Sociotechnical Synthesis

Diabetes mellitus consists of a group of metabolic diseases which all share a common characteristic of inducing elevated blood glucose levels. This increase is often due to a dysregulation (type I diabetes) or dysfunction (type II diabetes) of native insulin, and current statistics suggest approximately 34.2 million individuals in the United States are affected by diabetes. The current standard for treatment is the self-administration of insulin, but this has become difficult for many diabetic patients as insulin prices are at an all-time high and are predicted to continue increasing. This situation calls for a deeper look into the insulin market and the consequent rising tensions between diabetic patients and pharmaceutical companies, as well as the viability of a new supplemental treatment which can be taken by diabetic patients to reduce their reliance on insulin.

My technical project aimed to find a new supplemental treatment for diabetic patients through a synthetic biology approach. Specifically, I designed a bacterium which can mimic the effects of insulin by increasing the conversion from glucose to glycogen. This was done by designing a novel plasmid, called pKID1, which contains four genes involved in glycogen synthesis. These genes are placed under the control of a rhamnose-inducible promoter, such that the genes in glycogen synthesis are only expressed in the presence of rhamnose. This plasmid was transformed into electrocompetent JM109 cells and the expression under rhamnose was verified by measuring the protein expression with a western blot. Functionality of the plasmid was then tested by measuring the intracellular glycogen concentration after a 6-hour culture in glucose-supplemented M9 media, which showed a significant increase in intracellular glycogen in pKID1 transformed cells compared to control cells. This design represents a prototype probiotic treatment, which would work by having a diabetic patient take probiotic pill prior to a

meal. The bacteria would then work in the small intestine and mimic the effects of insulin by uptaking extracellular glucose and converting it into glycogen. The potential of this prototype to be used as a probiotic offers a less expensive treatment method for diabetic patients by reducing their reliance on expensive insulin.

My STS research focuses on how insulin market came to the position where it is today and the relationship between diabetic patients and the pharmaceutical industry. I begin by discussing the history of insulin and the price trends which have brought the United States insulin market to where it is today. I then look into policy and legislation changes at both the federal and state level and the attempts made by the government to control the insulin market. To understand the relationship between diabetic patients and the pharmaceutical industry, I break down the insulin production pipeline and the advocates for each side of this relationship. Through this paper, I conclude that the conflict between diabetic patients and pharmaceutical companies is complex and that blame can not easily be placed on either side. This conflict arises from several different factors all leading to the rise in insulin prices and the decrease in insulin availability for diabetic patients. While there is no clear solution currently to this conflict, a combination of new legislation giving control to the insulin market combined with looking outwards at how other nations have controlled drug prices may give insight into a potential solution.

Working on both the technical and sociotechnical aspects of this project have given me important insight into how the technical skills and concepts I have learned have an impact on other individuals worldwide. Specifically, the design of a potential drug is only the first part of the drug design and manufacturing process. How the drug is actually accessible to individuals and their efficacy outside of the laboratory setting is a completely separate process which needs

to be considered during the research and development phase in order to maximize the benefits of the product to its intended consumers.