Molecular Basis of Electrophysiological Diversity of Neocortial Interneurons - *Award Winning Poster*

Toledo-Rodriguez M.[1], Blumenfel B.[1], Wu C.Z.[1], Luo J.Y.[1], Mae S.L.[1], Attali B.[2], Markram H.[1]

[1] Department of Neurobiology, Weizmann Institute of Science

[2] Department of Physiology, Medical School, Tel Aviv University

A major challenge in the post-genomic era is to establish the functions of specific genes and combinations of genes. This effort is fundamental to deriving the genetic basis of the structure and function of the nervous system. The immense computational power that underlies the cognitive and adaptive capabilities of the nervous system arises from interactions of a vast number of neurons with a spectrum of complex and electrophysiological behaviors. While it is believed that these electrophysiological behaviors are generated because neurons express different combinations of ion channel genes, the actual expression profile that underlie the behavior of any specific type of neuron, is not known.

Towards this aim, we have generate a comprehensive single cell cDNA library of morphologically and electrophysiologically fully characterized rat neocortical neurons. We have obtained whole-cell patch-clamp recordings from different classes of interneurons and pyramidal cells and derived a comprehensive breakdown of their electrophysiological properties. After the electrophysiological recordings and loading the neurons with the anatomical dye biocytin, we aspirated the cell´s cytoplasm for subsequent RT-PCR testing for the simultaneous expression of more than 50 genes, including more than 30 channel alpha and beta subunits, 3 calcium binding proteins, 10 neuropeptides and 5 synthesizing enzymes.

The obtained data provided new insights in the expression of neuropeptides, calcium binding proteins and neurotransmitter generating enzymes in neocortical interneurons and pyramidal cells and revealed a variety of (co)-expression patterns of the detected mRNAs encoding for ion channel subunits. Furthermore, data analysis led to the correlation of gene expression patterns and electrophysiological behavior, and even allowed for determining how the expression of specific ion channel subunits influences specific electrophysiological features. The mathematical means for correlating the electrophysiological behavior and genetic expression pattern of a cell provide a formula that allows the prediction of either of these characteristics when given the other.

We will present the results of detail correlations between mRNA profiles and electrophysiological features as well as the algorithm derived from this results that allows to predict the electrophysiological behavior of the neuron based on its gene expression profile.