Mitochondria play a central role in cell bioenergetics and control multiple aspects of neuronal life and death. Neurons are particularly dependent on proper mitochondrial function, because of the high energy demands associated with maintenance of ionic gradients and synaptic vesicle recycling. Mitochondria are highly dynamic organelles shaped by fission and fusion, which affects mitochondrial transport, synaptic plasticity and survival. Mitochondria also play a prominent role in Ca\(^{2+}\) signaling and Ca\(^{2+}\)-dependent functions in neurons including excitability, synaptic plasticity, ATP synthesis, and neurotoxicity. In the first part of his talk, Dr. Usachev will focus on the roles of the mitochondrial Ca\(^{2+}\) uniporters MCU and MCUb in shaping neuronal Ca\(^{2+}\) signaling, regulating synaptic transmission and controlling neural network excitability and susceptibility to seizures and epilepsy. In the second half of his presentation, Dr. Usachev will describe the role of phosphorylation-dependent regulation of mitochondrial fission and fusion (MFF) and the role of protein kinase A/AKAP1 and protein phosphatase PP2A/B\(\beta\) signaling complexes in regulating mitochondrial dynamics and bioenergetics as well as controlling resistance to neuronal toxicity in ischemic stroke.

How the MFF machinery and mitochondrial Ca\(^{2+}\) transport interact and how both processes could be therapeutically targeted for treating stroke and epilepsy will be also discussed.

1. Medvedeva Y.V., Kim M.-S. and Usachev Y.M.: Mechanisms of prolonged presynaptic Ca\(^{2+}\) signaling and glutamate release induced by TRPV1 activation in rat sensory neurons. Journal of Neuroscience 28:5295-5311, 2008. PMCID: PMC2694046**This article was featured in the "This week in the journal" section, and was highlighted in EurekAlert, an online global news service operated by AAAS, and selected for Faculty of 1000 Biology.