Thesis Portfolio

Design of a Pembrolizumab Manufacturing Plant Using Continuous Bioprocess Technology and Single-Use Bioreactors

(Technical Report)

Historical Analysis of Insulin Pricing and the Implications for Low-Access States such as Kentucky

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

There is currently a major push in the pharmaceutical industry to implement continuous bioprocessing techniques to reduce process time and overall manufacturing costs. This project seeks to design a manufacturing facility for the IgG4 monoclonal antibody therapeutic Keytruda (pembrolizumab) that integrates continuous technology in place of the more common batch-process approach. Keytruda is a protein therapeutic used to treat a variety of cancers including advanced melanoma and lung cancer. This design additionally implements single-use bioreactor bags in place of traditional steel bioreactors. These single-use bioreactors reduce plant cost and environmental impact by minimizing the need for the corrosive cleaning chemicals typically employed.

The unit operations that comprise this facility are continuous perfusion reactors, tangential flow filtration, depth and sterile filtration, viral inactivation, Protein A chromatography, cation exchange chromatography, anion exchange chromatography, viral filtration, and a variety of diafiltration buffer exchanges.

The design of biopharmaceutical facilities is inherently connected to healthcare in that a reduction in production costs can in turn reduce the amount paid by patients. Additionally, increases in process yield can improve drug accessibility throughout the world. Although Keytruda is a contemporary biological therapeutic, the prices of many previously developed protein therapeutics are still costly and often disputed. The price of insulin therapeutics, in particular, has been highly contested in recent years. This research, therefore, analyzes the trends in insulin prices and corresponding price increases in conjunction with the historical interactions of the stakeholders involved in these price changes. The actor-network theory and justice-based ethics

will be incorporated to study these interactions and the implications of price inflations for users of protein therapeutics. Actor-network theory proposes that interactions between objects, ideas, processes, and humans can constantly reconfigure society. Justice-based ethics is concerned with the meaning of what is “fair” and inherently applies to healthcare distribution.

This research primarily consists of a document analysis of drug patents, federal and state healthcare policy, pharmaceutical company growth and sales, and the involvement of healthcare providers. Through this combination of the actor-network theory and justice-based ethics, this research will suggest a co-occurrence between the events and actions of various stakeholders and these price inflations. The justice-based approach will subsequently explore the implications of further price increases for patients with low-access to healthcare, namely those in the Southeast United States.

By combining my work in producing a cost-effective manufacturing process for producing protein therapeutics with a historical understanding of contributions to drug-price inflations, this research will suggest possible societal and technical avenues for improving humanity’s benefit from medical innovations.