2025 RHODE ISLAND SUMMER

UNDERGRADUATE RESEARCH SYMPOSIUM

Friday, August 1, 2025

UNIVERSITY OF RHODE ISLAND

CENTER FOR BIOTECHNOLOGY & LIFE SCIENCES
FASCITELLI CENTER FOR ADVANCED ENGINEERING
PARAMAZ AVEDISIAN '54 HALL, COLLEGE OF PHARMACY

Sponsored by

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2025 RHODE ISLAND SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

8:00 – 9:00 AM **CHECK-IN & CONTINENTAL BREAKFAST**
- CENTER FOR BIOTECHNOLOGY & LIFE SCIENCE

POSTER SET-UP
- FASCITELLI CENTER FOR ADVANCED ENGINEERING
- PARAMAZ AVEDISIAN '54 HALL, COLLEGE OF PHARMACY

9:00 – 9:30 AM **WELCOMING REMARKS**
- CENTER FOR BIOTECHNOLOGY & LIFE SCIENCE

DR. BETHANY JENKINS
- VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT, UNIVERSITY OF RHODE ISLAND

DR. MANYUL IM
- PROVOST AND VICE PRESIDENT FOR ACADEMIC AFFAIRS, RHODE ISLAND COLLEGE

DR. MICHAEL LYNES
- PROFESSOR OF MOLECULAR & CELLULAR BIOLOGY, UNIVERSITY OF CONNECTICUT

9:30 – 11:00 AM **POSTER SESSION A**
- FASCITELLI CENTER FOR ADVANCED ENGINEERING
- PARAMAZ AVEDISIAN '54 HALL, COLLEGE OF PHARMACY

11 AM - 12:30 PM **POSTER SESSION B**
- FASCITELLI CENTER FOR ADVANCED ENGINEERING
- PARAMAZ AVEDISIAN '54 HALL, COLLEGE OF PHARMACY

POSTER PRESENTATION SCHEDULE

** PLEASE NOTE: Posters are to be set up prior to the welcoming remarks and should remain up until 12:30 PM. Posters are to be presented according to the schedule below.

Session	Presentation Times
A	9:30 – 11:00
B	11:00 – 12:30

Poster numbers	Location
1-25 (A & B)	Fascitelli Center for Advanced Engineering, 1st Floor (FCAE – Toray)
26-49 (A & B)	Fascitelli Center for Advanced Engineering, Ground Floor (FCAE – Lower Level)
50-74 (A & B)	Paramaz Avedisian '54 Hall, College of Pharmacy (Avedisian)

NOTE: an Author Index is located at the end of this document

POSTER SESSION A
9:30 – 11:00 AM

Fascitelli Center for Advanced Engineering, 1st Floor
1-A to 25-A

Fascitelli Center for Advanced Engineering, Ground Floor
26-A to 49-A

Paramaz Avedisian '54 Hall, College of Pharmacy
50-A to 74-A

Small Plastic in Small Plankton, a Big Problem: The Impacts of Microplastics on Comb Jelly Feeding Behavior

Marcus Raposo[1], Elizabeth Shepard[2], Cassandra DeBlois[2] & Anabela Maia[2]

[1]Biology, Roger Williams University, Bristol, RI
[2]Biology, Rhode Island College, Providence RI

The complex trophic interactions of Narragansett Bay contribute to the health and well-being of Rhode Island residents and rich aquatic biodiversity. Understanding such interactions enables informed decision-making in the prevention of ecological damage and maintenance of environmental quality. As human industrialization introduces ever increasing quantities of pollutants, such as microplastics, to natural environments, their unique implications for wildlife should be explored. The comb jelly (*Mnemiopsis leidyi*) is among the most impactful planktonic predators in a wide range of marine and estuarine environments, including Narragansett Bay. Thus, examining the impacts of microplastics on the feeding behaviors of Narragansett Bay comb jellies can contribute to our understanding of the trophic transport of microplastics. Adult comb jellies were captured from shallow waters of Hundred Acre Cove in Barrington, RI. These ctenophores were individually filmed while feeding on *Artemia* with a high-speed camera recording at 240 frames per second. Utilizing the video analysis software Kinovea, the individuals' digestive systems, lobes, and consumed food particles (when captured) were tracked during trials. We then calculated the mean and maximum velocity and acceleration along with total displacement for each landmark. During feeding, velocity and acceleration values reached a maximum of 17.0 cm/s and 4.07×10^3 cm/s^2, respectively, contributing to 23.7 cm of total displacement. Across trials, the average velocity of the comb jelly's digestive system was 2.23 cm/s while the average lobe velocity was 3.51 cm/s. We will compare these feeding trials to trials in the presence of microplastics to understand the mechanical consequences comb jellies face in response to the contamination of microplastics into their environments.

Adapting Coastal Resiliency Activities to the Community

Alexander da Silva, Zulay Izazaga, Amanda Solano & Anabela Resende da Maia

Biology, Rhode Island College, Providence, RI

Coastal communities have faced increasing threats to their homes, infrastructure, and natural resources due to climate change. Rising sea levels, more frequent flooding, pollution, and waterway contamination continue to place these areas at significant risk. Educating communities about coastal resiliency is a key strategy for mitigating these impacts by increasing awareness, preparedness, and engagement. We aim to develop inclusive and accessible educational tools that effectively communicate the importance of coastal resiliency to diverse communities. We focused on creating and sharing materials that are multilingual, engaging, and adaptable to various age groups and cultural contexts. To this end, we developed a project website that offers project introduction videos, workforce development resources and free, non-proprietary lesson plans and hands-on activities with reduced barriers for educators to use. These resources are available in English, Spanish, and Portuguese, expanding access to non-English-speaking populations. We also produced a series of videos that highlight ongoing resiliency efforts and assess areas vulnerable to water contamination and flooding. In collaboration with the Woonasquatucket River Watershed Council, we deployed an adapted diatom activity, originally designed for middle school students, at a local paddle event. This activity encouraged participants to engage with their waterways while learning about environmental indicators and ecosystem health. By combining technology, community partnerships, and culturally relevant content, we have created a model for scalable and inclusive coastal resiliency education. Our efforts demonstrate the importance of meeting communities where they are, both linguistically and geographically, to build understanding and inspire action. Through accessible resources and direct engagement, we aim to empower coastal communities with the knowledge and tools needed to better understand and respond to the challenges posed by climate change.

Detecting Harmful Algae Using DNA-Based Electrochemical Sensors: A Step Toward Safer Waters

Yhoalibeth Alcantara, Luke KrawczaK, Avelina Espinosa, Jennifer Pearce & Allison Marn

Biology, Roger Williams University, Bristol, RI

Harmful algal blooms (HABs) are often caused by toxic protists like *Pseudo-nitzschia*. HABs pose serious threats to marine ecosystems, public health, and fisheries. Current detection methods tend to be time consuming and require laboratory analysis. We developed an electrochemical genosensor to detect *Pseudo-nitzschia* species. The sensor operates by measuring changes in current when a complementary DNA strand hybridize on a modified gold electrode surface. We tested several concentrations of the complementary strand and sequence controls (mismatches and non-complementary strands) to determine sensitivity and specificity. We detected a significant drop in peak current with fully complementary DNA, indicating strong hybridization and target detection. This sensor has potential for rapid, on-site environmental monitoring of toxic algae, providing a faster and more accessible alternative to traditional labbased methods.

Webpage Development for Data Visualization of an In Situ Distributed Temperature Sensing System

Susanna Majkut, Katie Burrows & Brennan Phillips

College of Engineering, University of Rhode Island, Kingston, RI

Distributed temperature sensing (DTS) is a method used to obtain a synoptic dataset of temperature readings over a continuous length of fiber optic cable deployed on the seabed. DTS systems can measure temperature with a precision up to 0.01°C, and sampling frequency up to 5 seconds, every 0.25m on a fiber optic cable up to 10km in length. In collaboration with Ocean Networks Canada, a unique deep-sea DTS system developed at URI will live-stream temperature data for a year from an offshore hydrothermal vent field to address questions about seafloor seismic activity and how hydrothermal venting and subseafloor circulation is affected. In order to manage and view such a large influx of live-streamed DTS data, a data visualization website is being developed. The goal of this project is to eventually host a website that features interactive plotting, enabling users to view clean plots of DTS data over varying timespans and spatial areas. Presently, the website is capable of displaying previously collected DTS data plots, processed using MATLAB. These development efforts will be integrated into the interactive data visualization webpage in the future.

