



Ion Transport through Biological Membranes: An Integrated Theoretical Approach (Lecture Notes in Biomathematics)

M.C. Mackey

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This book illustrates some of the ways physics and mathematics have been, and are being, used to elucidate the underlying mechanisms of passive ion movement through biological membranes in general, and the membranes of excitable cells in particular. I have made no effort to be comprehensive in my introduction of biological material and the reader interested in a brief account of single cell electrophysiology from a physically-oriented biologist's viewpoint will find the chapters by Woodbury (1965) an excellent introduction. Part I is introductory in nature, exploring the basic electrical properties of inexcitable and excitable cell plasma membranes. Cable theory is utilized to illustrate the function of the non-decrementing action potential as a signaling mechanism for the long range transmission of information in the nervous system, and to gain some insight into the gross behaviour of neurons. The detailed analysis of Hodgkin and Huxley on the squid giant axon membrane ionic conductance properties is reviewed briefly, and some facets of membrane behaviour that have been revealed since the appearance of their work are discussed. Part II examines the foundations of electrodiffusion theory, and the use of that theory in trying to develop quantitative explanations of the observed membrane properties of excitable cells, in particular the squid giant axon. In addition, an ad hoc formulation of electrodiffusion theory including active transport is presented to illustrate the qualitative nature of cellular homeostasis with respect to intracellular ionic concentrations and membrane potential, and cellular responses to prolonged stimulation.

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