Nerve Cell Regeneration

Timothy Alberg, Biomedical Engineering Program University of Rhode Island

Neurons are the cells that make up the nervous system in living organisms. The nervous system is divided into two subgroups of neurons, the Central Nervous System (CNS), and the Peripheral Nervous System (PNS). CNS neurons make up the brain and spinal cord, and are typically un-myelinated. PNS neurons extend out from the CNS to the rest of the body. PNS neurons vary greatly in length,and are typically myelinated. Damage to neurons from either the PNS or the CNS usually results in loss of nervous function below the severed neurons. These cells normally do not regenerate, and if they do, the new neuron usually does not pair up correctly with any of the neurons downstream. This complication led to research in Nerve Cell Regeneration.

Many scientists have researched Nerve Cell Regeneration, and many have come to similar yet distinct results regarding it. The PNS is usually their first target for experimentation. Some have tried 'Nerve grafting', removing segments of neurons from one part of the body and placing it where the damaged neuron is, or autografting and found it to be successful for the most part. While this places new neurons there, it does not guarantee that the neuron will grow in the right direction, or complete the synapses with other neurons. Other researchers have made biodegradable polymers that are soluble to water. These polymers can range from 100 to 500 microns in thickness, and usually have pre-cut paths in them for the neurons to grow in. Seeded with Schwann Cells, these polymers help stimulate nerve growth in the damaged section of the PNS by actively myelinating the growing neuron as it grows down the grooves of the polymer. This however is not the case for the CNS.

As it turns out, Schwann Cells and Oligodendrocytes are two major inhibiting problems with nerve cell regeneration in the CNS. Oligodendrocytes serve a similar purpose to myelin, with the exception that oligodendrocytes also connect CNS neurons together at multiple points, along with allowing the action potential to transmit at a fast speed across the axon (neck) of the neuron. Oligodendrocytes produce inhibitory proteins in the CNS upon injury, thus preventing nerve re-growth. Several studies found that there are unique proteins that aid in nerve regeneration in the PNS and could possibly help with regeneration in the CNS. One such protein is NF-kappaB, a protein that reacts to signals emitted from Schwann Cells and turns certain genes on and off to allow nerve regeneration. Unfortunately, NF-kappaB also stimulates oligodendrocyte and myelin production around the neurons, which is bad for the CNS.

In 1999, several researchers experimented with nerve cell regeneration by purposely injuring some PNS neurons within a week of injuring some CNS neurons and discovered that by damaging the PNS, the nervous system was 'primed' with cyclic AMP, another signaling molecule found in high amounts during nerve re-growth/injury, and allowed the CNS to actually re-grow by considerable amounts. Six years ago, a research team conductedsimilar tests using cyclic AMP. They discovered that cAMP, when administered to CNS neurons before injury, greatly increased the regeneration rate. Using cAMP for nerve regeneration is still being tested since high doses of it may affect other systems of the body in negative ways.

Unfortunately, nerve cell regeneration is still a problem due to the fact that the neurons do not always re-grow in the right direction. Scientist plan to use nanotechnology in the future to create artificial grafts/maps for the nerves to grow correctly down. They also plan to use magnetic and mechanical tension to bypass the inhibitory signals that oligodendrocytes produce in the CNS. The future of nerve cell regeneration is bright, and soon, it will be a problem of the past.

References

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