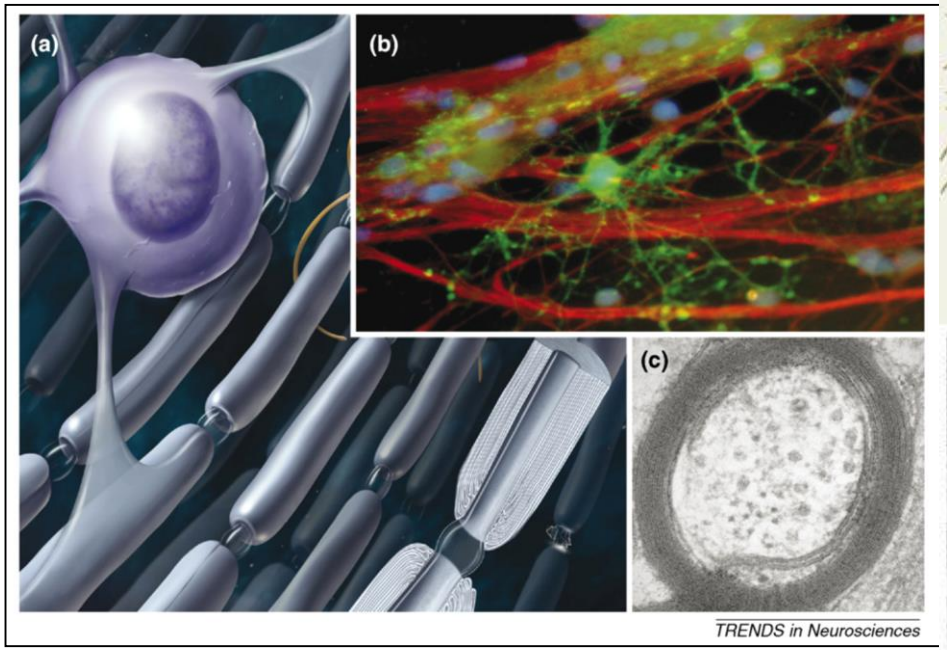
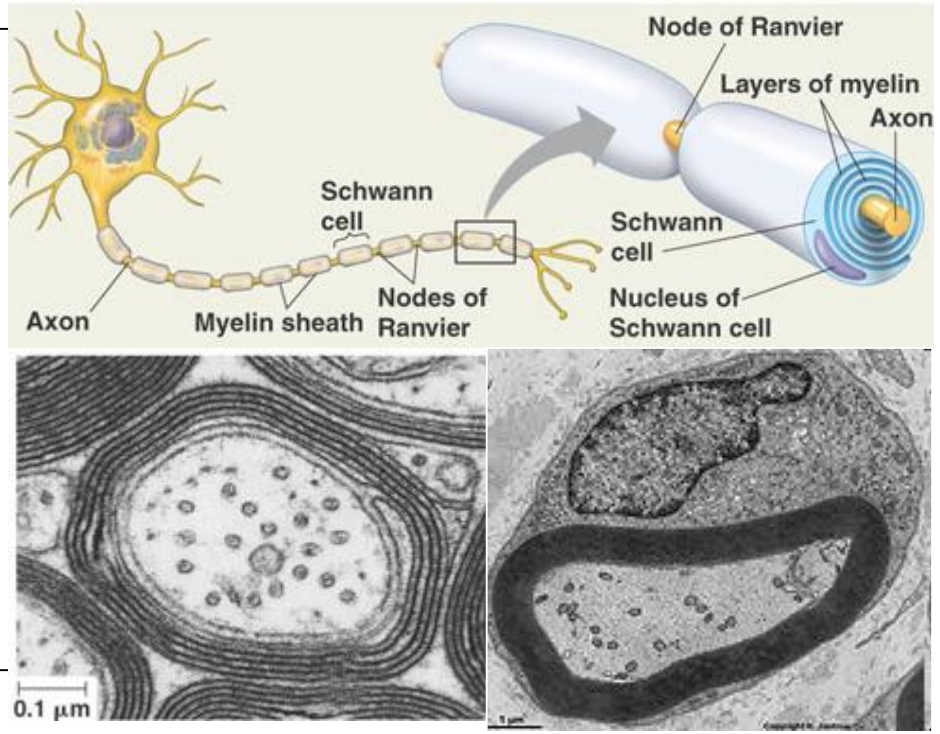
Myelinating cells





