Topic: Medical Biotechnology

Biotechnology Enabled Nerve Regeneration: Hope for the Elusive Cure for Neurodegenerative Disease

Megha Agrawal, PhD **- Executive Editor**

Neurodegenerative disease and spinal cord injury are serious medical conditions that result in irreversible nerve damage and subsequent damage to the central nervous system. Our nervous system is made of neurons. The principal role of nerves is to carry messages from one part of the body to another in the form of tiny electrical signals (Figure 1). These messages carried by nerves are referred as nerve impulses. The consequences of nerve damage from neurodegeneration are huge that can trigger catastrophic health events leading to severe functional deficits, paralysis and eventual cell deaths.

Advances in medical biotechnology have made it possible for the researchers to synthesize rare enzymes that promote regeneration and growth of injured nerve cells. To this end, researchers are pursuing Neurotrophins (NTs) as a possible avenue for nerve regeneration. NTs are proteins that involve a sequence of small molecular chains that possesses potent neurotrophic properties, which promote the development of neurons. NTs correspond to a family of neurotrophic growth factors and found to be the key for the development and functional maintenance of the central nervous system (CNS). They participate in neurogenesis, neuronal survival, axonal growth, synaptogenesis and activity-dependent forms of synaptic plasticity [1].

*Figure 1: Messages are carried by the nerve cells from one part of the body to another [**Source:** www.planet-science.com/].*

NT Treatments Enhance Neuronal Survival and Repair after Spinal Cord Injury (SCI) and Traumatic Brain Injury (TBI)

As we discussed above, NTs play important roles in many aspects of nerve regeneration after traumatic CNS injury that leads to spinal cord injury (SCI) and traumatic brain injury (TBI). NT treatments have been reported to enhance neuronal survival, axonal regrowth, remyelination and synaptic plasticity (Figure 2) [1].

Trauma to the spinal cord causes devastating health damages. These include severing axons and disrupting microvasculature that eventually kills neurons and glia, and induces the formation of a dense glial-fibroblastic scar, which results in a permanent impairment or loss of sensory and motor functions. Researchers studied severed neurons that showed ongoing and progressive apoptosis. They found that surviving neurons make only a limited spontaneous attempt to regrow. However, the regenerating axons fail to enter or traverse the lesion area (Figure 2). The applications of NTs have shown that some functional recovery can be achieved by systematic treatments of NTs. In the injured spinal cord, neurotrophin delivery takes place by various methods, which supports the growth of discrete neuronal populations. For example, it has been observed that nerve growth factor (NGF) supports the sprouting and regeneration of cholinergic local motor axons, primary nociceptive axons, and cerulospinal axons [1].

