Thesis Portfolio

Designing an Updated System for Time Lapse Microscopy to Study *Toxoplasma gondii* Invasion in Intestinal Epithelial Cells
(Technical Report)

A Framework for Improving Early Access to Nutritional and Mental Healthcare to Decrease the Prevalence of Preventable Diseases in the United States
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Carolyn Graham
Spring, 2021

Department of Biomedical Engineering

Table of Contents

Sociotechnical Synthesis

Designing an Updated System for Time Lapse Microscopy to Study *Toxoplasma gondii* Invasion in Intestinal Epithelial Cells

A Framework for Improving Early Access to Nutritional and Mental Healthcare to Decrease the Prevalence of Preventable Diseases in the United States

Thesis Prospectus

Sociotechnical Synthesis

The United States Healthcare system is reactive, focused primarily on diagnosing and then treating health issues after they occur, rather than preventing them from occurring in the first place. Much of this reactive treatment consists of treatment for chronic diseases. Heart disease and diabetes, both common chronic diseases, are leading causes of death in the United States. However, the prevalence of chronic diseases such as these could be significantly decreased if preventative measures were taken to eliminate traditional risk factors. This is an example of how society tends to seek technological fixes to symptoms of a problem, instead of focusing on fixing the root cause of the problem. Therefore, both the STS research paper and the technical paper investigate methods for treating the underlying problems behind diseases as a means of reducing the need for reactive treatment. For the technical topic, a mechanobiology approach is used to study the underlying causes of toxoplasmosis, an illness similar to the flu, with the goal of determining how underlying health problems can increase risk of developing severe toxoplasmosis. Similarly, the STS research paper lays out a framework for improved nutritional and mental healthcare to be implemented in the United States education system as a means for preventing a plethora of diseases before they set in.

The technical paper focuses on the design process for an environmental chamber to mimic physiological conditions for cell stretching experiments with intestinal epithelial cells. These cell stretching experiments are ultimately used to determine the relationship between toxoplasmosis and the abnormal peristalsis associated with inflammatory bowel disease, with the hypothesis that abnormal peristalsis results in increased susceptibility to toxoplasmosis. Although the technical project did not pass the stage of conducting cell stretch experiments, there

is potential for these experiments to later yield information that leads to the development of a therapeutic option for toxoplasmosis.

The STS paper uses actor-network theory, policy analysis, and network analysis to study the connection between nutritional and mental healthcare, and how to improve access to both through educational programs, with an additional focus on equity. A framework for the expansion of nutritional and mental healthcare through educational programs in schools and increased access is proposed as a form of preventative healthcare. This form of preventative healthcare has the potential to decrease the prevalence of many preventable chronic diseases, and consequently reverse the increasing social and economic burden of chronic diseases on the United States healthcare system.