Mechanical Engineering Department Seminar

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1130 Mechanical Engineering
111 Church Street SE, Minneapolis, MN 55455

Biophysical Stimuli in Neural Engineering

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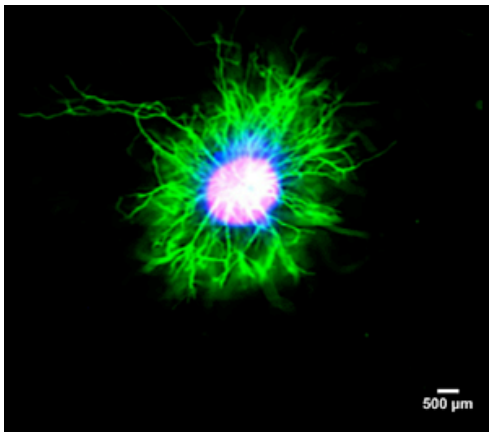
In the United States alone, there are hundreds of thousands of injuries to the peripheral nervous system (PNS) annually. Following PNS injury, damage to neural tissue and the surrounding area often results in failed axonal re-growth and a subsequent loss of function. Due to this lack of functional regeneration, tissue engineering strategies focusing on cellular, biophysical, biochemical, and mechanical guidance cues have been explored to address the challenge of large-gap injuries. To date these engineered strategies are unable to match or exceed the current gold standard, nerve autografts, which are in limited supply, motivating the development of new approaches. Exogenous electrical stimulation may provide an alternative route to enhance axonal re-growth following large-gap PNS injuries and deep brain stimulation is being used in a variety of neurological disorders and degenerative diseases (Parkinson's, Depression, Alzheimer's), despite the lack of a mechanistic basis for parameter selection (magnitude, duty cycle and duration). In vivo, endogenous electrical currents (<140 mV/mm) are present during embryogenesis and influence tissue organization. Neurons from lower order model systems (non-mammalian) with robust regenerative capacities (i.e. *Xenopus*) are responsive to exogenous electrical stimulation but it is not clear is this is retained for cellular players of the peripheral nerve post-natally. Changes in neurite outgrowth and non-neuronal cells (e.g. Schwann cell and endothelial cell) were investigated following exposure to exogenous DC electrical stimulation to promote re-growth following injury. Our group has shown that electrical stimulation, both direct current (DC) stimulation and AC stimulation, of Schwann cells resulted in significant and sustained release of NGF following a single stimulation and can be reproduced following the application of additional stimuli in addition to increasing neuronal growth. Therefore, manipulating SC behavior (migration, alignment, growth factor release) with an external electric field may provide improved functional outcomes and facilitate nerve repair. Other key non-neural cells at the injury site, macrophages, appear to be responsive to biophysical stimuli by expressing increased M2 markers in preliminary experiments. Biophysical stimulation can be applied to the injured nerve will not only to support nerve regrowth but induce the pro-regenerative response of many key cells in the peripheral nerve. Optimizing exogenous electrical stimulation to manipulate both neural and non-neural support cells while gaining a mechanistic understanding of cellular responses to the stimulus may lead to rationally designed stimulation



Bio: Dr. Thompson is an Associate Professor of Biomedical Engineering and directs a research program in Neural Engineering with funding from NIH, NSF, DOD and New York State Department of Health (NYSTEM and NYSCIRP). Her academic credentials include degrees in Chemical Engineering (B.S., M.S and Ph.D.). She was a Pre-doctoral NIH trainee in Biotechnology with training in both Engineering and the Life Sciences. Dr. Thompson was a post-doctoral research fellow at the Center for Engineering in Medicine with appointments at Harvard Medical School, Massachusetts General Hospital and Shriners Burns Hospital. Dr. Thompson is a recipient of the JD Watson Young Investigator Award and was a recipient of the Rensselaer School of Engineering Research Excellence Award. Dr. Thompson serves as the Graduate Program Admissions Chair in Biomedical Engineering. Dr. Thompson serves on the Executive Board and a training faculty for the Rensselaer NIH Pre-doctoral Biomolecular Sciences and Engineering Training Program. Her laboratory is engaged in neural tissue engineering research for nerve regeneration, spinal cord injury repair and neurodegenerative diseases.