DANDRITE
Danish Research Institute of Translational Neuroscience
Nordic EMBL Partnership for Molecular Medicine

DANDRITE Topical Seminar

by visitor Andreas Neef

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From 15:15-16:00

Aud. 6, 3rd floor, building 1170
Aarhus University, Ole Worms Allé 3, 8000 Aarhus C

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The biophysical basis of the high-bandwidth information encoding in cortical neurons

A cerebral neuron receives a continuously fluctuating input through thousands of synapses. It encodes and relays this input to thousands of downstream neurons using action potentials. Therefore, the dynamics with which discrete action potentials are generated in response to a continuous input, represents a fundamental bottleneck for the flow of information in neural populations. In the last decade it became clear that the bandwidth of information encoding in neural populations in the cerebral cortex is much higher than previously predicted by simulations with conductance based models. The biophysical basis of this large bandwidth is not understood, as even basic parameters such as sodium channel surface density and kinetics are still under debate. We used high resolution electrophysiology and fluorescence microscopy to quantify sodium channel properties and distributions in neurons and relate them to the ability to encode information with a high bandwidth.

A precise characterization of sodium channel properties in the cell bodies of cortical pyramidal cells allowed us to conclude that each square micrometer contains 20 to 30 sodium channels. By combining current clamp and immunofluorescence in cultured hippocampal neurons we could achieve semi-quantitative fluorescence labelling and obtain estimates for the axonal density of sodium channels.

We found the bandwidth of information encoding to be similar between cultured neurons and neurons in slices. Using cultured neurons as a model system, we studied the maturation of neuronal properties in the first weeks in culture. In parallel to the increased bandwidth, other neuronal properties changed: the axonal sodium channel density, the dendritic morphology and the sub-micrometer organization of axon initial segment structure. The presentation details, how those properties influenced the bandwidth of information encoding.

Host: Group Leader Poul Nissen, DANDRITE