Early Life Stage Vulnerability in Sea Urchins: Interactive Effects of Hyposalinity and Elevated Temperature

Nailea Estrada & Carla Narvaez

Biology, Rhode Island College, Providence RI

Marine heatwaves and heavy rainfall are increasing in frequency and intensity due to climate change, posing significant stressors to marine ecosystems. Stenohaline and exothermic organisms are more susceptible to these stressors due to their narrow range of tolerance for salinity and temperature. Sea urchins, particularly juveniles, have lower mobility and are at risk due to their inability to escape these coastal stressors. While prior studies have evaluated adult sea urchin resilience and transgenerational effects to changing sea temperatures and salinities, the direct morphological response of juveniles to these stressors remains poorly understood. Given the important role of sea urchins in shaping temperate benthic environments such as kelp forests, changes in juvenile morphology and fitness may have broader implications for community structure and ecosystem resilience. This study examined how repeated exposure to marine heatwaves and hyposalinity events affect the morphological development of juvenile purple sea urchins (*Strongylocentrotus purpuratus*). To test this, juveniles were subjected to a simulated heatwave temperature and three hyposalinity events by gradually lowering and restoring salinity levels. Morphological traits (test diameter [μm], spine length [μm], and tube foot disc area [μm]) were quantified using standardized photographs analyzed following each exposure. Results revealed a significant negative effect of elevated temperature on spine length, indicating impaired structural growth under thermal stress. Additionally, a significant interaction between temperature and salinity was found for test diameter and tube foot disc area, suggesting that combined stressors can produce compounded effects on juvenile morphology. These findings highlight the susceptibility of early life stages to climate-driven stress and underscore the importance of understanding juvenile responses for predicting future population dynamics.

Pain on a Molecular Scale

Zoe Walsh

Community College of Rhode Island, Warwick, RI

This project is very dear to me as an artist with chronic pain. What inspired me to partake in this project was facing the harsh reality of my chronic kidney stones. Needing surgical stent placement to correct the blockage in my right ureter was horrifying; the recovery process has always been far more than physical. The Illuminexions exhibition gave me an outlet to turn such a traumatic experience into something that can bring people together.

'Pain on a Molecular Scale' focuses on numerous parts of the body—more specifically the cells that make up the very essence of our being. These are the same cells that work hard to keep us alive, but also the ones responsible for our pain. My piece aims to shine light on chronic pain and illness, which is often considered taboo or even grotesque by some. By recreating microscopic images by hand, I am able to brew curiosity and discussion for subject matter that does not frequent the mouths of many people. No matter how squeamish an individual may be, they are able to find beauty and admiration for even the grossest aspects of what makes us human.

'The Circle of Life' is how I chose to display my twenty-four drawings. Creating an interactive centerpiece ties viewers together by mimicking the functions of a microscope. Without labeling, the audience is left to discuss with one another what exactly they are observing. This forces them to work together to find the answers to their questions, much like the way chronically ill people rely on each other for advice and a sense of understanding.

Cyclic Mechanical Strain Modulates Uptake and Retention of DNA-Functionalized SWCNTs In Vitro

Jonas Finauer[1], Raodatullah Abodunrin[1], David Jaworski[2], Iordania Constantinou[2] & Daniel Roxbury[1]

[1]Chemical Engineering, University of Rhode Island, Kingston, RI
[2]PVZ, Technische Universität Braunschweig, Braunschweig, Germany

Cells constantly interact with their dynamic physical microenvironment, which plays a key role in processes such as the uptake and intracellular trafficking of nanomaterials. Single-walled carbon nanotubes (SWCNTs), when functionalized with single stranded DNA (ssDNA), have been demonstrated to bind to cell surface receptors and enter cells via the endosomal pathway, with uptake kinetics strongly depending on cell type and physiological state. To better replicate physiological conditions in vitro, our project investigates how cyclic mechanical strain and substrate stiffness influence the internalization and intracellular processing of ssDNA-SWCNTs in live cells. Using a custom-built, light microscopy-compatible stretching device to apply controlled cyclic strain, A549 lung adenocarcinoma cells are cultured on elastomeric membranes with defined stiffness to mimic strain conditions in vivo. SWCNT Fluorescence intensity and spatial distribution is monitored over time via Near-infrared hyperspectral fluorescence microscopy. By comparing static and stretched conditions, we evaluate how mechanical forces modulate uptake efficiency, vesicular transport pathways, and long-term retention of the nanotubes. This integrated approach aims to provide a deeper understanding of how mechanical stimuli and dosing parameters synergistically regulate nano-bio interactions. Our findings could inform the design of safer and more effective nanoparticle-based delivery systems and bio-compatible sensors, ultimately contributing to advancements in nanomedicine, drug delivery, and mechanobiology.

Measuring of Ingestion and Egestion Rates in the Purple Sea Urchin (*Arbacia punctulata*) to Inform Biofouling Control in Shellfish Co-Culture

Erin Sweeney, Brendan Elba & Coleen Suckling

Fisheries, Animal & Veterinary Sciences, University of Rhode Island, Kingston, RI

The integration of grazing sea urchins into shellfish aquaculture presents a sustainable strategy for reducing biofouling, a persistent challenge in aquaculture operations. The Atlantic Purple Sea Urchin (*Arbacia punctulata*) is a potential candidate for such co-culture opportunities, but ingestion and egestion patterns in response to varying diet types are not well understood. This study compared ingestion and egestion rates of A. punctulata when fed either a natural magroalgal diet (*Sacchrina latissima*) or a formulated diet consisting of alginic acid, dried *S. latissima*, agar-agar, and oyster meat. Twelve urchins were monitored in a controlled, flow-through seawater system to assess feed intake, egesta output, and body mass change. Urchins were individually housed and fed approximately 5 g of formulated diet and 2 g of natural diet weekly to evaluate digestive processing and potential efficiency in organic waste reduction. Diet composition was evaluated in relation to ingestion efficiency and egestion, and long-term monitoring is ongoing to assess potential seasonal variation in feeding behavior and waste output. Preliminary findings suggest diet type influences ingestion efficiency and waste output, informing the application of *A. punctulata* as a sustainable grazing solution in aquaculture settings.

Sand Tiger Shark Movement Patterns Revealed through Acoustic Telemetry

Ava Cieplinski[1], David Taylor[1], Kimberly Lavoie[2], Jon Dodd[2] & Chris Parkins[3]

[1]Marine Biology, Roger Williams University, Bristol, RI
[2]Atlantic Shark Institute, Wakefield, RI
[3]Division of Marine Fisheries, Rhode Island Environmental Management, Jamestown, RI

This study utilized passive acoustic telemetry to investigate the movement ecology of juvenile sand tiger sharks (*Carcharias taurus*) along the U.S. East Coast. In June 2024, five individuals were tagged near Galilee, Rhode Island. Subsequent acoustic detections provided insights into seasonal movement patterns and associated environmental conditions. Four of the five tagged sharks (three males, one female) were detected by acoustic receiver arrays and exhibited high site fidelity from June through early October, primarily occupying nearshore habitats within Block Island/Rhode Island Sound and Nantucket Sound. These areas were characterized by mean sea surface temperatures (SST) of 19.7 °C (range: 16.9-23.4 °C). By mid-October, sharks initiated southward coastal migrations, likely in response to declining SST. By late October, detections occurred off southern New Jersey, where mean SSTs were 16.9 °C (range: 16.3-17.6 °C). Shark presence was also associated with surface chlorophyll-a concentrations, a proxy for primary productivity. Throughout the monitoring period, sharks occupied waters with mean chlorophyll-a concentrations of 5.13 mg/m^3 (range: 2.6-20.98 mg/m^3), which exhibited relatively low spatial and temporal variability. In June 2025, five additional juvenile sand tiger sharks were tagged. Upon retrieval of 2025 data, further analyses will assess interannual consistency in migration patterns among 2024-tagged individuals and evaluate whether newly tagged sharks exhibit similar environmental responses and movement behaviors.

Impact of Information Nudges on Willingness to Pay to Remove Microplastics from Drinking Water: Evidence from an Online Randomized Experiment

Annalise Wabler[1], Sonia Refulio-Coronado[2], Katherine Westerman[2] & Emi Uchida[2]

[1]Environment & Natural Resources, Ohio State University, Columbus, OH
[2]Environmental & Natural Resource Economics, University of Rhode Island, Kingston, RI

The average person consumes up to five grams of microplastics, plastics smaller than 5mm in size, a week, primarily through tap and bottled water. Filtration devices on the market work to remove microplastics, but it is unknown how much people utilize these technologies and which factors influence their willingness to adopt and willingness-to-pay (WTP) for them. In this study, we examine the effect of an information nudge on consumers' WTP for a water filter that removes microplastics in their drinking water. We will recruit respondents through the Prolific platform to complete online surveys designed and administered in Qualtrics. The first survey intends to identify respondents' primary source of drinking water: tap, bottled, or filtered water. Those who do not already have a microplastic-removing water filter will be invited to participate in a second survey, which will randomly assign survey respondents to the control group, which receives a simple definition of microplastics, and the treatment group, which receives a message that includes information about the potential concentration of microplastics in their primary drinking water source. Then, all participants will be asked to select one out of two water filter options with different hypothetical attributes in a choice experiment. The attributes include water filter type, microplastic removal, certification by the NSF, and price. Results are pending as data collection is ongoing. We hypothesize increased WTP for microplastic removal by respondents who receive the nudge. If effective, the information intervention could serve as an affordable tool for policymakers to encourage uptake of microplastic-removing technologies.

