Evans, J. D.

Analytical solution of the cable equation with synaptic reversal potentials for passive neurons with tip-to-tip dendrodendritic coupling. (English) Zbl 1071.92004

Math. Biosci. 196, No. 2, 125-152 (2005).

Summary: A passive cable model is presented for a pair of electrotonically coupled neurons in order to investigate the effects of tip-to-tip dendrodendritic gap junctions on the interaction between excitation and either pre or postsynaptic inhibition. The model represents each dendritic tree by a tapered equivalent cylinder attached to an isopotential soma. Analytical solutions of the cable equation with synaptic reversal potentials are considered for each neuron to yield a system of Volterra integral equations for the voltage. The solution to the system of linear integral equations (expressed as a Neumann series) is used to determine the current spread within the two coupled neurons, and to re-examine the sensitivity of the soma potentials (in particular) to the coupling resistance for various loci of synaptic inputs. The model is actually posed generally, so that active as well as passive properties could be considered. In the active case, a system of non-linear integral equations is derived for the voltage.

MSC:

92C20 Neural biology
78A70 Biological applications of optics and electromagnetic theory
45D05 Volterra integral equations
45A05 Linear integral equations

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