REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHB-27-07

Synthetic Biology-Powered Closed-Loop Systems for Sensing and Delivery of Interventions

PROJECT DESCRIPTION: Modern warfare operations often occur in volatile, uncertain, complex, and ambiguous environments with limited logistical support. In these challenging circumstances, wearable platforms capable of assessing warfighters' physical and cognitive distress are valuable tools for maintaining health and optimizing performance. Our solution involves the development of a novel wearable platform that exploits synthetic biology to sense biomarkers related to different conditions and deliver targeted biochemical interventions. This closed-loop system requires no user intervention to monitor and mitigate issues encountered in the field.

The goal of this project is to develop closed-loop systems within living cells, specifically utilizing the probiotic *E. coli* strain Nissle 1917. These *E. coli* cells will be engineered to sense biomarkers indicative of specific conditions, integrate information, and autonomously produce mitigation responses through a genetically encoded feedback loop. Previously developed biological sensing elements, such as regulatory proteins—allosteric transcription factors—will be employed to detect specific health and performance biomarkers. In response to these biomarkers, the engineered pathway will trigger the production of appropriate mitigation compounds. This approach will enable continuous monitoring of warfighters' health and performance status and autonomously deliver relevant interventions to optimize health and performance levels.

LEARNING OBJECTIVES: Under the guidance of a mentor, you will gain hands-on experience to complement your education and support your academic and professional goals. Along the way, you will engage in activities and research in several areas, including but not limited to:

1. Conduct literature reviews to support the project.
2. Learn about and engage with bacterial engineering techniques, closed-loop systems, allosteric transcription factors, and human health and performance biomarkers.

ACADEMIC LEVEL: Undergraduate; Master's; Doctoral

DISCIPLINES NEEDED: Biology/Synthetic Biology; Biomedical Engineering, Biochemistry

RESEARCH LOCATION: Wright-Patterson Air Force Base, Dayton, Ohio

RESEARCH MENTOR: Svetlana Harbaugh, Ph. D

Biochemistry, Moscow State Lomonosov University, 1999



Dr. Svetlana Harbaugh is a Research Scientist at the 711th Human Performance Wing of the Air Force Research Laboratory, USA. She earned her Master's degree in Chemistry and PhD in Biochemistry from Moscow State Lomonosov University, Russia. Her research focuses on designing and engineering living systems and their derivatives for sensing and augmenting human health and performance.

The material was CLEARED on 10 Dec 2025; Reference Number: AFRL-2025-5591.