The possible role of extracellular tissue in biological neural networks

Jiří J. Mareš, Václav Špička, and Pavel Hubík

Institute of Physics, v.v.i., Czech Academy of Sciences, Cukrovarnická 10, 162 00 Praha 6, Czech Republic

As we have recently shown [1], the transfer of action potential via the nervous fibre is ultimately controlled, in contrast to standard theory [2] but in agreement with experiments, by the quantum diffusion of Na^+ and K^+ ions. Accordingly, the diffusion of polarization wave along the axon membrane inevitably excites the response in surrounding extracellular (EC) medium, where equalizing currents are induced. It results in temporal potential distribution in EC tissue biasing the synapses and dendrites of all vicinal neurons. We propose that just this, so called, ephaptic coupling [3,4] between neighbouring neurons, completes the local neural network and is responsible for information processing. Such an idea is obviously incompatible with current models of neural networks of McCulloch-Pitts' [5] and Rosenblatt's [6] type, which assume only the synaptic interactions and are thus convenient merely for artificial networks. In this paper, we are making an attempt to describe mathematically electric interactions within a cluster of neurons imbedded in EC medium with the aim to show, how the information passing through such a system is modified.

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