

What are the advantages and disadvantages of myelin?

<http://en.wikipedia.org/wiki/Myelin>

The main purpose of a myelin layer (or sheath) is to increase the speed at which impulses propagate along the myelinated fiber. Along unmyelinated fibers, impulses move continuously as waves, but, in myelinated fibers, they hop or "propagate by saltatory conduction." Myelin decreases capacitance and increases electrical resistance across the cell membrane (the axolemma). Thus, myelination helps prevent the electrical current from leaving the axon. It has been suggested that myelin permits larger body size by maintaining agile communication between distant body parts.^[3]

Myelinated fibers lack voltage-gated ion channels (approximately 25 $\mu\text{m}/\text{m}^2$) along the myelinated internodes, exposing them only at the nodes of Ranvier. Here, they are found far more abundantly (between 2,000-12,000 $\mu\text{m}/\text{m}^2$).^[4] Myelinated fibers succeed in reducing sodium leakage into the extracellular fluid (ECF), maintaining a strong separation of charge between the intracellular fluid (ICF) and the ECF. This increases sodium's ability to travel along the axon more freely. However, the sodium diffuses along the axolemma rapidly, but is decremental by nature. The sodium cannot trigger the opening of the voltage-gated sodium channels as it becomes weaker. The nodes of Ranvier, being exposed to the ECF every 1 mm or so, contain large amounts of voltage-gated sodium channels, and allow enough sodium into the axon to regenerate the action potential.^[5] Each time the action potential reaches a node of Ranvier, it is restored to its original action potential (+35mV).^[4]

<http://www.lifescitrc.org/resource.cfm?submissionID=292>

For invertebrates, propagation of action potentials down unmyelinated axons is sufficient for rapid conduction. For faster propagation velocities, the axon becomes larger in diameter. However, increasing the speed of action potentials by increasing the diameter of the axon is not feasible in vertebrates. Squid giant axons are up to 1 mm in diameter and have very rapid propagation velocities. Mammalian nerves have about 400 fibers in the same cross-sectional area as the squid giant axon. Thus, if each of the fibers were as large as the squid giant axon, each mammalian nerve would be approximately 2 cm in diameter! Thus, vertebrates have evolved another mechanism for increasing nerve conduction: wrapping the axons in insulating membranes of a myelin sheath. Some axons have as many as 150 wraps of Schwann cells around them, thereby increasing the effective thickness of the axonal membrane 100-fold and eliminating ion leaks across cell membranes except at the periodic gaps called Nodes of Ranvier.

<http://www.pbrc.hawaii.edu/~danh/InvertebrateMyelin/advantages.html>

advantages of myelin: Myelin speeds the conduction of nerve impulses by a factor of 10 compared to unmyelinated fibers of the same diameter.

- Provides economy of space. Its speed-up of impulses permits a trade-off with size that allows a much more compact nervous system for a given axonal conduction speed
 - Promoting nervous systems such as ours with large numbers of neurons engaged in massively parallel computation.
 - To attain the same inter-hemispheric travel time for nerve impulses using unmyelinated axons would require scaling up brain dimensions over 100-fold.

Disadvantages of myelin

- It costs a significant amount in metabolic energy to produce the many layers of lipid-rich membrane that comprise myelin.
 - This can be a particularly bothersome problem in environments such as the "oligotrophic" open ocean, which is distant from continent-based sources of nutrients.
- Key biosynthetic resources required for myelin may be limited for some organisms in some ecosystems
 - Lipids required for myelin membranes may be less readily available from a diet where food quality is poor, and metabolically expensive to manufacture
 - Cholesterol, which is not synthesized by protostomes (the most common invertebrates) and hence is an essential "vitamin" in their diets