Oligodendrocytes

Schwann cells

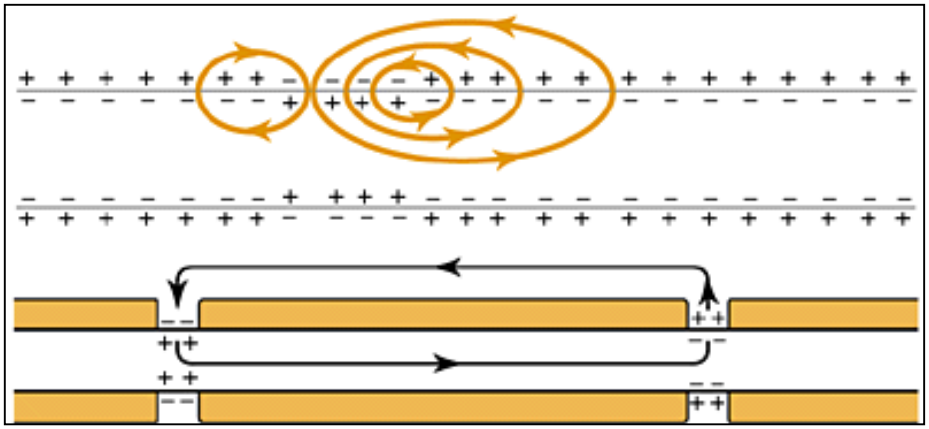
The evolution of rapid conduction

Nervous systems have evolved two basic mechanisms for increasing the conduction speed of the electrical impulse:

1) Giant axons: using axons several times larger in diameter than the norm, as for example in the well-known case of the squid giant axon.

2) Myelination: encasing axons in helical or concentrically wrapped multilamellar sheets of insulating plasma membrane — the myelin sheath.

Each mechanism, alone or in combination, is employed in nervous systems of many taxa, both vertebrate and invertebrate.



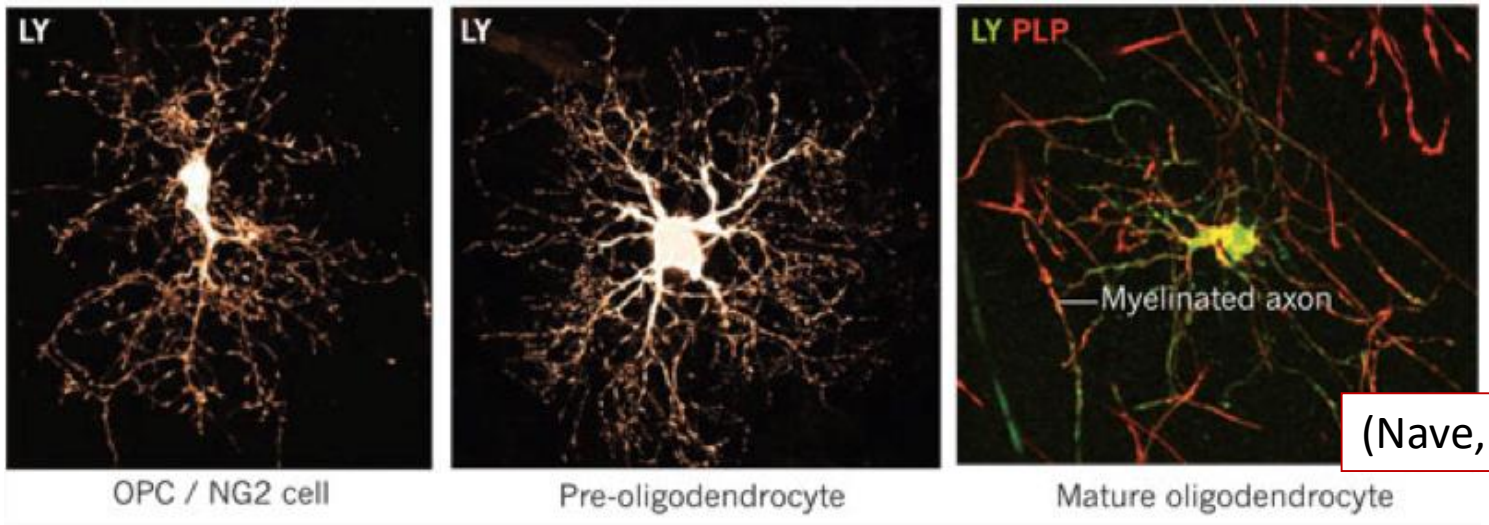
Impulse conduction in unmyelinated (top) and myelinated (bottom) fibers