Acoustofluidic Pumping via Sidewall Sharp-Edge Microchannels for Lab-on-a-Chip Applications

Chloe Anzalone-Evans[1], Erfan Eskandari[2], Conner Ham[2] & Yang Lin[2]

[1]Mechanical Engineering, University of Maryland, College Park, MD
[2]Mechanical Engineering, University of Rhode Island, Kingston, RI

The use of acoustic technology in microfluidic devices has made crucial advancements in lab-on-a-chip applications due to its contactless operation and excellent biocompatibility. Acoustofluidic systems use acoustic streaming generated by oscillating structures to create mixing and pumping effects. Sharp-edge acoustofluidic designs are particularly attractive for biomedical applications because they eliminate the need for bulky external pumps and allow simpler, portable, and contamination-free platforms. This study aimed to develop a sharp-edge microfluidic channel design capable of effective fluid pumping at a smaller scale than previously demonstrated. In particular, the design incorporates sidewall sharp-edge structures, which are protrusions along the channel walls that oscillate in response to acoustic actuation. These oscillations disrupt laminar flow, enhancing fluid mixing and transport. We examined the effects of tip angle, sharp-edge size, sharp-edge pattern, frequency, and applied voltage, specifically for narrow channel widths of 30-60 μm, which are smaller than those used in past studies. To investigate these parameters, microfluidic chips were designed using SolidWorks and printed with a NanoOne 3D printer. Each printed chip was assembled onto a piezoelectric disk and fitted with a container to hold fluid. The devices were then studied under a microscope using 1.9 nm fluorescent nanoparticles across different frequencies to determine optimal acoustic actuation conditions. This study identified the resonant frequency of the devices at 32 kHz at which particles exhibited vigorous and uncontrolled motion. Effective and stable pumping was achieved at 3.1 kHz. These results provide valuable insight for designing sharp-edge acoustofluidic devices and will be directly applied toward developing a 3D scaffold sharp-edge microstructure for lab-on-a-chip and cell culturing applications.

FCAE - Toray

Magnetic Biofouling Release in Polymer Composites

Ethan Marchetti[1], Robert D'Ambrosca[1,2], Liam Kennings[3], Jensen McTighe[4], Jason Dahl[4], Ryan Poling-Skutvik[2] & Irene Andreu[2]

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[2]Chemical, Biomolecular, & Materials Engineering, University of Rhode Island, Kingston, RI
[3]Electrical, Computer & Biomedical Engineering, University of Rhode Island, Kingston, RI
[4]Ocean Engineering, University of Rhode Island, Kingston, RI

Unmanned underwater vehicles for seafloor exploration encounter issues after biofouling such as increased weight, changed hydrodynamics and polymer degradation. Cleaning processes typically involve removing the robot from the water and physically scrubbing it, or treating it with a biocidal agent. These cleaning processes lead to instrument downtime and allow the potential for further polymer degradation.

Within the past few years, novel coatings have been explored to combat biofouling, but often rely on toxic biocidal agents, which face stringent regulations due to environmental concerns, or present intricate and fragile surface features, making them difficult to manufacture and maintain in operation. Here, we propose to emulate antibiofouling observed in living animals by fabricating a magnetic composite that can be distally activated using magnetic fields to induce surface movement. Particle image velocimetry reveals that this magnetically-generated undulatory motion leads to the formation of fluid vortices, with the possibility of preventing bacterial deposition. When taken in combination with a functionalized surface micropatterning, which acts as an intended bactericidal mechanism, these novel magnetoactive materials can prevent the need for traditional biofouling removal techniques and require only a few steps to reproduce using commercially viable products. An analysis of Staphylococcus Epidermidis biofilm formation on these composite surfaces, under the influence of a dynamic magnetic field, examines the effectiveness of this actuation in a fluid environment.

Designing a Water Quality Monitoring Tank Prototype for Matunuck Oyster Hatchery

Aidan Hartell, Jane Carrick, Kristofer Gomes & Andrew Davies

Oceanography, University of Rhode Island, Narragansett, RI

Harmful algal blooms are a threat to shellfish aquaculture and preventive measures should be put into place to see when they will occur and to protect the shellfish stocks. In the Narragansett Bay in March of 2017, there was a closure of the shellfish fishery due to domoic acid levels overcoming the regulatory limit of 20 μg domoic acid g^{-1}. Species of algae from the genus *Pseudonitzschia* spp. are responsible for releasing domoic acid into the environment when they are stressed by levels of low nitrogen or high pCO_2. The population of *Pseudonitzschia* spp and domoic acid concentrations have been found to have an inverse relationship with Chlorophyll a concentrations. Domoic acid bioaccumulates in shellfish and when consumed by humans, can cause Amnesic Shellfish Poisoning (ASP) which causes seizures and permanent short-term memory loss. Shellfish farms are at risk due to the potential of having their whole stock being affected by the toxic algae. In order to mitigate risks of potential water quality issues in Rhode Island aquaculture systems, we designed a water quality monitoring system that detects the conductivity (salinity), temperature, dissolved oxygen, pH, chlorophyll presence, and turbidity using a HydroCAT-EP V2 sensor. This tank was constructed with PVC piping and is designed with a flow meter to measure the flow rate, a water level sensor to make sure that the sensor is always submerged , and an electric ball valve to flush out any solid particles that settle. Water enters through the bottom of the tank and leaves at the top and if the water were to stop pumping into the system, the tank will still be filled with water due to the design of the inflow. The purpose is to have the water be replaced in the tank at a given interval so that there can be constant monitoring of the water that is being pumped through the aquaculture system. The sensor will be connected to a Campbell Scientific CR6 datalogger that allows for remote observation of the data while it is being collected. Using the data collected from the sensor, we hope to allow for constant monitoring of the system so that the parameters stay within the preferred range for growing oysters.

The Implications of Climate Change-Induced Dormancy Loss on the Microbiome of the Temperate Coral *Astrangia poculata*

Mia Sarris[1], Anna Dormitzer[2], Megan Harrington[1], Ciaran Fitzpatrick[1], Alicia Shickle[1], Anya Brown[3], Sean Grace[4], Justin McAlister[5] & Koty Sharp[1]

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[4]Biology, Southern Connecticut State University, New Haven, CT
[5]Environmental Studies, College of the Holy Cross, Worcester, MA

Astrangia poculata, a temperate coral found along the U.S. East Coast, specifically in Narragansett Bay, typically undergoes a hibernation period, termed quiescence, when temperatures drop below 5°C during the winter months. Previous research demonstrates that the *A. poculata* microbiome exhibits predictable seasonal shifts around quiescence. Post-quiescence microbiome dynamics in *A. poculata* can help identify taxa that drive microbiome re-assembly after environmental disturbance and may be valuable for understanding tropical coral recovery from disease and bleaching. This study follows the microbiome through a non-quiescent winter (when sea surface temperatures in Narragansett Bay did not drop below 5°C for sustained periods) and compares the data with previously published *A. poculata* microbiomes from quiescent years.

We used high-throughput 16SrRNA gene sequencing to characterize microbiome composition in *A. poculata* across the non-quiescent winters. Across the seasonal timepoints in the non-quiescent year, alpha diversity was only significantly different as measured by species richness but not by Inverse Simpson or Exponentiated Shannon metrics. Microbiome composition significantly changed across the sampling time, driven by differential abundance of eight bacterial families taxa: Endozoicomomadaceae, Flavobacteriaceae, Fokiniaceae, Terasakiellaceae, Rubritaleaceae, Pirellulaceae, Tappiaceae, and Bacteria (unknown family). Comparative analysis with previously published microbiomes from quiescent *A. poculata* suggests substantial differences, including a lack of the highly predictable post-quiescence re-assembly of the microbiome. Ongoing work includes continued comparison with previously published microbiomes, and generation of new models of host-microbial interactions in corals that did not undergo quiescence. Shifts in microbiome dynamics may have significant implications for coral health and broader ecosystem stability. Understanding how *A. poculata*'s microbiome responds to warming waters can provide insight into how climate change influences host-microbe interactions and inform future monitoring and management strategies for coastal ecosystem changes, including what animals need to survive climate change.

