PURDUE UNIVERSITY | Weldon School of Biomedical Engineering

BME 3rd Year Seminar Series
Friday, October 25th, 2024
1:30 – 2:30 PM EST
MJIS 1001

Evaluation links:
Laura Nunez Alvarez: https://purdue.ca1.qualtrics.com/jfe/form/SV_38aeZ2NTMmCejH0
Elizabeth Frazier: https://purdue.ca1.qualtrics.com/jfe/form/SV_5toy71VUvqTEs18

Evaluation surveys should only be completed after the seminar has taken place, and only by those who attended the seminar.

A Multiscale Approach to Understanding Tissue Expansion-Induced Changes in Skin Mechanics and Cellular Behavior

Laura Nunez Alvarez (Adrian Buganza Tepole, advisor)

Abstract: Breast cancer is the most diagnosed cancer in women in the US. Approximately 50% of patients opt for or are advised to undergo a mastectomy. After removal, patients can undergo Breast Reconstruction Surgery (BRS), mostly done with Tissue Expansion (TE). TE complications include necrosis, excessive asymmetry, and capsular contraction, as TE is alternated with Radiotherapy (RT). Unfortunately, little is known about the cellular processes that drive those changes and the combined effect of TE and RT on skin tissue and cells. The present study aims to quantify tissue changes, such as skin stiffness, through biaxial testing, collagen architecture changes through histology analysis, and cellular changes through protein quantification. Collected and reported data will feed a TE multiscale model to predict growth and inform BRS protocols.
We will use a porcine model with applied TE and RT for mechanical testing and histology analysis. From this model, we will quantify the cellular expression of mechanoresponsive proteins such as YAP and TE-induced area growth. Moreover, we will create a 3D culture that mimics the cell environment under TE and RT to translate our results to the human case. This 3D model will have dermis-like fibrillar hydrogels and human skin cells. We will quantify protein expression, growth, and mechanical properties, as done in the animal model. We expect the nuclear YAP activation, collagen production, and proliferative activity to increase with stretching time. We also expect the hydrogel stiffness to correlate with fiber

network changes. We will describe the multiscale TE dynamics with a cell signaling model linked to a tissue physical model. This study will provide a multiscale characterization of the skin tissue and cellular activity when they undergo TE. Our results will help elucidate critical factors in the BRS process that will help design better protocols to diminish adverse effects.

Emergence of integrated visual motion responses across the cortical hierarchy
Elizabeth Frazier (Maria Dadarlat Makin/Anne Sereno, advisors)

Abstract: The perception of visual motion is fundamental for navigating and interacting with our surroundings. In the brain, visual motion is first detected locally by neurons in the primary visual cortex (V1), whose responses are limited to small, discrete regions of the visual field. To recognize coherent motion of larger visual scenes, like a flock of birds or the flow direction of a river, higher visual areas must integrate the spatially distinct local motion signals from V1 (e.g., movement of a single bird) into a unified global motion percept. While specific cortical regions are known to specialize in this process, it remains unclear how integrated motion signals emerge throughout the cortical network. In this study, we investigated the emergence of motion sensitivity across the visual cortex of mice using two types of motion stimuli: drifting gratings (representing local motion) and random dot kinematograms (RDKs; representing global motion). We recorded mesoscale neural responses to these stimuli using *in vivo* two-photon calcium imaging in mice expressing GCaMP6s, a fluorescent indicator of neuronal activity. Our results showed a gradient of motion selectivity along the cortical hierarchy, with V1 robustly responding to grating stimuli and higher visual areas exhibiting enhanced tuning to the direction of the RDKs. This gradient was matched by an increase in neural response latencies, suggesting higher visual areas may perform spatiotemporal integration of local motion into a global motion signal. Furthermore, analyses of latent neural population dynamics revealed distinct encoding patterns for the two types of motion stimuli. These findings deepen our understanding of the functional role of mouse higher visual areas in visual motion processing. Ultimately, this work has important implications for expanding the utility of mouse models in studying the maladaptive changes in visual motion perception that characterize many neurological conditions.