Biophysical networks underlying electrical phenotype of dopaminergic neurons

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Any type of neurons can be easily identified based on its electrophysiological activity, such as its pattern of spontaneous activity, the shape of its action potential, its dendritic integration, etc. How is stability of such electrical phenotype achieved, what are its molecular principles, and what is the degree of robustness of electrical phenotype in the face of different perturbations are questions only very partially answered. We studied these questions on dopaminergic neurons of the substantia nigra pars compacta. Our work involved characterizing the electrical phenotype of these neurons and measuring its post-natal development and its stability at mature stages. We also characterized the specific relationships of electrophysiological parameters underlying the electrical phenotype. In order to determine how complex electrical phenotype is achieved, we then investigated the networks of co-regulation of ion channels at the genetic and at the protein levels. Our results suggest that ion channel gene expression and protein interactions display a modular structure that may be involved in stabilizing phenotype. We also show that electrical phenotype also presents such a modular structure. Our ultimate goal is to provide a systems-level approach to robustness of electrical phenotype.
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