The Air We Share: Quantifying Atmospheric Microplastics in Rhode Island

Ella Membrino, Madison Gebo & Lillian Jeznach

Engineering, Roger William University, Bristol, RI

Microplastics pollution is a widespread and growing concern for Rhode Island due to the high urban land cover and the importance of surrounding marine life to the local economy. Currently, there's no atmospheric microplastics data for the state of Rhode Island. The goal of this study was to quantify microplastics in atmospheric deposition and ambient air in the Narragansett Bay watershed in Rhode Island. Atmospheric deposition (microplastics/m^2/day) was collected in a student designed stainless steel collector on the Roger Williams University campus in Bristol, RI. Ambient air microplastics (microplastics/m^3/day) were determined from two high flow total suspended particulate samplers in Providence, RI. One sampler was located on the campus of Providence College (PC) and the other at the Providence Department of Public Works (DPW), located in the Port of Providence. Deposition samples were collected over 48 hours, rinsed out of the sampler with DI water, filtered onto glass fiber filter paper, and stained with Nile Red. Ambient air samples were collected over 24 hours by drawing 37cfm through the sampler and onto a 400cm^2 quartz filter. A 2x2cm^2 filter punch from the quartz filter was processed and analyzed from each location for each month of 2024. Samples were sonicated to release particles from the filter, digested with 1M KOH to remove organic matter, then filtered onto glass fiber filter paper and stained with Nile Red. All samples were analyzed to quantify microplastics, compare locations, and compare monthly changes and relationships with temperature, precipitation, and wind speed. Based on the analysis, the majority of atmospheric microplastics in all the atmospheric samples were fibers followed by fragments. Ambient air microplastic concentrations sampled on the same day tended to be greater at PC than the Providence DPW. From the current data collected, ambient air concentrations were not correlated with daily air temperature, wind speed, or precipitation. In addition, greater atmospheric fluxes were measured at lower wind speeds. This project is part of a larger long-term microplastic sampling campaign involving undergraduate researchers to develop a database of freshwater and atmospheric microplastic data. This research will help to better understand microplastic distributions across the state which is needed in order to develop effective solutions and technology to combat the abundance of microplastics that are a growing global and local issue.

Working on Roger Williams University's FerryCliffe Farm: Developing New Gear, Supporting Local Farmers, and Community Engagement

Heidi Hoeft, Isaiah Porter, Antonio Gonzalez, Branalysa Varela & Malcolm Bowen

Center for Economic & Environmental Development, Roger Williams University, Bristol, RI

With a current world population of roughly 8 billion people, sustainable food sources are a necessity. Bivalve shellfish, abundant in Rhode Island's coastal waters, are one of the most environmentally and economically sustainable food sources. The impact of aquaculture farms goes beyond increasing shellfish numbers and improving water quality. The operations grow healthy food and create habitats for other species, providing valuable ecosystem services. The RWU Center for Economic and Environmental Development (CEED) maintains the Luther H. Blount Shellfish Hatchery on campus, and shellfish produced there are distributed in support of farming, research, and restoration. Some animals produced in the hatchery are moved to CEED's outdoor nursery facility and ultimately to the FerryCliffe experimental aquaculture farm in Mount Hope Bay (2022-04-046), where eastern oysters (*Crassostrea virginica*), bay scallops (*Argopecten irradians*), and hard clams (*Mercenaria mercenaria*) are raised, in addition to several other species. FerryCliffe Farm also collaborates with other institutions for research, collects and contains broodstock for hatchery use, and functions as an extension site for local farms. Together these operations serve as a resource for Rhode Island's shellfish aquaculture industry. Year-round, current and new oyster grow-out gear and husbandry methods are tested on the farm, including a novel device to reduce the time and effort of hauling and relocating bottom cages. RWU CEED collaborates with local aquaculture equipment manufacturers to aid in developing proprietary aquaculture technology. CEED provides nursery space and extension expertise to several local farmers, and the program facilitates public shellfish enhancement and awareness programs in local communities through partnerships with municipalities, state agencies, and NGOs such as Rhode Island Shellfisherman's Association (RISA). Community engagement initiatives in CEED's aquaculture operations include development of curriculum for hands-on learning experiences as well as the applied shellfish aquaculture course, open to both RWU students and the public. Through partnerships with non-profits and student-led initiatives, CEED and its programs increase access and pathways to aquaculture and marine industry careers. Public awareness, development of new gear and methods, and experimental research play major roles in the growth of more sustainable farming and the shellfish aquaculture industry.

Investigating the Inflammatory Effects of Microplastics on Human Health Using 3D Liver Models

Carlynn Rychener[1], Janitha Unagolla[2] & Jyothi Menon[2]

[1]Chemistry & Biochemistry, University of South Carolina, Columbia, SC
[2]Biomedical & Pharmaceutical Sciences, University of Rhode Island, Kingston, RI

The prevalence of microplastics/nanoplastics (MPs/NPs) in daily life has raised significant concerns for human health. The impact of microplastics on the liver, one of the primary organs that comes in direct contact with MPs/NPs following ingestion, is of particular interest due to the greater risk of long-term accumulation and exposure. To investigate the effect of MPs/NPs on the liver, human hepatocellular (Hep G2) liver cells were cultured on 3D-bioprinted hydrogel scaffolds and treated with various concentrations of 0.1 μm polystyrene microplastic beads (PS-MPs) for various time periods. After 7 days of exposure to PS-MPs, the cells that were not treated with PS-MPs had an average viability of 94.80% ± 5.21% while the cells treated with 250 and 500 μg/ml PS-MPs had an average viability of 89.30 % ± 10.71% and 88.37% ± 11.64% respectively. This dose-dependent decrease in viability, while not significant, indicates further inquiries at longer timepoints and with higher concentrations of MPs/NPs are needed to provide better insight into the long-term impacts of microplastics on human health.

Developing an Optical Microscopy Method to Detect Microplastics in Environmental Samples

Rowan Bixler[1], Mohammadjavad Hajirezaei[2] & Ryan Poling-Skutvik[2]

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Microplastic contamination in coastal environments poses a growing threat to ecosystems and human health, yet current detection methods for these microscopic particles are often limited by long processing times, high cost, limited availability, and low signal detection for complex samples. This project aims to develop an optical microscopy technique using Differential Dynamic Microscopy (DDM) to identify and characterize microplastics in environmental water samples. A DDM-based approach would provide valuable information to help track microplastics. To test the approach, PMMA and polystyrene microplastic samples were prepared in water and imaged with brightfield microscopy. Videos of particles were recorded for measurement with DDM. Results verify that the diffusivity increases from the substrate bottom upwards toward the center of the specimen, demonstrating the particles are in genuine Brownian motion. Additionally, the amplitude extracted with DDM is a function of the wavevector (q), and the local minima in amplitude can define the effective length scale of the particles. This effective length scale can be a distinguishing signature of polymer chemistry, opening a new pathway for material characterization using DDM.

Biodegradation of Bioplastics using Bacteria Isolated from Wastewater

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Plastic pollution is a major global issue, and bioplastics are a promising alternative. While they are biodegradable, most require specific industrial composting conditions to fully degrade. Improper disposal often leads them to wastewater systems, especially in cities with combined sewers–their breakdown not yet well understood. This project aims to simulate bioplastic biodegradation in wastewater treatment plants using liquid culture incubation of bacteria isolated from a wastewater facility in Providence, RI. Composite cutlery made with polylactic acid (PLA) and polystyrene/agave fiber (PSAC) were used as testing materials. The two materials were evaluated under two conditions: unaltered ("as-received") and artificially weathered via 10-day exposure in a UV aging chamber. Biodegradation assays were conducted over 14- and 28-day incubation periods. At the end of each cycle, the samples were analyzed using weight loss (%), composition (FTIR), surface imaging (SEM), and leaching of metals (ICP-MS). Overall, sample weight loss ranged from 0.005% to 0.384%, with the highest observed in weathered PSAC at two weeks and the lowest in unweathered PLA controls. PLA showed modest degradation (up to 0.290%) with limited impact from UV weathering, while PSAC exhibited greater variability and higher losses in weathered conditions. The effect of UV pre-treatment appears material-dependent and may be inconclusive based on current results. SEM analysis revealed surface micro-cracks and bacterial attachment on both plastics, absent in controls, indicating microbial activity. ICP-MS analysis revealed elevated calcium leaching, 2241 ± 635 ppb for PSAC and 1641 ± 195 ppb for PLA, attributed to agave ash and kaolin additives, respectively. FTIR data indicated agave fiber degradation and diminished polystyrene peak intensity in PSAC, while PLA showed overall peak attenuation, suggesting minor structural changes. While minor degradation was observed, the extent was negligible, less than 0.4% over four weeks, compared to the >90% biodegradation typically achieved in industrial composting after 12 weeks. These results suggest that bioplastics may persist similarly to conventional plastics in wastewater treatment settings. If bioplastics are used, disposed of and littered in the same way as conventional plastics, we risk replicating the same environmental challenges these facilities currently face. Further studies are essential to fully understand the fate of bioplastics.

