Northeastern University
College of Engineering

## October 22, 2025 | 108 Snell Engineering Center | 12:00PM

# Alumni Seminar Speaker

***Stimulating Excitable Cells with Optosomes: Development of a Non-viral Cell Derived Vesicle Capable of Stimulating Excitable Cells in Response to Light Stimulus***


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**Abstract:** For years, researchers have studied and developed neuromodulation techniques meant to stimulate and/or inhibit excitable cells both in research and clinical settings. A method to excite cells with light, termed Optogenetics, has been researched extensively since its discovery in the early 2000's. A major constraint of Optogenetics is the expression of the necessary light-gated ion channels most often achieved using a viral vector. While this is not overly concerning in research settings, clinical applications of optogenetics have been slow to develop as the use of viral vectors in humans presents challenges regarding safety. Additionally, foreign opsin genes are believed to be a permanent addition to the transfected cells.

This dissertation aimed to develop Optosomes; a cell-derived vesicle containing excitatory opsin that couples with excitable cells via Gap-Junctions that conduct the stimulus current from the opsin into the cell. Initial production of Optosomes followed established protocols for producing Giant Plasma Membrane Vesicles (GPMVs) in which small volumes of cytoplasm are encapsulated in a piece of the cell's plasma membrane. The number of GPMVs produced varied with pH, cell confluency, and base medium having a noticeable impact on the number of GPMVs generated. Optosome production required the creation of a stable cell line expressing Channelrhodopsin-2 (ChR2) and connexin-43 (Cx43) proteins required to form Gap-Junctions. Two separate transfections in the series generated a ChR2-Cx43 Hek293 cell line capable of producing Optosomes at a high concentration. Finally, a mathematical model was built to simulate Optosome stimulation of excitable cells and how changes in the size of Optosomes and cells affect the strength of stimulus generated. The result of these simulations and attempts to stimulate neonatal Cardiomyocytes (CM) in vitro confirmed that the majority of Optosomes produced were too small to generate a stimulus capable of exciting CMs. Production of Optosomes with larger diameters or the use of a different strand of ChR2 is needed to increase the number of Optosomes able to stimulate CMs will be needed moving forward.


**Biography:** After spending nearly two years working on the development of a new automated Biomanufacturing system in the Love Lab, Bill was accepted and enrolled in the PhD program for Chemical Engineering. After finding his home for the next 7 years in the Koppes Lab, he got to work both on forming his thesis and integrating into the community at Northeastern. In pursuing his Ph. D, he had started to appreciate how applying mathematical modeling techniques to biological systems offers a whole new perspective when trying to understand the complex innerworkings of the human body. It offered a nice juxtaposition to the time spent in lab running hands on experiments that are less about math and academic prowess and more about technique, adaptability, and problem solving in real time. Bill has sed the better part of his twenties working in Research and its why he was so eager to pursue a PhD as he hopes to work his way into scientist positions overseeing research and development projects. Still residing in Boston, he hopes to find a position in the New England Area after submitting his Dissertation; staying close to family and friends in the area.


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