# Electrical stimulation for myelination via compartmentalized microfluidic platform.

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***Abstract -*** Demyelination of myelinated axons in the nerve system is the most devastating feature of various neurological diseases. In turn, the reduction in conduction ability causes deficiency in sensation, movement, cognition, or other functions depending on which nerves are involved. Oligodendrocyte progenitor cells (OPCs) play an important role in the repair of demyelination for a number of neurological diseases and injuries due to their potential to differentiate into new myelinating oligodendrocytes. This is important because of the resulting remyelination of demyelinated axons. Enabling endogenous OPCs to differentiate into mature oligodendrocytes is a key factor in the remyelination of demyelinated axons. However, for unknown reasons, there is a limit in the remyelination of axons by endogenous oligodendrocytes. Furthermore, therapies for remyelination of axons by OPCs that are currently available are marginal or not very effective. Some evidence suggests that the electrical activity of neurons, in the form of action potentials along the axon, plays a necessary role in oligodendrocyte development. Electrical stimulation, an artificial activation of electrical activity of neurons, in the medullary pyramid can promote proliferation and differentiation of OPCs that are in contact with corticospinal axons. Although electrical stimulation of neuron/oligodendrocytes shows the enhanced myelination in vitro and in vivo, the neuroprotective role and signaling mechanism of electrical stimulation is not yet understood and deemed controversial. The novel compartmentalized microfluidic platform allowed us to examine the effect of focal electrical stimulation for myelination in development and demyelinating conditions. These chambers separated neurons into 3 parts: soma, axon and axonal terminal. Our system was able to stimulate axons focally: the point between cell soma and axon or the point between axon and axonal terminal. Here, we applied 3-compartmentalized microfluidic platform to evaluate the role of electrical stimulation for myelination. Our compartmentalized microfluidic platform would provide the mechanisms for the electrical stimulation in the treatment of demyelinating diseases. In addition, this system will allow us to provide high throughput system for drug screening in demyelinating diseases.

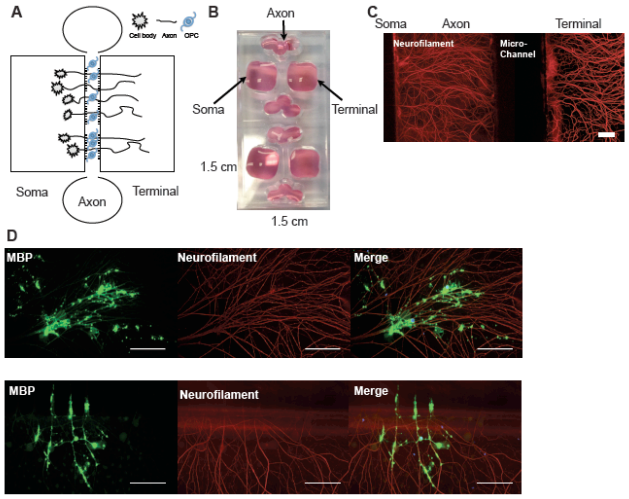


**Figure 1. Compartmentalized microfluidic platforms and myelination** (A) Schematic of 3 compartmentalized microfluidic platform. Neurons are fluidically isolated by 3 compartments: Soma, Axon and Terminal. Primary DRG neurons were plated on Soma compartment. Axons were extendedthen passed through micro-channels until Terminal compartment. OPC (oligodendrocyte precursor cell) were plated on Axon compartment (center). Oliogdendrocyte myelination on axons with/without electrical stimulation were observed. (B) 3 comparmentalized microfluidic platform filled with neurons and OPCs. (C) Axon growth in 3compartmentalized microfluidic platform visualized by neurofilament antibody. (D) Representative myelinated axons in the Axon compartment. Myelin Basic Protein (MBP) is the protein expressed in myelin of mature oligodendrocytes. MBP expression in oligodendrocytes was visualized as Green. Axon was visualized by neurofilament antibody (Red). Merged images showedthat MBP expressing oligodendrocyte processes were completely wrapping axons. (Scale bar: 100 μm)