Thesis Project Portfolio

Creating a Three-Dimensional, Perfusable Capillary *In Vitro* to model Cerebral Cavernous Malformation

(Technical Report)

Analyzing the Experiences of Women in Engineering Research at The University of Virginia

(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

Lauren Porter

Spring, 2024

Department of Biomedical Engineering

Table of Contents

Sociotechnical Synthesis

Cerebral Cavernous Malformation (CCM) is a vascular disease that affects the brain and spinal cord and causes the formation of lesions. It has been hypothesized that CCM functions with Knudson's two-hit mechanism: the first “hit” involves an inherited genetic mutation, and the second “hit” is unknown. I hypothesized that the second “hit” is related to endothelial cell exposure to shear stress. It has been proven that hemodynamic shear stress significantly impacts endothelial cell morphology and function, but there have been no published findings linking shear stress to the initiation of CCM. Studying cell response to shear stress due to flow through a tubular vessel requires a model that recapitulates the anatomical structure of vasculature. CCM has previously been studied in mouse models, but it is very difficult to study cellular mechanisms and cell response to shear stress in vivo. Hydrogel scaffolds have been widely researched as a basis for manufacturing engineered tissues, organs, and blood vessels in three dimensions (3D). My technical capstone project aimed to elucidate the role of endothelial shear stress in CCM causation by designing an *in vitro* 3D, perfusable, artificial capillary.

It is important to have a diverse workforce in engineering research laboratories to ensure that problems affecting diverse populations are studied. My socio-technical thesis focused on analyzing the experiences of women in engineering research at the University of Virginia (UVA) to answer the question: how can universities increase equity, diversity, and inclusion (DEI) of women into engineering academia?

To answer this question, I conducted a survey on gender dynamics in engineering research laboratories at the University of Virginia and gathered 85 responses. I analyzed these responses within the framework of feminist theory to determine the areas where UVA needs the greatest improvement and the areas where UVA excels. Overall, the survey found that the two most commonly cited positive actions UVA has taken were the positive culture created by other female engineering students and female researchers having supportive faculty advisors and mentors. The two most commonly cited examples of things UVA could improve upon were to hire more diverse faculty and to establish a clearer reporting system for instances of gender-based violence, harassment, or discrimination.

By developing strategies for universities to increase the DEI of women into engineering academia, this thesis aims to lay foundations for creating laboratories where researchers from a wide variety of backgrounds are represented and contribute to revolutionary science. Particularly in the field of biomedical engineering, this means that diseases affecting historically underrepresented and oppressed groups are more likely to receive the attention, study, and funding they deserve.