Exploration of Real-Time Digital Twin Simulations for Power Systems

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Diesel engine generator sets, commonly utilized in distributed remote site power systems and naval power systems, are essential for producing and supplying electricity when other power sources are not available. As such, there is a demand for more reliable, efficient, and resilient power systems. The design and implementation of prototypes and novel control systems can be costly and/or impossible if physical access to these remote systems is unavailable or if operations cannot be interrupted to perform fault analysis. Digital twins, serving as virtual replicas of physical systems, offer a strategic approach for the asset management of energy systems, enabling performance analysis, predictive diagnostics, and operational optimization that significantly reduce development time and cost.

This project presents a physics-based digital twin of a diesel generator system using MATLAB Simulink and Simscape. The twin simulates key dynamics such as output power and voltage during load variations as well as electromagnetic excitation behavior. Model parameterization is based on manufacturer data of a CAT 3512B (60 Hz) generator set in the absence of historical operational field data. A Speedgoat Performance Real-Time Target Machine provides multi-core support for complex models to run in real-time as well as FPGA processors and I/O modules for rapid controller prototyping (RCP) and hardware-in-the-loop (HIL) testing. Results align with published transient performance responses.

Improving Resilience of Hatchery-Reared Blue Mussels (*Mytilus edulis*) to Ocean Acidification with Diet and Seawater Buffering: 3rd Field Deployment Results

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As wild blue mussel seed declines in the Gulf of Maine, mussel growers are relying increasingly on hatchery production to stock their farms. While mussel populations are currently under pressure from predation by the invasive European green crab, ocean acidification (OA) is expected to be another stressor – especially among earliest life stage mussels – as climate change progresses. Traditionally, shellfish hatcheries have implemented seawater buffering to mitigate low pH in their incoming seawater. Here, live microalgae diet optimization is proposed as an alternative strategy for rendering blue mussel larvae inherently more resilient to OA in a hatchery scenario. Following an initial microalgae growth and nutritional analysis phase, 4 diets – each consisting of a flagellate and a diatom species – were created to emphasize different nutritional parameters (industry standard, high calorie, high DHA, high EPA/protein). A first experimental trial tested larval/early juvenile response (survival and growth) to a 2-level seawater pH treatment (7.80/present day, 7.30/year 2100) and a 4-level diet treatment, and a second experimental trial tested response to the pH treatment, a reduced 2-level diet treatment, and a 2-level seawater buffering treatment (soda ash buffering, no buffering). Each trial was followed by a field deployment of experimental mussels at each of 2 mussel farms in different locations along the Maine coast (Blue Hill Bay Mussels and Bangs Island Mussels) to reanalyze mussel responses after they achieved market size. Finally, a third experimental trial and field deployment – the subject of this presentation – selected the most effective treatment combinations from the previous trial and repeated them with a reduced number of commercial-size larval tanks. The experimental trials tested the efficacy of diet optimization for improving blue mussel resilience to OA, as well as its interaction with seawater buffering.

Plastic-Degrading Genes in River and Deep Ocean Metagenomic Samples

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The pollution of global waterways with microplastics is a pervasive issue. An estimated 9–14 billion kilograms of plastic waste enters the ocean each year (Reddy, S. & Lau, W. 2020). A potential solution to this issue is bioremediation, where microorganisms with plastic-degrading genes (PDGs) break down plastics into non-toxic substances. Previously, our research group constructed and optimized a pipeline to identify PDGs from protein sequences gathered from metagenome assembled genomes (MAGs). Our goal for this project was to find metagenomic datasets that could be processed and analyzed with the pipeline to characterize new PDGs and examine their abundance among different environments. We examined two datasets of metagenomic samples, one from deep-ocean water sampling (Acinas, S.G., et al. 2021) and the other from a combination of surface water and pore water samples taken at regular intervals over a 48-hour period in the Erpe River (Rodríguez-Ramos Josué, et al. 2023) in Germany. In a wastewater-impacted river in Belgium, environmentally similar to the Erpe River, it was estimated that 623 kilograms of microplastics are deposited to the freshwater system annually (Maaike Vercauteren, et al. 2023). We found that the deep-ocean data yielded predicted PDGs at a much higher proportion than the river data. While there was no significant relationship between the abundance of predicted PDGs in the deep-ocean dataset and the nearest land, some interesting geographic patterns still emerge. All six of the samples taken in the Pacific Basin had abundances of predicted PDGs in the top third of all thirty-two deep-ocean metagenomic sampling locations. This greater number of predicted PDGs may be because dense plastic particles are more prevalent in the Pacific Ocean than in other regions (Zhao, S., et al. 2025), leading to greater plastic pollution in the deep ocean in this region. The river sampling data time points with the greatest variation in MAGs compared to adjacent samples (Rodríguez-Ramos Josué, et al. 2023) also had the greatest proportion of predicted PDGs, potentially indicating that greater variation in the types of microorganisms in the river leads to higher yields of predicted PDGs.

Distinct Chemosynthetic Symbiosis Patterns in Deep-Sea Mussels from Kick 'Em Jenny Volcano

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Deep-sea mussels of the genera *Bathymodiolus* and *Gigantidas* are foundation fauna able to survive at food-limited deep-sea cold seeps due to their symbiotic relationship with chemosynthetic bacteria. These bacteria, either methane-oxidizing (MOX) or sulfur-oxidizing (SOX), break down the chemicals present in seeping fluids to generate the energy needed for the primary nutrition of their host. Here, we used gene barcoding to survey a collection of deep-sea mussels and their associated bacterial symbionts from cold seeps on the Kick 'Em Jenny submarine volcano (Grenada). Altogether, we uncovered the presence of two mussel species complexes: *B. boomerang/ B. heckerae* and *G. mauritanicus/ G. childressi*. In the 14 *B. boomerang/ B.heckerae* individuals we surveyed, both MOX and SOX symbionts were consistently present. In contrast, only MOX symbionts were detected in association with the two *G. mauritanicus/ G. childressi* individuals, though the low sample size for this species complex makes it difficult to draw definitive conclusions about symbiont association patterns. Ultimately, our work suggests that, despite co-occurring at the same cold seeps, these two species complexes have distinct patterns of symbiont association and may consequently have different nutritional dynamics. The purpose of this research is to further understand the distribution and diversity of deep-sea mussels and the symbionts that allow them to survive at deep-sea cold seeps.

Enhancing Aquaculture Literacy and Diversity through Virtual Reality: An Extension-Focused Approach

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Field-based and hands-on learning is essential for undergraduate student development, providing real-world context and enhancing academic engagement. However, these experiences are not always accessible to all students due to different limitations. To address this issue, this study explores the use of virtual reality (VR) and 360-degree video technologies as immersive, classroom-based alternatives to traditional fieldwork. By collaborating with shellfish farmers in Rhode Island and Bali, Indonesia, we created a diverse and developing digital media library that highlights aquaculture practices across different cultural and environmental settings. High-quality footage was captured using the Insta360 Pro 2 and stitched together to create an effective VR experience, which was edited using CapCut and delivered through VR headsets. These immersive materials were designed to enhance education, promote aquaculture literacy, and support outreach and extension programming. The integration of VR into educational environments offers new opportunities to engage diverse audiences, broaden access to experiential learning, and support Rhode Island's Blue Economy.

Anisotropic Design and Manufacturing Approaches for Large-scale Continuous Fiber 3D-Printed Structures

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This research explores large-scale 3D printing using continuous fiber-reinforced materials to manufacture lightweight structural components with tailored mechanical properties. Unlike conventional 3D-printing structures which use thermoplastic filaments with separate wall and infill structures, continuous fiber 3D printing can create anisotropic structures by having a single continuous fiber path, eliminating the need for infill. This anisotropy can help tailor strength, stiffness, and failure behavior to meet specific load requirements.

