Recently, the Promislow lab found that levels of metabolites in the carnitine pathway can be used to estimate age in the fruit fly, Drosophila melanogaster. This ‘metabolite clock’ not only predicts an individual’s age, but also shows that when an individual’s predicted age is older than its chronological age, it has a higher mortality rate than other flies its age, and vice-versa. The carnitine pathway is required for energy production via fatty acid oxidation, for which carnitine also removes cellular waste products, and which may influence aging. I hypothesized that higher levels of carnitine would be associated with a longer lifespan, sustained by ongoing energy production and reduced cellular toxin accumulation. To test the effect of the carnitine pathway on fly aging, I measured the lifespan of flies while either supplying additional carnitine, or treating with the carnitine biosynthesis inhibitor etomoxir. I expect flies treated with supplemental carnitine to live longer than control flies, and that etomoxir-treated flies will live shorter than control flies. Approximately 125 female Drosophila melanogaster were assigned to food vials in each condition, plus a control condition that lacked added carnitine or etomoxir. I recorded deaths every two days, transferring remaining flies to fresh vials. Once all flies are dead, I use survival analysis to determine if either treatment affects lifespan, thus testing for a role of the carnitine pathway in fly mortality. Should the results support my hypothesis, I may explore the role that fatty acid oxidation has in aging, or to what degree the metabolome clock is affected by manipulation of the carnitine pathway.

Designing and Integrating a Blue Fluorescent Protein-Tagged Alpha-actinin Plasmid for Analyzing Sarcomere Dynamics in Relation to Tension Sensors in Cardiomyocytes

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Hypertrophic cardiomyopathy is a disease affecting millions
of people worldwide, characterized by thickened heart tissue, which makes pumping difficult for the heart. Since the restructur- ing of the heart is influenced by remodeling at the cellular level, the overall goal of the project is to investigate the mechanics of how cells sense tension in their environment and its relationship to regulating cell remodeling. The direction in which sarcomeres, the basic contractile unit in the heart, are added influences the shape of the cells and consequently the shape of the overall heart. To study this relationship, it is necessary to visualize the sarcomeres for correlat- ing acquired tension data from FRET sensors. By attaching a fluorophore to a sarcomeric protein such as alpha-actinin, it is possible to visualize sarcomeres using fluorescent micro-scopy. For this project, I developed a blue fluorescent pro-tein (BFP)-tagged alpha-actinin plasmid through molecular cloning techniques. I used restriction enzymes and PCR to isolate and amplify the genes of interest from a different plasmid, then used Gibson Assembly to insert the genes into a plasmid containing ampicillin resistance to construct the fi- nal BFP-tagged alpha-actinin plasmid. Preliminary results showed successful expression of the transiently transfected BFP construct in cardiomyocytes. The next steps are to op- timize the transfection for higher efficiency, adapt an exist- ing data analysis pipeline for analyzing sarcomere dynamics, and develop a set of parameters for efficient image acquisi- tion. Many existing therapies for hypertrophic cardiomyopa-thy only address symptoms but do not solve the underlying issue of systolic dysfunction. Rather than taking a genetic or biochemical approach, which can be difficult to develop, this research project focuses on the mechanical interactions in the heart and studying the contractile forces may yield more insight into this disease and build the informational founda- tion for developing future therapies to prevent or treat hyper- trophic cardiomyopathy.

Developing Propped Metal-Organic Frameworks for Carbon Dioxide Adsorption

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A critical strategy for achieving carbon neutrality is carbon dioxide (CO2) storage and sequestration, wherein CO2 is removed from emissions and stored underground. Current state of the art technologies, such as aqueous amine solu- tions, suffer from poor stability and recyclability primarily due to their homogenous nature. Metal–organic frameworks (MOFs), extended porous crystalline networks of metal nodes connected by organic linkers, have emerged as an exciting class of potential solid state CO2 storage materials owing to their high internal surface area and facile tunability. Here, we outline the synthesis of an expanded framework ana-logue of Matériaux de l’Institut Lavoisier-53 (MIL-53) frame-work functionalized with either ester based crosslinked lig-ands or bulky tert-butoxy carbonyl (BOC) protected carboxy-lates or amines, both of which prop open the pores of the framework. Expanded MIL-53 was characterized by pow-der x-ray diffraction, gas sorption analysis, thermogravimetic analysis, and proton nuclear magnetic resonance (NMR) digestion experiments. These myriad techniques reveal that the expanded MIL-53 framework’s surface area increases with higher incorporation of either ester based crosslinkers or bulky BOC groups. Subsequent thermal removal of the crosslinker or BOC groups to reveal the respective free func- tional group proceeds without compromising the structural integrity of the framework. Notably, the resultant ‘open’ pore structure is inaccessible without first propping the pores open. Future work will focus on investigating the carboxylate func- tionalized and amine functionalized frameworks for gas separ-ations and storage.

Using Non-Dispersive Infrared Sensors to Measure Carbon Dioxide (CO2) Footprint in Areas of High Construction Within the Puget Sound Region of Washington State

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The construction sector has always had a significant influence on CO2 footprints in a given area (Pomponi, 2021). How- ever, there are no recent studies quantifying the effect of construc-tion activities on localized CO2 concentrations. Previous research conducted in the early 1990s has shown that construc-tion increases CO2 concentrations by over 11% (Mazria, 2018). However, this research was done over three decades ago, and since then, CO2 concentrations have increased globally over 40%, necessitating updated measurements. My re-search group and I will investigate construction sites of vari-ous degrees in the Puget Sound region to determine the effect of construction activities on local CO2 concentrations. Pre-liminary data has shown an increase of 140 ppm (±8 ppm) in CO2 concentration when implementing a method of measur-ing CO2 concentrations in regions of high and low construc-tion activity within urban, suburban, and rural areas. This re-search is key to understanding the health implications of the increased construction within the Puget Sound region and its effects on our ecosystems.

