Thesis Project Portfolio

Proposed Methods to Optimize Growth, Imaging, and Analysis of *Bacteroides Thetaiotaomicron* Biofilms

(Technical Topic)

Evaluating Social and Technological Influences on Patient Misuse in the Rise in Antibiotic Resistance

(STS Topic)

An Undergraduate Thesis

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Table of Contents

Executive Summary

The technical work and STS research carried out in this study both regard the medicinal use of antibiotics. The technical project studies the impact of sphingolipids on the growth dynamics of B. theta (Bacteroides thetaiotaomicron), a prominent gut bacterium, in order to better understand such dynamics and to inform our understanding of the human gut microbiome. A healthy, well-balanced microbiome defends the gut against certain pathogenic bacteria and pathologies that arise from bacterial imbalance, so understanding growth kinetics and their dependence on sphingolipid production offers an alternative path to treatment from antibiotics. Additionally, better understanding the dependence of growth on biochemical signals such as sphingolipids provides possible avenues for new antibiotics and provides an opportunity to better predict the impact of antibiotics on the balance of gut bacteria. In this way, the technical and STS research topics taken up here explore the application of antibiotics and its alternatives for the remission of bacteriogenic diseases.

The aims of the technical project contained here were (1) to stain the biofilms of B. theta, B. theta with sphingolipid knocked out bacteria, and B.theta with sphingolipid inhibition (treated with myriocin) and (2) to perform image analysis to determine the percent coverage, depth, and general features of each biofilm. This research aims to evaluate the impact of sphingolipid production on biofilm formation in B. theta. An abnormal balance of gut bacteria species can result in dysbiosis of the gastrointestinal microbiome, which is linked to a number of diseases, including inflammatory bowel diseases, such as crohn's disease (CD) and ulcerative colitis (UC). An abundance of host produced sphingolipids and a deficiency of microbe produced sphingolipids have each been associated with CD and UC (Brown et. al, 2019). Recent literature suggests sphingolipids play a role in determining microbe dominance (Lee et. al, 2021).

Measuring the impact of sphingolipids on B. theta's growth and biofilm formation primarily serves to inform models of the gut microbiome which include B. theta and by extension serves to design and validate therapeutic strategies including antibiotics, probiotics, and microbiota transplant.

The STS research paper contained here examines the influence of social and technological factors on the misuse of antibiotics by patients which may promote rising resistance. Antibiotics are a powerful force in the fight against disease, but bacteria are reclaiming these tools at an alarming rate. Evidence suggests that the rise of bacterial resistance to antibiotics is affected by the cooperation of patients in the responsible use of this technology. An evaluation will be made first using the social construction of technology and then using technological determinism as frameworks. Because other work has detailed the role of producers and clinicians in the misuse of antibiotics, but inadequate attention has been given to patients' role in the process, this paper will focus on the patients' choices whether to follow an antibiotic regimen. The paper will also only consider how misuse may promote resistance, rather than how patients' desire to seek out antibiotic treatment may affect it. By detailing the factors motivating patients to misuse antibiotics, I hope to provide a framework that can be used both to understand the choices of healthcare consumers as they influence the development of antibiotic resistance and to better manage their involvement by addressing relevant design elements, public health education, and doctor-patient relationships.

The solutions both to bacteriogenic diseases and to rising antimicrobial resistance depend on social and technical factors. Working to understand the growth mechanisms of gut bacteria shows that there are alternatives to antibiotics and emphasizes that controlling bacterial growth isn't simply about killing some bacteria but about growing the right bacteria in healthy

proportions, a reframing of the problem away from the zero-sum mindset of some technological deterministic accounts. Understanding the social context of technical solutions and the technical limitations of social initiatives in this study has allowed for a more robust understanding of the problem which integrates social and technical components.

Works Cited

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