In this project, spiral and sinusoidal plate toolpaths were developed with the intent to fabricate at a much faster rate compared to traditional 3D-printing using carbon fiber-nylon coaxial printing where we can investigate how geometry and fiber orientation affect mechanical performance. To achieve anisotropy in the 3D-printed structures, the tool paths must be generated such that structures are manufactured in a certain sequence of events, hence CAD designs transferred to traditional 3D printing software's aren't feasible as slicers decide the optimal toolpath. These designs were developed using MATLAB to generate continuous tool paths, ensuring uninterrupted fiber placement throughout the structure. The spiral pattern offers smooth radial stress distribution and efficient load transfer, while the sinusoidal pattern introduces wave-like reinforcement paths that can absorb and dissipate energy. Both approaches aim to move beyond traditional grid or linear paths in small-scale printing, manufacturing complex geometries that can be easily implemented in large-format systems.

By focusing on the design and manufacturing process, this research highlights the unique advantages of continuous fiber 3D printing for large-scale applications, including better strength-to-weight ratios, reduced material consumption, and customizable anisotropic properties. Planned mechanical testing, including hammer impact and shock tube tests, will assess the strength and failure behavior of these anisotropically printed plates. This initial phase emphasizes the importance of integrating computational design tools and anisotropic principles early in the fabrication process. These advancements hold promise for the use of 3D-printed composites in underwater vehicles, where lightweight and high-performance structures are critical.

Microwave-Assisted Synthesis and Characterization of Copper Based Nanomaterials

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Heusler alloys are well known to possess a wide variety of electronic and magnetic properties depending on the elements involved, allowing them to exhibit both semiconductor and metallic behaviors based on their spin orientation. We seek to investigate these properties in Cu_2FeAl nanoparticles. These materials were synthesized via a microwave-assisted hot-injection method, which allows for rapid iteration and controlled modification of reaction parameters. The resulting nanoparticles were characterized by X-ray diffraction (XRD) and X-ray fluorescence (XRF) for phase identification and elemental composition, respectively. The optical properties were assessed using UV-Vis spectroscopy, showing absorption in the 590-600 nm range. The synthesized materials exhibited slight ferromagnetic behavior when exposed to a magnetic field, and XRD analysis confirmed that the crystallography was consistent with the literature, with estimated particle sizes below 12 nm according to Scherrer broadening.

A Demonstration of Germicidal Ultraviolet Indoor Air Sanitation to Mitigate Flus, Colds, and the Next Pandemic

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Germicidal ultraviolet-C light (GUV) at 222 nm has shown to be the most effective tool to clean indoor air and prevent airborne transmission of respiratory viruses. Previous work has shown that 222nm GUV inactivates pathogens without threatening skin and eye health. As a demonstration study to show the extent of the effectiveness and safety of the technology, we installed five 222 nm GUV (far-UVC) fixtures at our Roger Williams University campus: one in the campus health center and four in a classroom. We used a radiometer to quantify the fluence emitted from the far-UVC devices and software from Columbia University to estimate average room-level viral inactivation. We also used dosimetric film to quantify the exposure received by students occupying the classroom and the staff in the health center. We compared our results with existing US and International safety standards and found our measurements to be well below safety standards (maximum observed exposure for 8-hour exposure of 19% of safety standards). Results show a significant increase from 3 to 42 estimated equivalent air changes per hour, ultimately leading to risk reduction from 53% for 8 hour exposure with a supershedder to 5%, substantially mitigating superspreading events. We predict the inactivation rate of SARS-CoV-2 B to be 90% in under four minutes of 222 nm GUV use. This demonstration study linked with didactic training of students in relevant coursework and communication through news coverage to a broader population brought the power of GUV to a wider audience with the aim of increasing adoption of the technology.

Examining the Influence of Obesity Assessment Technique on Obesity Prevalence in Middle-Aged Women

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Body Mass Index (BMI) is commonly used as a surrogate for body fat status, as it does not directly measure body composition. As a result, individuals with excessive body fat may be misclassified as having "normal" weight, a known as normal weight obesity (NWO). NWO may lead to under-recognition of health risks and inadequate treatment. The purpose of this analysis was to examine the prevalence of obesity and NWO among a sample of middle-aged women using BMI and body composition analysis. A secondary aim was to characterize demographics of NWO, including physical activity levels (PA), menopausal status and quality of life, and number of chronic conditions and medications used. Data was collected from 106 middle-aged women (mean age = 53.01±6.20 years). BMI was calculated using laboratory measured height and weight and body composition (total fat mass and body fat percentage) via dual energy X-ray absorptiometry (DXA). Participants were categorized by BMI: normal weight (NW=18.5–24.9 kg/m²), overweight (OW=25.0–29.9 kg/m²), or obese (OB=≥30.0 kg/m²); and by body fat percentage: lean (L<30%) or obese (O≥30%) and were then sorted into four groups: NWL, NWO, OWO, and OBO. Steps/day and minutes of low-, moderate- and vigorous-intensity PA were assessed via accelerometer. Participants self-reported menopause status and completed the Menopause Specific Quality of Life Questionnaire (MENQOL) assessing vasomotor, psychosocial, physical, and sexual symptoms. Data was analyzed by group and differences between NWL and NWO were analyzed using independent t-tests for continuous data. Based on BMI, 45.3% of participants were NW, 34.9% OW, and 19.8% OB. 85.8% had >30% body fat. Of the sample, 31.1% were classified as NWO and 14.2% as NWL. BMI and %fat were significantly correlated in the OWO group (r=.373, p=0.02), but not in other groups. NWO participants were significantly older than NWL (p=0.04). No differences were found between NWL and NWO in menopausal status, chronic conditions, medication use, PA, or MENQOL scores (all p>0.05). While obesity and NWO were prevalent among middle-aged women using both BMI and DXA assessment, the factors most strongly associated with NWO were unable to be categorized using the current dataset. Health care professionals should be aware of discrepancies that can occur in classifying weight and body fat status when using BMI. Identification of those with NWO should be prioritized to allow for the adoption of preventative health.

Fabrication of Hydrogels for Drug Diffusion

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In this project, we study whether magnetic nanoparticles activated through alternating magnetic fields can enhance drug transport across a biomaterial. To test this hypothesis, we build a prototype experimental setup to monitor molecular transport across a hydrogel. The setup consists of an inner tube closed with a membrane filter holding the hydrogel, placed inside a large reservoir. Calcium-crosslinked alginate hydrogels were synthesized and the method for depositing the hydrogel within the tube was optimized. The hydrogel represents biological tissue and is loaded with magnetic nanoparticles that heat up under an alternating magnetic field. This setup will be used in a specialized device to apply alternating magnetic fields and it will enable systematic testing of drug diffusion in the presence and absence of alternating magnetic fields.

Metabolic Rates of *Ooceraea biroi*, the Clonal Raider Army Ants

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Energy needs change as animals grow and transition through phases of their life cycle. Previous work has found that ant colony metabolic rates also change as colonies grow, and as they transition through reproductive and non-reproductive phases. To better understand how different components of the colony contribute to the metabolic expenditure of the colony as a whole, we set out to understand how much energy is used by the constituents of *Ooceraea biroi* Clonal Raider ant colonies. *O. biroi* colonies are composed of individuals at different developmental stages: egg, larva, prepupa, pupa, and worker. Workers are the most mobile stage, which suggests that they release more energy because of their higher levels of activity. Since the brood is primarily immobile, they may release less energy. However, the brood might be spending a lot of energy on growth. To characterize energy use, we measured the CO_2 released by different colony components. The CO_2 released was divided by the weight of the component to get a standardized metabolic rate that could be compared across differently sized items. Additionally, we assessed weight distribution of workers in colonies by measuring the mass of 100-200 ants from three colonies. We also connected CO_2 release with different levels of behavior and mobility (resting, walking, running, and interacting with each other and the chamber) in workers. We observed that both workers and larvae contribute significantly to overall energy release. It was also observed that the pupa showed less energy release, likely due to their immobile state. Colonies showed a variety of weight distributions, but overall had one large peak. For connections between worker behaviors and energy expenditures, we have preliminary results showing different patterns of CO_2 release during different behaviors.

