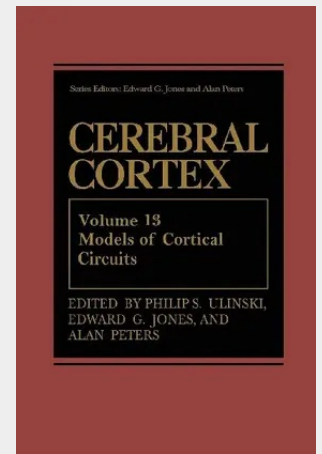


Cerebral Cortex

Models of Cortical Circuits

long-term plasticity and with approaches to learning and memory based on modification of Hebbian synapses are not considered. Relatively abstract attempts to understand higher level and cognitive processes based on neural nets represent a second, major area of work that is not treated. Models of cognitive processes based on dynamical systems methods in which no attempt is made to include the biophysical features of individual neurons are also not considered. vii viii

The ten major chapters fall into three groups. The first group deals with compartmental models of individual cortical neurons. Lyle Borg-Graham provides a PREFACE an introduction to the methods involved in constructing compartmental models and then reviews the existing models of hippocampal pyramidal cells. Because of the effectiveness of hippocampal slice preparations, these neurons have well characterized biophysical properties. This chapter illustrates how compartmental models can be used to synthesize experimental data and provide an integrative view of the properties of individual neurons. Paul Rhodes continues the theme by focusing on the role of voltage-gated channels located on the dendrites of cortical neurons. This is an area in which technological advances in the visualization of neurons in slice preparations based on infrared microscopy have greatly expanded the information available on dendritic function in just a few years. The chapter both reviews the experimental data on active dendritic conductances and emphasizes their potential functional roles. The second group of chapters deal with the generation of receptive field properties of neurons within visual cortex. They address issues stemming from the original attempt to understand how the receptive field properties of neurons in cat and monkey primary visual cortex are generated by interactions between geniculate afferents and cortical neurons. The chapter by Florentin Worgotter evaluates models that have been used to analyze the generation of receptive field properties. Rodney Douglas and his colleagues address a specific set of issues dealing with the role of intracortical excitation mediated by pyramidal cell collaterals. An important feature of this chapter is its relation to attempts to construct fabricated circuits that duplicate the function of cortical circuits. The chapter by Philip Ulinski focuses on the generation of motion-selective properties in cortical neurons. It seeks to identify cellular mechanisms used by neurons that respond preferentially to visual stimuli moving with particular speeds or directions. Matteo Carandini and his colleagues discuss the feature of cortical neurons, known as gain control, that allows neurons to respond effectively to visual stimuli by pooling information across populations of cortical neurons. The chapter by Hugh Wilson deals with the receptive field properties of extrastriate areas and introduces new work analyzing face-selective neurons. The final set of chapters consider models of ensembles of thalamic and cortical neurons. The chapter by William Lytton and Elizabeth Thomas uses the theory of dynamical systems to analyze the temporal relationships between thalamic and cortical neurons. An important feature of the interaction between thalamus and cortex is the presence of oscillations that depend in part upon the voltage-gated conductances present on individual neurons and in part on the structure of the overall network. Paul Bush continues this emphasis on oscillations by discussing a model that deals with the generation of synchronized oscillations in visual cortex. Oscillations of this kind have attracted substantial attention in recent years because of their potential role in cognitive processes. The last chapter, by Michael Hasselmo and Christiane Linster, reviews their work on modeling piriform cortex, emphasizing the role of cholinergic mechanisms in modulating the activity of cortical neurons. An attempt has been made throughout to make the volume accessible to readers with minimal mathematical backgrounds. The volume thus begins with a short history of models of cortical neurons and circuitry that introduce the principal modeling styles. The chapters by Worgotter and Ulinski contain more extensive



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