Carbon Dioxide (CO2) Levels in the At-Home Study Rooms of an Online Student and an In-Person Student

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Since the beginning of the COVID-19 outbreak in 2020, many
students have participated in online learning. Online students spend many hours every day studying at home in indoor spaces that lack ventilation and may have hazardous air quality. Prior research conducted by Tyler Jacobsen et al. (2019) reveals that CO₂ concentrations over 1,000 parts per million (ppm) can increase physiological stress and lower cognitive abilities. The goal of this project was to determine if the CO₂ levels in the at-home study environment of a student conducting online learning are higher than those of a student conducting in-person learning during study times. I predicted that if a student participates in online learning, then the CO₂ levels in their study environment will be higher than those in the study environment of a student conducting in-person learning during school hours (8 am-3 pm), but the levels will be similar during homework hours (4 pm-5 pm). A CO₂ air monitor collected data in the study rooms of an online learning student and an in-person learning student. Over several days, I recorded data every hour from 8 am to 5 pm, resulting in a time series showing CO₂ concentrations throughout a school day. Preliminary data reveals that the online student’s room consistently exceeds 1,000 ppm and varies greatly throughout the day, while the in-person student’s room remains below 1,000 ppm until they arrive home at 4 pm, at which point levels increase significantly. I only observed two locations during this quarter-long research study in General Chemistry and I need to collect data at more locations to determine if this study’s findings are representative of online learning versus in-person learning as a whole. Findings may be useful to educators when they are deciding if online education is a viable option for students in the future.

Perceptions on Mobility Aid Use for Children with Cerebral Palsy
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Cerebral palsy (CP) is caused by a brain injury at or near the time of birth. As a part of CP, gross motor function is impaired, so many individuals with CP use mobility aids including ankle foot orthoses (AFO) and supra-malleolar orthoses (SMO). While both AFOs and SMOs are designed to correct abnormal gait, AFOs are much taller and can be solid or hinged at the ankle. Despite the early age of diagnosis for CP and prevalent use of mobility aids, there is limited literature and scientific evidence on mobility aid use for children with CP under 5 years of age. This project builds off of a larger mixed-methods study investigating the status of early mobility aid use for young children with CP, by working with both clinicians (physical therapists, orthotists, physicians, etc.) and parents of children with CP. We have surveyed and interviewed clinicians and caregivers on mobility aids with questions focused around the prescription process, initial device use, and impacts. From these survey and interview responses, we qualitatively coded short answer and interview quotes and analyzed numerical data to identify trends. This project is a secondary data analysis with a focus on the factors that influence the type of orthoses a clinician more commonly prescribed. From our preliminary results from the survey, we have found that years of experience, place of work, or type of clinic have no impact on a clinician’s most commonly prescribed device. However, clinicians who most commonly prescribed solid AFOs considered range of motion most frequently when prescribing orthoses, versus joint stability for hinged AFO clinicians, or insurance coverage for SMO clinicians. These results will provide mechanical engineers and clinicians designing orthoses recommendations based on the perspectives of people supporting children with CP, hopefully leading to better device design and more standardized prescription.

Compression Mechanisms for Automated Breast Core-Needle Biopsy Handling and Diagnostics
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Breast cancer has higher fatality rates in low-to-middle-income countries (LMICs) within Sub-Saharan Africa compared to more developed countries. Extensive wait times for an evaluation and lack of timely follow-up care contribute to this disparity. In LMICs, breast core needle biopsies (CNBs) are commonly taken from patients by palpation, then transferred to pathologists who manually chemically preserve, slice, and analyze the tissue, which may take weeks to months for a report. We are developing CoreView, a fast, automated, and low-cost device with the ability to assess disease status within one patient visit. The CoreView instrument accepts fresh CNBs, automatically stains tissue surfaces, and generates an optical diagnostic image. For nuclei to be imaged rapidly with high-resolution within a limited depth of focus, the CNB must be pressed against a smooth clear surface, which also maximizes the tissue surface area being analyzed. To do this, compression mechanisms were modeled in SolidWorks using a piston approach and fluidic pumps to apply positive pressure. Breast tissue has low stiffness, requiring precise, applied forces. The CNB integrity and diagnostic image quality during compression was quantitatively video monitored and studied. As a control, images of compressed porcine breast CNBs were compared to matched uncompressed tissues to determine any damage with compression, and measured improvement in diagnostic image quality. Breast CNBs are expected to withstand a maximum pressure of 1.5 psi without significant tissue deformity; however, the threshold depends on the prototype dimensions/geometry.
The goal is to form high-magnification, panoramic diagnostic images along the entire length of 20 mm long CNBs with \( \sim 20 \times \) microscope objective lens within one minute using motorized stage and synchronized imaging. With a reliable design and precisely controlled compression process, CoreView allows for efficient, high-resolution tissue imaging and diagnostic analysis at the point of care, reducing health disparities through prompt breast cancer treatment.