Characterization of Muscle Spindles and Gait in a Model of Cerebral Palsy

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Cerebral palsy (CP) is a collection of motor disorders that is the most common cause of lifelong motor disability worldwide, affecting approximately 1 in 500 live births. It is caused by injuries to the developing nervous system during late gestation or early childhood, and typically involves spasticity (marked by hyperreflexia) and difficulties with gait (e.g. crouch gait). Stretch reflexes are attributed to sensory organs called muscle spindles, which detect stretch in skeletal muscles and activate Ia sensory afferents. Hyperreflexia in CP could involve irregularities in muscle spindle physiology, but this remains unexplored. In turn, hyperreflexia and irregular muscle spindle morphology may be correlated with gait abnormalities seen in CP. To explore this, we are investigating muscle spindle morphology in developing rabbits that have experienced prenatal hypoxia-ischemia (HI) injury, via surgical procedure at 70-80% gestation, and in sham-operated control rabbits that have been prenatally exposed to anesthetics but not HI. We are using immunofluorescent labeling of neurofilament (NF) and synaptic vesicle 2 (SV2) to visualize muscle spindle annulospiral (primary) endings, and α-bungarotoxin (α-BTX) to visualize the spindle's neuromuscular junctions. These structures will be identified in muscle tissue teased from the soleus of neonatal sham and HI rabbits, imaged by confocal microscopy, and analyzed to assess spindle morphology over early postnatal development. We are testing whether optical clearing of muscle enhances our ability to visualize spindles. We hypothesize that muscle spindles from HI rabbits will demonstrate delayed development when compared to that of sham kits; it is possible that delayed development or structural abnormalities within muscle spindles could contribute to hyperreflexia and gait abnormalities in CP. Impaired proprioception may contribute to deficits in motor control in CP; gait will be assessed in rabbit kits at two weeks of age using video recording. This information will then be analyzed in DeepLabCutTM to assess stride length, joint angle, and other limb activity seen within sham and HI rabbits. Findings from this project will contribute to further understanding of neuromuscular impairment in CP and development of potential therapeutic strategies to normalize muscle spindle physiology in this disorder.

Size Matters: The Impact of Cell Size on Yeast Replicative Lifespan

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How and why cells age remains a central question in biology. Studying aging in the eukaryotic model organism *Saccharomyces cerevisiae* (budding yeast) offers valuable insight into mechanisms that are conserved across more complex organisms. In budding yeast, cells divide asymmetrically: a mother cell forms a smaller daughter cell through a budding process. Over time, the mother accumulates age-related changes and eventually stops dividing, a process quantified by its replicative lifespan (RLS), the total number of daughter cells it produces before senescence or death. Cell size is a tightly regulated feature of cell physiology, but its role in cellular aging remains poorly understood. Although yeast and other cells are known to increase in size as they age, it is unclear whether a cell's initial size can influence how long it will live. To explore this question, we focused on the first bud emergence, the moment when a newly born yeast cell begins its first division by forming a small outgrowth (bud) that will become its first daughter. We asked whether the size of the cell at this early time point could predict its replicative lifespan. Using time-lapse microscopy and single-cell tracking, we measured cell size and division patterns across the full lifespan of individual yeast cells. We found that larger cells at first bud emergence tend to live longer than smaller ones. Moreover, larger young cells maintain a more stable size throughout their lifespan, whereas smaller young cells show more dramatic size increases as they age. These results suggest that a cell's starting size not only correlates with lifespan but may also influence how it regulates growth and maintains homeostasis over time. Our findings highlight how physical properties like size can shape the aging process and may reveal general principles of longevity that extend beyond yeast.

Coordinating Cell Size with Glucose Availability via Regulation of Mitotic Activator Cdc25

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Cells maintain a characteristic size to function. Most cells control their size by delaying cell cycle transitions until reaching a threshold size, suggesting they can sense and relay size information to cell cycle machinery. Studies in fission yeast have uncovered core regulators of size control and cell division in eukaryotes. These cells divide at a threshold size due to size-dependent activation of cyclin-dependent kinase (Cdk1), in part via nuclear accumulation of the phosphatase Cdc25. Under nutrient-rich conditions, Cdc25 nuclear accumulation scales with cell volume, helping establish a size threshold for division. However, in nutrient-limited environments such as low glucose, cells divide at a smaller size, raising the question of how Cdc25 regulation adapts to changing glucose conditions. To explore this, we investigated how glucose availability influences Cdc25 levels and localization. Using live-cell fluorescence microscopy and an automated ImageJ/MATLAB analysis pipeline, we quantified nuclear and cytoplasmic levels of Cdc25-mNeonGreen in wild-type cells across a range of glucose concentrations. Surprisingly, we found that cells accumulate more Cdc25 in the nucleus as a function of size when grown in low glucose, suggesting that nutrient cues can override the usual size-dependent scaling of Cdc25. To identify upstream regulators, we screened mutants of the glucose-sensing cAMP/PKA pathway, including pka1, gpa2, git3, and git5, and wound that disruption of these genes leads to elevated nuclear Cdc25, implicating this pathway as a negative regulator under glucose-rich conditions. In parallel, we observed that pub1Δ cells, lacking an E3 ubiquitin ligase implicated in glucose-dependent Cdc25 degradation, also exhibit elevated Cdc25 levels. These findings suggest that Pka1 and Pub1 may function in a shared or parallel pathway to restrict Cdc25 accumulation in high glucose environments. Together, our findings reveal that Cdc25 levels are actively modulated by glucose-responsive signaling pathways, allowing cells to adjust mitotic entry and division size according to glucose availability.

Wild Bee Foraging and Movement Behavior in Urban Gardens

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Despite posing several threats to insect pollinators, urban environments can harbor successful plant-pollinator communities with biodiverse green spaces. While bees collect pollen and nectar to meet their nutritional needs, there is limited data on the floral preferences of different species in urban areas. My research will examine how foraging bees balance their diets and where they are moving within urban Providence College (Providence, RI) gardens. During Summer 2025, I conducted mark-recapture surveys to collect behavioral data on two native species, *Bombus griseocollis* and *Agapostemon virescens*, and quadrat surveys to determine the floral foraging preferences of various species. These data will contribute to the greater understanding of bee foraging habits in urban areas and can be used in planning efforts to create more successful green spaces and community gardens.

The Art of Holding On (and Letting Go): Cellular-Level Morphology of Sea Urchin Duo Gland Adhesive System

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Developing adhesives that function in wet environments remains a major challenge in biomedical fields. While organisms such as mussels and oysters have inspired permanent underwater glues, sea urchins offer a model for strong yet reversible adhesion. This adhesion is regulated by a duo-gland system located in the disc at the distal end of the tube foot. Within the epidermis of the disc, adhesive and de-adhesive gland cells release granules that control attachment and detachment to substrata. Current knowledge on the fine-scale morphology of the duo gland system is limited to a single species found in the Mediterranean Ocean. In this study, three sea urchin species, found in the Pacific Ocean, were compared: two closely related species, *Strongylocentrotus purpuratus* and *Strongylocentrotus droebachiensis*, and a third species from the same family but a different genus, *Mesocentrotus franciscanus*. It was predicted that the two *Strongylocentrotus* species, which are more closely related in genus, would exhibit greater similarity in duo gland morphology than the more distantly related *M. franciscanus*. Longitudinal sections from one tube foot per species were imaged using transmission electron microscopy (TEM). Morphometric analysis was conducted using ImageJ to quantify the area and number of adhesive and de-adhesive cells and granules. No statistically significant differences were found among species in the measured traits. However, qualitative analysis of the images revealed that *S. purpuratus* and *S. droebachiensis* shared similar gland cell abundance and size characteristics, while *M. franciscanus* appeared to compensate by producing fewer but larger adhesive cells that contained more granules. These results contribute to the broader understanding of temporary biological adhesion and support future efforts to develop reusable adhesives inspired by echinoderms.

Characterizing the Functional Diversity of Rocky Intertidal Environments of Southern New England

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Tide pools are diverse ecosystems that support a wide range of important species, essential to our environment and marine habitats. Along the New England coastline, tide pools have been significantly impacted by human activity—whether through direct contact, such as walking through or collecting from them, or indirectly through the growing effects of climate change caused by human actions. Here, our goal is to implement multi-year monitoring of Southern New England environments, similar to efforts conducted by the UC Santa Cruz Multi-Agency Rocky Intertidal Network (MARINe) and the National Park Service Northeast Temperate Network's (NETN) long-term monitoring protocols. MARINe and the NETN have been using similar monitoring methods in California and Northern New England, respectively, providing a valuable dataset comparing biotic change on the Atlantic and Pacific coasts of North America, as we are following a similar protocol adapted from theirs. This year, we began establishing multi-year plots to monitor rocky intertidal zones in Southern New England; an area that, unlike Northern New England, has not been sampled using these methods and is more heavily impacted by human activity. We constructed quadrats out of PVC pipes to create rectangular frames that used to frame and take overview photos that are later scored in the lab. Our sampling protocol had us lay out 5 of these plots throughout all three intertidal zones. Starting at the high intertidal zone, also known as the Barnacle Zone, where our target species were barnacles. Following this, we moved to the mid intertidal zone, also called Mussel Zone. Finally, in the low intertidal zone, the Red Algae Zone, our target species group was red algae. Preliminary results from our field site at Kings Beach show that the Barnacle Zone is much more sparse than expected from previous work done by other researchers. Also notably absent from this field site were mobile predators, including sea stars and sea urchins. By collecting baseline data and continuing to survey the same plots and transects over time, we will gather data into how key New England tide pool species respond to local human activity and global climate change. Ultimately, by gaining a better understanding of how these systems change over time, we can predict how species might respond to future environmental shifts and develop conservation strategies to protect the most critical components of these ecosystems, ensuring healthy marine ecosystems.

