Thesis Portfolio

Identifying Nuclear Membrane Proteins that Facilitate Chromosomal Mechanotransduction

(Technical Report)

The Effect of Ethical Restrictions on Stem Cell Research and Innovation Since 1998

(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

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Spring, 2020

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Table of Contents

Sociotechnical Synthesis

Biomedical engineering has a wide array of focuses for study, including medical device technology, cellular and tissue engineering, and biomedical data science, among others. I have always been interested in tissue engineering and, in particular, the mechanism in which regeneration occurs within a tissue engineering construct. The motivation for both my technical work and STS research paper stem for my desire to understand key principles involved in tissue engineering and how they can be used to make a translational impact on society. Specifically, my technical work developed from my work in Dr. Thomas Barker's Matrix Biology and Engineering Laboratory. The lab seeks to understand how mechanotransduction plays a role in idiopathic pulmonary fibrosis, in order to develop therapies for the disease. Through my work in the lab over the past two and a half years, my technical project has been shaped to identify specific protein targets in early stage mechanotransduction. Because of my work in the Barker lab, along with the classes I have taken as an undergraduate, I have also learned about stem cells and their role in regeneration for tissue engineered constructs. These studies drove me to question how stem cell research has been affected by the ethical concerns surrounding their usage in translational studies. These motivations combine together to deliver both my technical and STS research papers to explore tissue engineering principles in a translation setting.

Idiopathic Pulmonary Fibrosis (IPF) is an end-stage lung disease that is mediated by force interactions within the lung epithelium. The current standard of care aims to reduce the symptoms of the disease through non-curative drug treatments or by lung transplantation. Our team aims to determine an additional upstream target that would reduce the progression of fibrosis. We hypothesize that LRP-130, CAPZ-α, and MATR3 play a role in force mechanotransduction and ultimately IPF. To determine the proteins involved in the mechanosensitive signaling pathway, a

magnetic precipitation technique is used to pull down the proteins involved. These proteins are then analyzed through proteomics techniques such as western blotting and immunofluorescence. A knockdown study was performed to determine the individual role the proteins play in YAP/TAZ nuclear translocation. LRP-130, CAPZ-α, and MATR3 have been established as potential proteins in the pathway and have been identified in samples subject to force. The localization of these proteins has been linked to the nuclear membrane. Additional knockdown studies will be performed to determine the extent to the protein's effect on YAP/TAZ nuclear translocation. Overall, we have observed that these proteins play a role in regulating the cellular response to force mechanotransduction. This work is significant to the future of IPF treatments as these proteins serve as potential targets for curative therapies.

Stem cells are a controversial, yet promising therapy to regenerate tissue and normal cellular function after injury. While stem cells offer a plethora of research and therapeutic possibilities, they have also generated a mass ethical rejection, leading to legislation that restricted their use. This paper explores the extent to which public and political discourse affected the development of novel stem cell technologies. Overall, this paper seeks to answer the research question "how has ethical rejection of stem cell research affected the progress of the field from 1998 to present day?" To conduct this research, historical and political case studies serve as a basis to understand how the progress of research was affected. In addition, the science, technology, and society frameworks of technological momentum and political technologies shape the understanding of eras of research as having a more constructivist or deterministic viewpoint, as well as determine the political nature of the technology as a whole. This research will specifically determine if certain stem cell technologies arose from periods of restriction, overcoming the barriers of political legislation to continue to strive for the development of life changing therapies.

By utilizing stem cells as a case study to understand the motivation behind novel research findings, these conclusions can be applied to other research areas to analyze technological progress and look toward the future growth for these technologies.

Through working on both the technical project and the STS research paper, I have gained knowledge in both an academic and translational setting. My technical project focuses on research and development work that will ultimately be used in translational therapies, however, the current stage of the research is particularly exploratory. In comparison, my STS research paper seeks to understand the effect of public discourse or the post translational reaction on research and development studies. By performing both of these projects in the same time period, I have learned to understand the impact of work done in both settings, while also keeping in mind how work in translational research can affect research and development and vice versa. These projects have been incredibly valuable to my understanding of biomedical research as a whole and, in particular, the importance of the public opinion on future work.