

Dr. Stys is a neurologist/basic neuroscientist and a leader in the study of pathophysiological mechanisms of white matter injury. He completed his neurology training at the University of Toronto and a post-doctoral fellowship at Yale. His lab has extensive expertise in electrophysiological recording methods in myelinated axons, as well as advanced imaging techniques including spectral confocal & multiphoton, and coherent anti-Stokes Raman scattering (CARS) microscopy.

Dr. Stys' team discovered several novel injury mechanisms responsible for axo-glial damage in a variety of conditions that involve glutamate excitotoxicity. Endogenously released glutamate activates receptors on axons, and surprisingly, on the myelin sheath itself. In addition, depolarization of fibers releases toxic amounts of Ca from intra-axonal Ca stores, dependent on Ca channels and ryanodine receptors, via a mechanism similar to excitation-contraction coupling in muscle cells. The various signaling molecules are organized along the internodal axolemma in discrete "axonal nanocomplexes", reminiscent of post-synaptic membranes of conventional interneuronal synapses. These findings led to the proposal of a new "axo-myelinic synapse" in the CNS, whereby electrical traffic along axons chemically signals the overlying myelin sheath. Acute or chronic dysregulation of this synapse may underpin a number of CNS disorders where white matter is a target, including demyelinating diseases. More recently, his team has been exploring protein misfolding in neurodegenerative diseases such as Alzheimer's. Using spectral methods his group is developing biomarkers for early detection. Also, his focus on neurodegeneration has extended to multiple sclerosis, with the suggestion that this disease also begins as a protein misfolding degeneration, with inflammation/auto-immunity secondary reactions to chronic myelin degradation.

Insights provided by his laboratory have provided important new mechanistic information for diseases such as multiple sclerosis, brain and spinal cord trauma, Alzheimer's disease and stroke, where axons, oligodendrocytes and myelin are prominent targets of damage.

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