Thesis Project Portfolio

Focused Ultrasound Assisted Delivery of Thiolated Nanoparticles in Tumor Microenvironments

(Technical Report)

An Analysis of Relevant Social Groups Prior to Major Animal Testing Regulation

(STS Research Paper)

An Undergraduate Thesis

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

My technical capstone project and my STS research project are directly connected through the use and study of animal testing. My technical capstone project focuses on the development of a novel therapeutic approach for treating brain cancer and features the use of an animal model. My STS research paper delves into the regulation history of animal testing which is used to bring new technologies like this to the market and was required until recently. By exploring these two connected elements simultaneously, I aim to gain a more holistic understanding of how technology shapes and is shaped by the socio-cultural context in which it operates and how these processes may affect the researchers themselves.

My technical capstone project centers around the development of thiolated nanoparticles for targeted drug delivery in the treatment of glioblastomas, a highly aggressive form of brain cancer. These nanoparticles are designed to exploit the increased level of thiol groups found in the tumor microenvironment, allowing for enhanced drug delivery directly to cancerous cells while minimizing systemic exposure and potential side effects. Through a series of experimental aims, including investigating exofacial thiol levels, synthesizing and testing nanoparticles, and utilizing focused ultrasound for enhanced delivery, the project aims to improve treatment outcomes for patients with glioblastomas in the future. Initial testing explored exofacial thiol levels across different cell lines, bEnd.3 (endothelial) cells GL261-Luc2 (cancer) cells. The goal of this portion was to validate the hypothesis that tumor cells express elevated thiol levels compared to normal cells. The next phase involved synthesizing and testing the actual thiolated nanoparticles and then treating cells with them to gauge their binding efficiency and transfection efficacy. The nanoparticles were found to have an increased transfection-to-binding ratio compared to unthiolated nanoparticles. Finally, we utilized focused ultrasound in combination

with microbubbles to determine the most effective time for focused ultrasound application during treatment with these nanoparticles.

My STS research paper traces the regulation history of animal testing from its mandated inception in drug approval processes in 1938 to a recent shift in legislation removing this requirement in 2022. In the paper I argue that animal testing represents two distinct artifacts shaped by different social contexts and motivations over time. The paper highlights the contributions of animal testing to medical advancements while acknowledging its limitations in predicting human responses and ensuring safety and also discusses emerging alternatives to animal testing and explores various ethical frameworks surrounding the practice. The paper's core analysis examines the shifting of relevant social groups attitudes towards animal testing and power over time. Through this analysis it was found that these groups were influenced by factors such as public safety concerns, business interests, and ethical considerations but that these differed between 1938 and 2022. The conclusion asserts that animal testing has evolved into two separate practices, each reflecting the prevailing societal values and motivations of its time. It emphasizes the importance of reassessing outdated practices in light of changing societal norms and technological advancements. Overall, the paper provides a comprehensive examination of the historical, ethical, and societal dimensions of animal testing, and pushes for future work to be done analyzing other timepoints in the history of animal testing regulation along with the regulation of other technological artifacts.

Working on both the technical capstone project and the STS research paper at the same time has enriched my understanding of both subjects by expanding the lens through which I viewed each one. While the capstone project delved into the practical application of nanoparticles for targeted drug delivery in glioblastomas, the STS research paper offered a

broader context by examining the historical, ethical, and societal dimensions of animal testing which is used heavily in my technical capstone projects experimentation. The synthesis of these two projects allowed me to see the technical aspects of my capstone within the larger landscape of biomedical research and ethical considerations. This was most prevalent with my work on animal testing due to the direct overlap but my STS work brought other testing methods and lab protocols into question. This allowed me to dig deeper and learn more about why we do things the way we do as researchers which has improved my ability to do future biomedical research. Conversely, insights gained from the technical challenges of nanoparticle synthesis and testing informed my understanding of the complexities involved in developing alternative methods to animal testing and provided an alternative view for why innovation for testing methods outside of animal testing has stifled. By doing the research and seeing how different models do not always share the same outcomes it highlighted that animal testing may be the status quo because other alternatives were not technologically feasible until recently and not that the requirement for animal testing stifled progress. Overall, working on both projects simultaneously allowed me to consider the technical and social lenses of technological development both separately and together thus increasing the level of consideration given to the smaller components of each project that may have otherwise gone unnoticed.