An Overview of Myelination in the Central and Peripheral Nervous System

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Neural Basis of Behavior
4/25/2013
Outline

• Defining the Nervous System
  - CNS and PNS
  - Neuron to Glia Ratio

• Glia
  - General role

• Myelin Producing Glia
  - Myelin
  - Oligodendrocytes
  - Schwann Cells
  - Differences

• Summary
Simple Brain and Glia Statistics

- The human brain is estimated to consist of 100 billion neurons.
- There is a glia ratio of ~3:1.
Glia

• Considered to be supporting cells of the nervous system
• Central Nervous System: Astrocytes, Microglia, and Oligodendrocytes
• Peripheral Nervous System: Schwann Cells
Myelin

- A lipid membrane that is produced from a myelin producing cell.
- The membrane wraps around an axon segment numerous times until it reaches an approximate ratio known as a “G” ratio.
- Myelin allows for fast saltatory conduction of action potentials.
- Provides trophic support to nerves.

http://www.alpco.com/

Wikipedia commons
Myelin Evolution

• Believed to have arisen ~600 million years ago.
• Found in all jawed vertebrates.

http://www.biotele.com/
http://bangordailynews.com/
Oligodendrocytes

- Myelin producing cells of the Central Nervous System.
- Can myelinate up to 50 axon segments from a single oligodendrocyte.

http://www.regenecell.com/
Development of Oligodendrocytes

Woodruff et al 2001
Disease associated with Oligodendrocytes

- Multiple Sclerosis is a disease of the central nervous system where the immune system attacks the myelin sheath.
- The attacks cause a loss of myelin and lead to impairment in neurological function and a shortened life.
- There are many suggestions as to what causes MS, ranging from genetics to environmental factors.
- It affects women more often than men.
Schwann Cells

• Myelin producing cells of the peripheral nervous system.
• One Schwann Cell myelinates one axon segment.

Wikipedia commons
Development of Schwann Cells
Development Continued

Tg: (Foxd3:17) 30 hpf
Development Continued on The Ultra-Structural Level

Pro-myelinating Schwann cell of a Mouse  |  Mouse Sciatic Nerve  | Monk 2011
Disease associated with Schwann Cells

• Charcot Marie Tooth disease is a peripheral nerve disease, where demyelination occurs causing a loss of nerve conduction.

• The loss of conduction leads to peripheral neuropathy and ultimately a loss of muscle function.

• Results from mutations in many different genes in Schwann cells.

• Affects on average 1 in 2,500 people

• Symptoms can start to show from teen years up until a person is in their 30s or 40s.

http://emedicine.medscape.com/
Peripheral Nerve Injury

• In injuries to the peripheral nerves, Schwann cells can de-differentiate into a precursor cell.

• The peripheral nerves that regenerate can then be re-myelinated by the de-differentiated Schwann cells.

http://www.bio2.rwth-aachen.de/
Other Interesting Differences between PNS and CNS Myelin

- The CNS and PNS have a different protein regulating the induction of myelin wrapping.
- GPR126 is necessary for myelination to occur in the PNS but not the CNS.
- This is while they share a common marker that also is necessary for the proper structure of the myelin wraps.

*In situ* hybridization for *mbp* in 5 days post fertilization *D. rerio* larvae of the gpr126 hypomorphic allele

Monk and Hakkinen (2012) Unpublished
In Summary

• Oligodendrocytes are the myelinating cells of the CNS.
• Schwann Cells are the myelinating cells of the PNS.
• Both have unique features in their cellular origin and how many axon segments they can myelinate.
• Demyelination results in devastating disease and as of now there is no way to reverse myelin loss.
Citations


• Kristjan R. Jessen & Rhona Mirsky. The origin and development of glial cells in peripheral nerves. (2005) Nature Reviews Neuroscience 6, 671-682 (September 2005) | doi:10.1038/nrn1746

Questions? Comments? Concerns?

http://www.uni-mainz.de/

http://jcb.rupress.org/

http://www.123rf.com/

http://scienceworld.wolfram.com/

http://archives.focus.hms.harvard.edu/