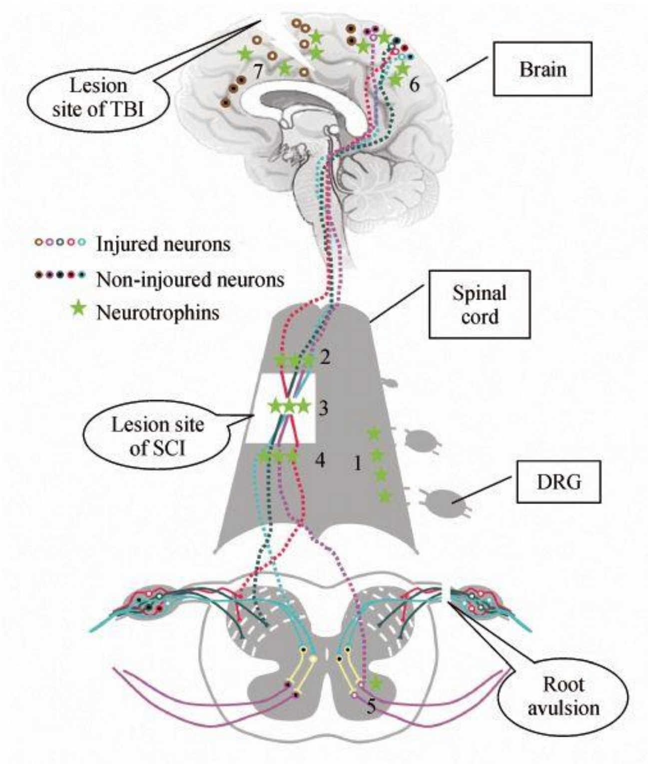

*Figure 2: Schematic illustrations of the treatments with Neurotrophin on nerve regeneration after neurotrauma. Traumatic injury in CNS, such as root avulsion, spinal cord injury (SCI), and traumatic brain injury (TBI), results in death of injured neurons and failure of severed axonal regeneration. Neurotrophin treatments are shown to induce sensory axons to regenerate through the dorsal root entry zone (DREZ) after (1) root avulsion (2) severed axons to re-grow (3) across the lesion site (4) into distal host tissues that enhance neuronal survival after SCI and TBI [**Source:** Front Biol (Beijing). 2013 Oct 1; 8(5): 486–495].*

Traumatic brain injury (TBI) is a complex medical condition that is summarized into four categories including primary injury, secondary injury, inflammatory response and repair-regeneration. The hallmark features of TBI are ongoing and progressive cell death and diffuse axonal injury. NT treatments have received broad attention in the therapy of TBI. NT-based treatment methods include restorative and regenerative strategies that have focused on enhancing the survival of injured neurons and replacing dysfunctional and dead cells. The research data demonstrates that combined neuronal replacement and neurotrophin therapy may selectively improve cognitive function following TBI [1].

Concluding Remarks

Medical biotechnology advances in synthesizing clinically important enzymes and proteins such as Neurotrophins have shown promise in a critical area in neuromedicine – nerve regeneration. To be able to restore the nerves and the functions of central nervous system and fatal injuries to spinal cord and brain is a huge step forward to discover new medical pathways to battle neurodegeneration. The future of medical biotechnology enabled drug industry looks bright.

Author's Biography

Dr. Megha Agrawal

Dr. Megha Agrawal is executive publisher of Biotechnology Kiosk. She has held senior academic positions at top-tier US institutions including University of Florida at Gainesville, Children's National Medical Center in Washington DC and the University of Illinois at Chicago, where she was a research faculty and principal investigator. Currently, she directs R&D programs in biotechnology at USA Prime Biotech. She received her Ph.D. in Biotechnology from the Indian Institute of Technology at Roorkee, which is one of the premier institutions in India with an outstanding reputation across the globe. She won a highly competitive research award given by the Council of Scientific and Industrial Research in India to carry out her PhD work. Dr. Agrawal's research on resveratrol has provided novel pathways to develop new therapeutics to combat neurodegenerative disorders. Dr. Agrawal has made significant contributions to develop a rapid, cost effective and more sensitive mechanism based in-vitro model of ischemic stroke as first tier of screening of neuroprotective drugs for their anti-stroke potential. Her research has impacted significantly to initiate new areas in neurodegeneration, neuroprotection and novel approaches to treat cerebral stroke related injuries and prevention.

Dr. Agrawal has published in internationally prestigious scientific journals in the field of biotechnology, neuroscience, stroke and molecular biology and biochemistry. She has been invited to give several talks at national and international meetings. Dr. Agrawal also serves as an Associate Editor for the international journal 'Frontiers in Molecular Bioscience (Molecular Diagnostics and Therapeutics)', a Nature-Frontier publication. In addition, she is on the editorial board of Drug and Metabolism Reviews and a contributing editor in Vacuum Advances in Biotechnology for Vacuum Technology and Coating Magazine and writes a monthly column in biotechnology. Dr. Agrawal can be reached at meghaagra@gmail.com

Reference for further reading:

1. Kelamangalath L & Smith G M (2013) Neurotrophin treatment to promote regeneration after traumatic CNS injury. Front Biol (Beijing) 8(5): 486-495.