Thesis Project Portfolio

Maximizing Acetyl-CoA Output by Genetically Engineering *E. coli* for the Overall Output of the Bioplastic PHB

(Technical Report)

Stakeholder Engagement in Pro-Sustainable Actions within Municipalities

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The world's continuing reliance on single-use, petroleum-based plastics has caused their production and use to lead to detrimental effects on the environment, such as pollution via greenhouse gases. The leaching of plastics into the environment also pose a risk to human health due to its eventual consumption by humans through its entry into the food chain. Alternative solutions, such as bioplastics, provide a sustainable alternative to conventional plastics by sharing similar characteristics while being non-toxic and biodegradable. Bioplastics, such as polyhydroxybutyrate (PHB), also provide the ability to create a more circular economy by being natural byproducts of facilitated degradation of petroleum-based plastics, such as styrene, through metabolic mechanisms found in microorganisms like *E. coli*.

Transfoam LLC utilizes such pathways found in *E. coli* to design a bioengineered *E. coli* strain that employs two exogeneous plasmids that provide the microorganism the characteristics of styrene degradation (*sty*) and PHB production (*pha*). However, bioplastics like PHB are expensive and inefficient to manufacture in comparison to the mass manufacturing of conventional plastics. The technical thesis aims to ameliorate this problem by increasing its production of PHB by increasing a precursor metabolite to PHB production called acetyl-CoA through gene edits on nonessential pathways in a modified *E. coli* strain by Transfoam LLC (i.e., *E. coli* without the *sty* plasmid). In addition to experimental validation of potential gene edits, a metabolic model was built concurrently to simulate the metabolism of the edited microorganism and to determine other potential gene knockouts.

Although optimizing the efficiency of the production of bioplastic increases its potential to become more mainstream in the current plastic market, a waste and recycling infrastructure is also needed to properly facilitate the use and disposal of bioplastics. The STS thesis aims to provide such insights by investigating how municipalities, such as Chicago, Illinois, engage its stakeholders in the development of pro-sustainable actions like recycling. The City of Chicago provides a platform to investigate the weaknesses in stakeholder engagement due to their lack of improvement in their recycling rates despite their ongoing efforts to improve their waste and recycling infrastructure. Additionally, the City's history of environmental injustices due to past racist urban policies highlight how pro-environmental claims can exclude certain stakeholders, such as marginalized communities. By investigating how the City manages their internal stakeholders (e.g., private contractors for recycling pick-ups, the City of Chicago government) and addresses their external stakeholders (e.g., residential households, marginalized communities), insights can be garnered on how current waste and recycling infrastructures could be improved to better support the inclusion of bioplastics into creating a more circular economy.