PURDUE UNIVERSITY | Weldon School of Biomedical Engineering

BME 3rd Year Seminar Series
Friday, September 20th, 2024
1:30 – 2:30 PM EST
MJIS 1001

Evaluation links:
Sayeh Jalali Dowlatshahi: https://purdue.ca1.qualtrics.com/jfe/form/SV_9uZc5YCxKVBPVsy
Jeffery Coulter: https://purdue.ca1.qualtrics.com/jfe/form/SV_4UDdcU7Dnqx6CVw

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

Quantification and Validation of Cervical Cancer-Associated Protein Biomarkers for Point-of-Care Early Cervical Cancer Detection

Sayeh Jalali Dowlatshahi (Jaqueline Linnes, advisor)

Abstract: Cervical cancer is the fourth most common cancer in women and the fourth leading cause of cancer-related deaths among them globally. Current gold-standard cervical cancer screening techniques are expensive and time-consuming, possess low sensitivity or specificity, and require trained personnel and sophisticated instrumentation, limiting their implementation in low-resource settings. Therefore, a low-cost, rapid, sensitive, and specific point-of-care (POC) early-stage cervical cancer diagnostic assay is urgently needed. This research develops a complete workflow for cervical sample collection, processing, testing, and result interpretation, for a POC cervical cancer screening test based on a paper-based lateral flow immunoassay (LFIA). Common cervical samplers were compared to identify the one with optimal cellular recovery. Subsequently, a simplified cell lysis technique using radioimmunoprecipitation assay lysis buffer was developed for specimen processing. The LFIA's target biomarker is topoisomerase II alpha (TOP2A), an enzyme innately involved in DNA replication that tends to be overexpressed in cervical cancer patients. The test's colorimetric labels are 40-nm gold nanoparticles conjugated to mouse anti-TOP2A detector antibody (dAb) molecules. Conjugation efficiency was assessed through commercial quality control dipstick tests and dynamic light scattering. The chosen conjugate was then

used with in-house dipstick assays to determine the control line's optimal goat anti-mouse immunoglobulin G antibody concentration. The test line's performance is being evaluated by testing various dAb:protein molar ratios using in-house dipstick tests. Once optimized, all these parameters will be incorporated into the TOP2A LFIA design. The device performance will be evaluated with lysates of clinical cervical swab specimens. Furthermore, the feasibility of multiplexing TOP2A with other known cervical cancer protein biomarkers and machine learning-assisted result interpretation will be investigated. This low-cost rapid test will enable sensitive and specific cervical cancer screening in resource-limited regions, leading to more timely diagnosis and earlier effective treatment.

A hybrid discrete-continuum model for simulating multiscale biological systems
Jeffery Coulter (Taeyoon Kim/David Umulis, advisors)

Abstract: Biological systems often consist of constituent elements operating at distinct temporal and spatial scales. For example, calcium is a small ion that diffuses quickly throughout the cell and its signaling is known to interact with the actin cytoskeleton to regulate cell-scale morphology and function. It has been suggested that a relationship between calcium and actin is involved in diverse phenomena ranging from fertilization to long-term potentiation. However, due to the differences in length and time scales at which these components operate, attempts to model such systems must make sacrifices regarding information loss or computational effort. Biochemical reactions are often modeled as continuous systems using differential equations while discrete models more accurately capture the dynamics and structure of actin filaments. Here, we present a method that combines discrete and continuum approaches to model filament networks coupled with biochemistry.