

Thesis Portfolio

Increasing the Production of dsRNA for Use as Biological Pesticides
(Technical Report)

The Societal Implications of Ethical Ambiguities in Biohacking
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

Synthetic biology is the gateway to modern biotechnology. One important application is to develop the next generation of biopesticide technologies. RNAi biopesticides utilize synthetic biology to protect crops and mitigate the environmental and human health risks associated with traditional chemical pesticides. However, RNAi biopesticides have not yet been commercialized in the agriculture industry. The technical report describes how to improve the efficacy of RNAi biopesticide technology in partnership with the startup company AgroSpheres, Inc. The STS report also involves an investigation of the impacts of synthetic biology in society through biohacking. This research involves risk analysis relating to the ethics involved in biohacking to promote safety in using powerful synthetic biology technologies.

One approach we took to enhance AgroSpheres' technology was to implement an exponential feed rate algorithm within their fed-batch fermentation process. We found the exponential feed rate that yielded the highest dsRNA production rate, best cell viability, and cell density. In addition, we characterized the expression patterns of the GFP-fused dsRNA binding protein under various experimental conditions. This product protein is expressed by the bacteria in order to stabilize prevent degradation of dsRNA used in the biopesticide. The impacts of various inducer concentrations on both cell growth and product protein production was studied in two different types of growth media. In addition, we tested the effects of various induction timing periods. From these studies, we were able to establish both an optimal inducer concentration in each media type and an ideal induction timing for product protein expression and biomass production. These improvements in both fermentation and protein expression support AgroSpheres' efforts to be the first commercially successful RNAi biopesticide.

The STS research paper investigates the impacts of the rise of biohacking in society. The topic is framed in the context of Ulrich Beck's reflexive modernization and world risk society theories. The ethical obscurities in biohacking are analyzed to determine how this creates uncertainties and risks to society. Specifically, this includes a review of the current ethical codes governing the biohacking community. I discuss weaknesses in the existing code of ethics and the role of additional factors such as the internet and the mass media in contributing to the development of risks that can threaten public wellbeing. However, I also examine the potential benefits of the current lack of ethical regulation for biohackers in promoting creativity and innovation through open science. The research supports Beck's idea of reflexive modernization through identifying how ethical uncertainties in biohacking affect society in order to encourage reflection and prevent disastrous outcomes.