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Electrophysiology of Axonal Constrictions[1] CHRISTOPHER JOHNSON, PETER JUNG, Ohio University, ANTHONY BROWN, Ohio State University
— Axons of myelinated neurons are constricted at the nodes of Ranvier, where they are directly exposed to the extracellular space and where the vast majority of the ion channels are located. These constrictions are generated by local regulation of the kinetics of neurofilaments the most important cytoskeletal elements of the axon. In this paper we discuss how this shape affects the electrophysiological function of the neuron. Specifically, although the nodes are short (about $1\mu m$) in comparison to the distance between nodes (hundreds of μm) they have a substantial influence on the conduction velocity of neurons. We show through computational modeling that nodal constrictions (all other features such as numbers of ion channels left constant) reduce the required fiber diameter for a given target conduction velocity by up to 50% in comparison to an unconstricted axon. We further show that the predicted optimal fiber morphologies closely match reported fiber morphologies.

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