PURDUE UNIVERSITY | Weldon School of Biomedical Engineering

BME 3rd Year Seminar Series
Friday, October 4th, 2024
1:30 – 2:30 PM EST
MJIS 1001

Evaluation links:
Derrick Dankwa: https://purdue.ca1.qualtrics.com/jfe/form/SV_5ySH0bGTMW2k2eW
Bibek Raut: https://purdue.ca1.qualtrics.com/jfe/form/SV_3epBmUlT7ICU3ZQ

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

A model-guided approach to designing a biological controller for macrophage paralysis in sepsis

Derrick Dankwa (Leo Green, advisor)

Abstract: Sepsis, a life-threatening condition characterized by the body's extreme response to infection, affects millions globally and is a leading cause of death in intensive care units. A critical aspect of sepsis pathophysiology is macrophage paralysis, where these vital immune cells become dysfunctional, severely compromising the body's ability to fight infection. Despite advances in sepsis management, effective therapies targeting macrophage paralysis remain elusive. Therapeutic modulating macrophage populations has been proposed as a novel strategy to dampen inflammation in septic conditions. To inform the design of a novel class of immunotherapies that control the critical divergence of the immune response during septicemia, we must understand the intricate differences in immune cell dynamics and coordinated molecular signals between healthy and septic states. Here, we deployed an ordinary differential equation (ODE)-based model to capture the hyper and hypo-inflammatory phases associated with sepsis. Our findings suggest that disrupted macrophage polarization results in excess monocytes, M1 and M2 macrophage phenotypes, leading to immune paralysis. Using our model-based analysis, we designed a proof-of-concept design of a biological controller that could effectively regulate macrophage dysregulation observed in sepsis. Our model describes a systems biology approach to

predicting and exploring critical parameters as potential therapeutic targets that promise to transition sepsis-induced inflammation toward an improved healing state.

AI Surveillance and On-Farm Diagnostics for Improved Livestock Farming
Bibek Raut (Mohit Verma, advisor)

Abstract: The rising global demand for animal-based products has increased pressure on animal farms to increase their productivity while maintaining high animal welfare standards. Concurrently, a shrinking pool of available labor and the specialized training required for effective in-person surveillance have led to less frequent animal health monitoring. Thus, there is a critical need for practical and deployable digital health and productivity technologies capable of providing real-time observations and analysis, to allow data-driven decision-making. To fill this gap, our study combines artificial intelligence (AI)-assisted surveillance with portable, on-farm nucleic acid-based diagnostics. The AI surveillance component is an intelligent sensor system that combines various video types with environmental sensors and provides insights into animal behaviors such as time spent feeding and drinking, number of aggressive incidents, as well as tracking body weight gains. This data-driven approach enables the detection of anomalies in behavior and environment, allowing farmers to focus on specific groups of animals that may require attention, thereby optimizing resource allocation and improving overall productivity. On the other hand, our portable nucleic acid-based tests employ loop-mediated isothermal amplification (LAMP) on microfluidic paper sensors, enabling rapid and cost-effective on-farm diagnostics and reducing the dependency on centralized facilities. Thus, by integrating continuous behavioral monitoring with advanced on-site diagnostics, the proposed system enhances decision-making processes, supports farm staff in their roles without replacing human expertise, and helps improve animal welfare and increase farm productivity.