Arrows show the flow of action currents in local circuits into the active region of the membrane. In unmyelinated fibers, the circuits flow through the adjacent piece of membrane, but in myelinated fibers the circuit flow jumps to the next node.

Benefits of myelin

- Reduces energy consumption of restoring ion gradients.
- Increase in conduction velocity as an insulator with no increase in axon diameters
  - allowed complex yet compact nervous systems to evolve.
- Protection: signals from glia are required for long-term integrity and survival of axons

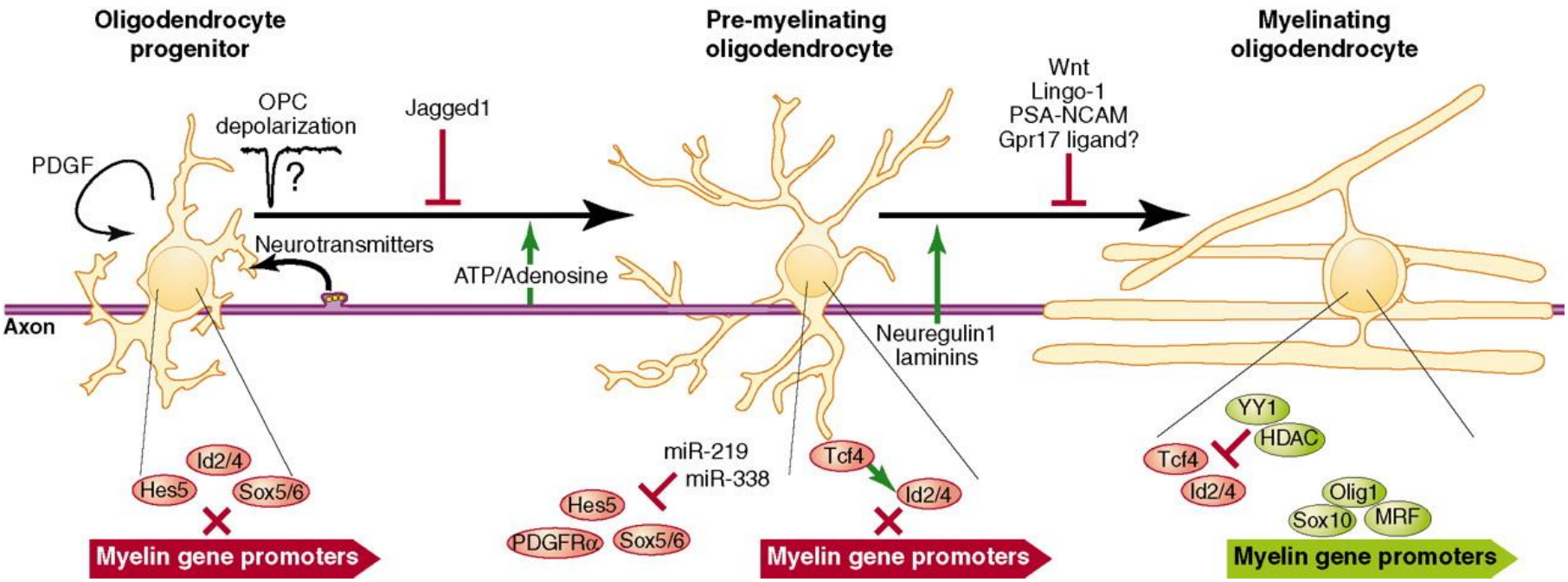
Oligodendrocyte development



(Nave, 2010)

- OPCs are morphologically complex, but their function is not well-understood.
- NG2(+) OPCs express glutamate receptors and receive transient synaptic input from unmyelinated axons.

