Bilayers at the ILL

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Metabolic incorporation of deuterium into nerve myelin

Wednesday, 11 December 2019 14:00 (30 minutes)

Myelin sheaths are the differentiated membrane assemblies in the central and peripheral nervous systems (CNS; PNS) that wrap nerve fibers in a jelly-roll-like arrangement. The regular organization along fibers of these electrically-insulating, multilamellar, lipid-rich sheaths is responsible for the rapid conduction of electrical signals from one node of Ranvier to the next node. The disruption of myelin structure is the basis for many demyelinating neuropathies in the nervous system, including multiple sclerosis, Guillain-Barré syndrome and CIDP, and hereditary motor and sensory neuropathies. Understanding what brings about myelin destabilization requires knowledge of its structure, which, because of its paracrystalline order, is an appealing target for diffraction studies [1]. Owing to exceptional improvements in neutron scattering instrumentation for detecting deuterium (2H or D) in myelinated nerves [2,3], we explored the localization of D in myelin after its metabolic-incorporation via drinking water into pregnant dams and their developing embryos. We observed significant differences in the neutron diffraction patterns from the myelinated nerves of H2O- versus D2O-fed dams and their pups. Neutron scattering length density profiles showed a major increase in density in the middle of the myelin membrane bilayer. Mass spectrometry confirmed the presence of D-labeled lipids—phosphatidylserine, sulfatide, phosphatidylinositol, phosphatidylethanolamine, and triacylglycerol—in the nervous tissue from the D2O-fed mice. Whereas the lipids from the D2O-dam were 75-80% deuterated, the lipids from the D2O-pups were ~99% deuterated. Moreover, the deuterated lipids for the pups vs. the dam had different incorporation patterns of the label.

1. H Inouye, DA Kirschner. In: Molecules: Aggregation, Nucleation, Crystallization – Beyond Medical and Other Implications (Eds. J Sedzik, P Riccio), World Scientific Publishing (Singapore), 2009, pp. 75-94.
2. AR Denninger, B Demé, V Cristiglio, G LeDuc, et al., Acta Cryst D70 (2014):3198-3211
3. AR Denninger, A Breglio, KJ Maheras, G LeDuc, et al., Biophys J. 109 (2015):1387-1397.

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