is the first time such a global bifurcation has been computed.

Volume I of this two-volume, interdisciplinary work is a unified presentation of a broad range of state-of-the-art topics in the rapidly growing field of mathematical modeling in the biological sciences. The chapters are thematically organized into the following main areas: cellular biophysics, regulatory networks, developmental biology, biomedical applications, data analysis and model validation. The work will be an excellent reference text for a broad audience of researchers, practitioners, and advanced students in this rapidly growing field at the intersection of applied mathematics, experimental biology and medicine, computational biology, biochemistry, computer science, and physics.

The experimental and theoretical investigation of nuclei far from the valley of beta-stability is the main subject of modern nuclear structure research. Although the most successful nuclear structure models are purely phenomenological, they nevertheless exploit basic properties of QCD at low energies. This book focuses on the current efforts to bridge the gap between phenomenology and the principles derived from QCD using the extended density functional approach which is based on the successful DFT methods to tackle similarly complex interacting systems in molecular and condensed matter physics. Conceived as a series of pedagogical lectures, this volume addresses researchers in the field as well as postgraduate students and non-specialized scientists from related areas who seek a high-level but accessible introduction to the subject.

The two volumes of this new edition of the Handbook cover the basic biological, medical, physical, and electrical engineering principles. They also include experimental results concerning how electric and magnetic fields affect biological systems—both as potential hazards to health and potential tools for medical treatment and scientific research. They also include material on the relationship between the science and the regulatory processes concerning human exposure to the fields. Like its predecessors, this edition is intended to be useful as a reference book but also for introducing the reader to bioelectromagnetics or some of its aspects. FEATURES • New topics include coverage of electromagnetic effects in the terahertz region, effects on plants, and explicitly applying feedback concepts to the analysis of biological electromagnetic effects • Expanded coverage of electromagnetic brain stimulation, characterization and modeling of epithelial wounds, and recent lab experiments on at all frequencies • Section on background for setting standards and precautionary principle • Discussion of recent epidemiological, laboratory, and theoretical results; including: WHO IARC syntheses of epidemiological results on both high and low frequency fields, IITRI lab study of cancer in mice exposed to cell phone-like radiation, and other RF studies • All chapters updated by internationally acknowledged experts in the field