Schematic of the **oligodendrocyte lineage** showing some of the intrinsic and extrinsic factors that influence oligodendrocyte differentiation and the myelination of individual axons.



Emery, Science 2010;330:779-782

Science
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Specific mRNAs are transported from the olygodendrocyte cell body to paranodal regions for local protein syntesis of myelin proteins

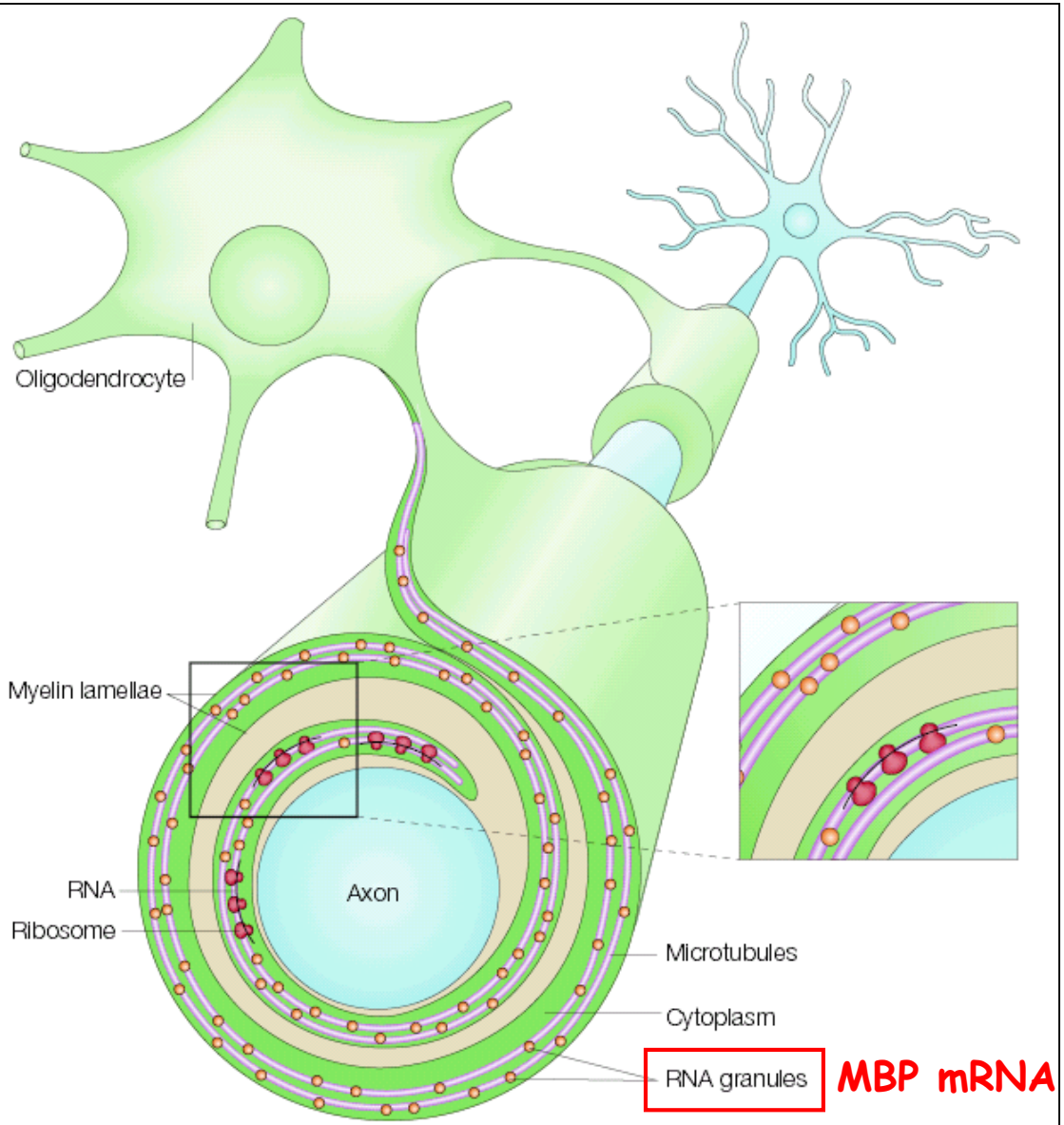
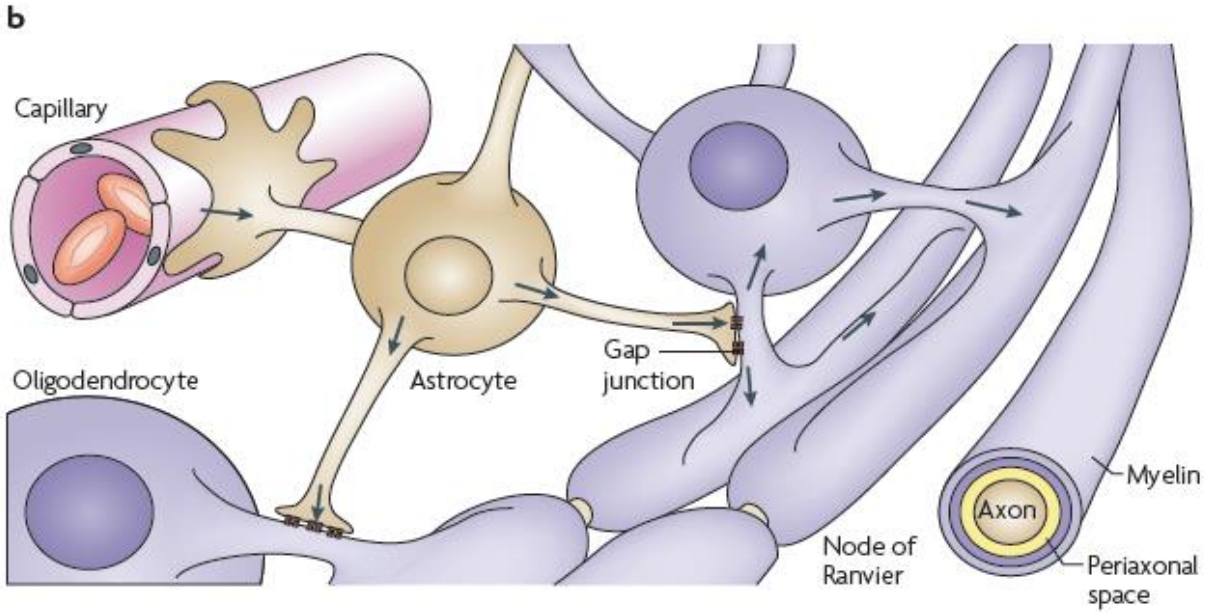


Figure 1 | **Ensheathment of an axon by oligodendrocytes.** An oligodendrocyte extends and surrounds neighbouring axons and the myelinating process develops a distinct protein and lipid composition. The synthesis of some myelin proteins — and presumably the assembly of new membrane — occurs at sites distal to the cell body as a result of microtubule-based transport of RNA granules (orange circles) that contain mRNA (blue lines) and ribosomes (red circles) from the nucleus to the paranodes.

Sherman & Brophy, 2005

Oligodendrocytes, through coupling to astrocytes, maintain a system for the trophic support of axons



Oligodendrocytes are also coupled by gap junctions to astrocytes that reach the blood–brain barrier. In addition to simple diffusion, cytosolic ‘perfusion’ could attenuate concentration differences of metabolites with high axonal turnover. Similar to fast axonal transport, glial intracellular transport may depend on tubular tracks and the fine architecture of this channel system.

Nave 2010