Mechanical Engineering
Fall 2008 Seminars
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Axon stretch-growth: **Discovery of a new and important form of nervous system development**

Bryan J. Pfister, PhD
Department of Biomedical Engineering New Jersey Institute of Technology

Early in development, axons navigate via a growth cone over seemingly large distances to reach their target. However, well after axons integrate with their targets and establish synaptic connections, animals and their nervous systems continue to grow several orders of magnitude in size. For instance, the blue whale can grow an estimated 4cm/day and the giraffe's neck increases by about 2cm/day at peak growth. It is conceivable that stretching forces, exerted on axons by the enlarging body, initiate and maintain *stretch growth* of the axon cylinder. This poorly recognized process of *axon stretch-growth*, likely represents the primary mechanism that drives the formation of long nerves in animals.

We have recently have shown that integrated axons can in fact undergo surprisingly rapid growth solely through the application of mechanical stretch. Far exceeding the approximately 1mm/d rate of growth cone extension, integrated axons quickly adapted to stretch-growth rates reaching at least 1cm/d, producing large axon fascicles 10cm in length while maintaining normal cytoskeletal ultrastructure. Importantly, these stretch-grown axons retain the ability to generate and transmit action potentials.

Pursuing a new approach to nervous system repair, stretch-grown axon tracts were developed into nervous tissue constructs designed to span peripheral nerve or spinal cord lesions. We have recently transplanted these nervous tissue constructs to bridge a 1cm lesion in the rat spinal cord and sciatic nerve transection. Transplanted stretch-grown axon tracts maintain their pre-transplant geometry, survive for several months and send axons to integrate with viable host tissue at each end of the lesion. The ability to rapidly create living nervous tissue constructs that recapitulates the uniaxial orientations of the original nerve offers an unexplored and potentially complimentary direction in nerve repair. Ideally, bridging nerve damage with living axon tracts may serve to establish or promote new functional connections.

Bryan J. Pfister, PhD, is an assistant professor in the department of biomedical engineering at New Jersey Institute of Technology who is a specialist in neural tissue engineering. In 2007, Pfister received a prestigious Faculty Early Career Development Award from the National Science Foundation to support and expand his research into rapid axon stretch growth, a technique for regenerating damaged or diseased nerve cells. Pfister received his PhD in materials science engineering and his MS degree in mechanical engineering, both from Johns Hopkins University, and his BS degree in interdisciplinary engineering and management from Clarkson University.

For More Information Contact: Dr. Joga Rao (973) 596-5601, raoi@njit.edu