**Thesis Project Portfolio**

# OrChID-Bio: Organs-on-a-Chip with Integrated Detection of Bioluminescence

(Technical Report)

# An Ethical Consideration of Organoid Technology

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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## Sociotechnical Synthesis

### Introduction

Organoids are emerging powerful technology systems that mimic the complexity of organs and provide an opportunity to accurately model human biology. Organ-on-chips (OoCs) are 3D microdevices that model the structure, functionality, and behavior of specific tissues or organs using human cells. OoCs serve as a branch under the organoid technology field but have an added device fabrication component of incorporating microfabricated fluidic channels and microelectronics. OoCs devices are currently used to replicate human organ functions in a controlled laboratory setting for drug testing and disease research. The goal of the Technical Capstone project is to contribute to the development of OoCs in a clinical setting by enhancing the accuracy of bioluminescent monitoring instrumentation in the microfluidic device. The STS research project will focus on the ethical consideration of organoid technology use, as the field is continuously changing and growing faster than regulations can manage. Working at the intersection of medicine and engineering, Organs-on-a-chip present an enormous advancement in the field of biomedical research and therapeutic design. As such, the technology of organoids and OoCs pose several ethical considerations. By carefully reviewing current policies and understanding the gaps in regulation of this technology, a framework can be created to responsible and transparent development, addressing potential risks, and promoting the ethical use of these innovative advancements in healthcare and research.

### Project Summaries

The technical portion of my thesis produced is to contribute to the development of OoCs in a clinical setting by enhancing the accuracy of bioluminescent monitoring instrumentation in the microfluidic device. The two aims of the project are to integrate and optimize isolated functional components of the current OoC into a cohesive protocol and analyze bioluminescence data from a circadian timescale. The listed aims were implemented by testing the OoC system in the laboratory environment on human and mouse enteroids modified for bioluminescence and cultured on two different commercial Organs-on-a-chip systems. The data collected will be validated by data collected from off-chip monitoring using a KronosDio luminometer, which is the device currently used for bioluminescence monitoring in this lab. The team also developed computational tools to analyze circadian rhythms of intestines-on- a-chip over days to weeks while tracking gene expression of human tissues in micro-physiologic systems. At the conclusion of this project, the Capstone team demonstrated an integrated OoC system for detection of bioluminescence for circadian rhythm analysis.

In my STS research, I performed a review of existing literature on organoid technology and current ethical guidelines. Similarly, I also analyzed the ethical frameworks that exist in the field using the STS lens of responsible research and innovation. This also helped in researching and selecting the best consent framework for donors of organoids while still allowing broad use of the technology. I also studied organoid development policy of major corporations and governments to understand how privacy concerns and commercialization of this technology is being addressed. Lastly, case studies and workshops from various patients and donor perspectives were used to understand the future trajectory of the field in the public view.

## Conclusion

Working at the intersection of medicine and engineering, Organs-on-a-chip present an enormous advancement in the field of biomedical research and therapeutic design. The OoC system will present a more efficient and streamlined method of analyzing intestinal tissue using real-time bioluminescence detection. As such, my STS research helps put into perspective the greater implications of the technology I am building. Using the responsible research and innovation lens was important to understand how technology can be limitless while maintaining ethical standards. Working with these projects together built my engineer's sense of morality and reinforced my commitment to leveraging cutting-edge innovation responsibly, ensuring that scientific progress aligns with ethical considerations for the benefit of society.

Finally, I'd like to acknowledge my STS professor, Professor Richard Jacques, my capstone advisors, Dr. Sean Moore, Dr. Vinicios Alves Da Silva, Georgia Brousseau, and Professor Timothy Allen, and my capstone teammates, Stone Zhang and Hamza Ahmed.