# THE CHALLENGE OF BIOLOGICAL ORGANIZATION TO MATHEMATICAL DESCRIPTION

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To gain knowledge about the internal organization of living systems is the goal of every research biologist and is especially tantalizing to those who work in my field—the neurophysiology of the brain. It is only comparatively recently that the approach through mathematical models and artificial simulation has been added to the classical scientific methods of analysis and synthesis, of stimulus and response (with the brain in between as a black box).

Much is owed to the influence of such figures as Norbert Wiener with their insistence on similarities between living and nonliving systems in terms of information transmission and control, and it is not mere chance that the evolution of this type of biological research should develop in the age of computers. It is easy to forget that only 15 years ago it was rare for a biologist to have access to a computer, let alone to have thought out his problems in the form of questions that could be put to a computer.

Successful modeling requires a close symbiosis of mathematician and biologist, each with his special knowledge and with a common language that allows them to understand each other exactly. For the biologist the practical test of a model is matching it to some aspect of physiological reality, yet often the material the mathematician is given to work with is not physiological reality at all—but the hypothetical concept of the biologist, a hypothesis that may be erroneous.

There have been, and still continue to be, many intriguing mathematical models proposed for various facets of neuronal mechanisms. Possibly the most widely used model in neurophysiology is the one for the conduction of the nerve impulse which we owe to Hodgkin and Huxley. Their mathematical model was originally published in 1952 [13] and more explicitly stated in 1958 [14].

This is a model which describes the movements of potassium out of, and sodium ions into, the nerve when impulses pass along the fiber in the form of electrical action potentials. These ionic fluxes result from a sequence of changes in permeability of the membrane of the nerve to potassium and sodium ions [15].

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