3D Printing of Soft Materials

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Within the biomedical industry, there has been significant interest towards developing biological structures, scaffolding for tissues, and organs that can be generated using additive manufacturing. In order to effectively do this, researchers must identify which materials are viable for this type of printing and the rheological limitations of each. A category of materials known as soft materials is a group of substances that have a unique microstructure, allowing them to experience solid-like and liquid-like properties, including viscoelasticity and yield stress. Additionally, these materials are known to be thixotropic and shear-thinning, which means their behavior is dependent on the mechanical stress applied as well as the amount of time it takes for the material to recover its internal molecular structure. In an effort to expand the effectiveness of these materials in 3D printing processes, we have focused on understanding the printing parameters that lead to effective printing for a few common printable structures, such as cylinders. By modifying the geometry of the cylinder, including its total height, layer thickness, and radius, in conjunction with linear printing speed, extrusion speed, and printer head size, we can obtain a large amount of data about printing behavior. Then, utilizing this data, we can identify the impact of each printing parameter on the yielding and buckling behavior of the cylinder. This can then be used to determine which printing properties are most suitable for generating clean, cylindrical prints. Overall, this information has determined that the radius has a significant impact on printing performance. Additionally, a print will perform better as the extrusion speed increases relative to the linear printing speed, generally. Ultimately, this information can be used to help the biomedical industry generate precise, effective, and structurally accurate prints.

Emotional Neglect in Childhood Among Those Who Misuse Benzodiazepines

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Introduction: Benzodiazepine misuse remains most prevalent among young adults aged 18-25, with 5.2% reporting misuse in 2018. Misuse is attributed to both recreational and self-medicating factors related to anxiety or sleep disturbances and psychosocial stressors. Emotional neglect in childhood, a form of maltreatment, is associated with long-term mental health issues and vulnerability to substance misuse. The current study seeks to examine the association between emotional neglect in childhood and increased benzodiazepine misuse in young adulthood in Rhode Island young adults.

Methods: A total of 1,008 young adults aged 18-25 from the 2024 Rhode Island Young Adult Survey were recruited. This is a cross-sectional, web-based survey examining behavioral health. Benzodiazepine misuse was measured asking, Have you ever used non-prescribed benzodiazepines? Emotional neglect in childhood was assessed asking, Did you feel that no one in your family loved you or thought you were special? Multivariable logistic regressions were used to examine the association between emotional neglect in childhood and odds of benzodiazepine misuse while controlling for sexual and gender identity, race/ethnicity, age, and social ladder.

Results: 5.6% of participants reported benzodiazepine misuse and 33.4% reported having experienced emotional neglect in childhood. 55.4% of those who reported benzodiazepine misuse also reported emotional neglect in childhood (p<0.001). Those who had a history of emotional neglect in childhood had a 2.80 (95%CI: 1.57,5.00) times the odds of benzodiazepine misuse.

Discussion: Emotional neglect in childhood is significantly associated with benzodiazepine misuse in young adulthood. The relationship can be explained by emotional dysregulation and impaired social bonding. Findings emphasize the need for early detection of emotional neglect in pediatric settings and school-based mental health programs, and implementation of prescription drug monitoring programs. Future studies should explore protective factors such as resilience and social support while expanding to diverse populations and regions to strengthen generalizability and applicability.

Witnessing Gun Violence and Problem Gambling Among Rhode Island Young Adults

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Objectives: Problem gambling is a growing public health concern linked to substantial emotional, financial, relational, occupational, and health harms. At the same time, rates of exposure to gun violence—particularly witnessing violence—are rising among young people. Despite increasing recognition of the impact of trauma on risky behaviors, limited research has explored the link between witnessing gun violence and problem gambling, especially in young adults. This study investigates the association between witnessing gun violence and problem gambling among young adults in Rhode Island, a population disproportionately affected by both issues.

Methods: This study included N=1,008 young adults aged 18 to 25 years who lived in Rhode Island for at least part of the year who participated in the 2024 Rhode Island Young Adult Survey. Witnessing gun violence and problem gambling were measured via self-report, web-based survey in Qualtrics. Problem gambling was assessed using the Brief Biosocial Gambling Screen (BBGS). Multivariable logistic regression assessed main effects after adjusting for age, sexual and gender status, race/ethnicity, social status, employment status, and student status.

Results: Overall, 4.3% of participants met the definition for problem gambling and 36.01% reported ever witnessing gun violence. Odds of problem gambling were higher in those who witnessed gun violence (AOR [95%CI]: 2.09 (1.09,4.01) while controlling for age, sexual and gender status, race/ethnicity, social status, employment status, and student status. Decreased odds of problem gambling were seen for those who were employed (AOR [95%CI]: 0.48 [0.24, 0.95]) and those who identified as a cisgender heterosexual female (AOR [95%CI]: 0.12 [0.04, 0.37]).

Conclusions: Findings suggest that witnessing gun violence is significantly associated with increased risk of problem gambling among young adults. This association highlights the potential role of trauma exposure in the development of maladaptive coping behaviors. Addressing community violence and integrating trauma-informed approaches into gambling prevention and treatment efforts may be critical for reducing gambling-related harm in this population.

Tangled Currents: The Complex Interactions of Nutrients, Metals, and Suspended Particles in Estuarine Waters

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Mount Hope Bay is a unique estuarine embayment waterbody, having two southern outlets to the ocean through the east passage of Narragansett Bay and the Sakonnet River. The main freshwater source into the bay comes from the Taunton River to the north, complemented by, to a lesser extent, the northerly rivers of the Kickemuit, Cole, and Lee. These inflows play a critical role in shaping the bay's stratification, nutrient distribution and sediment transport. Stokes Law describes particles being held suspended in the water column due to upwards buoyancy force driven by its velocity and viscosity. Once the flow stops or is significantly slowed the particles will begin to fall out of suspension. This study hypothesized that the intersection of river inflows and estuarine mixing in the Mount Hope Bay promotes increased sedimentation. Water quality indices (O_2, pH, salinity, and turbidity) and nutrient concentrations (PO_4^{3-}, NO_2^-, NO_3^-) were assessed using HACH® analysis, and metal ion concentrations were assessed ICP-OES and XRF. Analysis of data determined a salt wedge – vertical gradient in salinity where freshwater and saltwater meet. The salt wedge was found in the upper Taunton River and found to correlate with elevated levels of suspended solids (22 mg/L, av: 8.1 mg/L), higher concentrations of both nutrients such as nitrate (6.45 mg/L, av: 1.8 mg/L) and nitrite (0.040 mg/L, av: 0.00965 mg/L), and metals were found in the bottom-most sample site. The increased concentrations of nitrate and nitrite are associated with an elevated turbidity (22 FTU), indicating a strong correlation between nutrient accumulation and particle suspension in lower layers. Phosphate levels were the highest in surface and mid-level samples (0.164 mg/L, 0.307 mg/L), having lower salinity than lower depths, suggesting that phosphate is introduced mainly through freshwater sources, and that it may not settle as readily as other particles. Total dissolved ions exhibited the same trend as the predicted values given by conductivity, despite being an order of magnitude off, as exhibited in site 1Mc actual and theoretical values (256740 mg/L, 25305 mg/L).

Hidden Riches Beneath the Surface: Enhancing Metal Revelation in Estuarine Waters Through Evaporation and Carbonate Removal

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High-tide transects were conducted in freshwater inputs to Mount Hope Bay (Kickemuit, Lee, Cole, and Taunton Rivers) to examine dissolved metal and organic carbon distributions. Surface, mid-depth, and bottom waters were sampled using Niskin bottles. Filtered and unfiltered samples were evaporated to dryness and analyzed for metals via XRF and ICP-OES following acid digestion. Organic carbon and bicarbonate content were measured by loss-on-ignition at 500°C and 1000°C, respectively. Unfiltered samples, containing more organic debris, yielded higher organic carbon percentages. Mass differences between filtered and unfiltered samples revealed clustering patterns, with the Lee River exhibiting the highest organic carbon, suggesting it is a major source of dissolved organic matter to the bay. Phosphate concentrations varied with salinity and depth, indicating estuarine stratification. Surface samples (19.5–26.5% salinity) showed elevated phosphate (0.01–0.28 mg/L), likely from runoff or riverine input. At mid-depth, phosphate peaked in Mt. Hope Bay and the Taunton River (0.6–1.0 mg/L), suggesting sediment resuspension or nutrient trapping. Bottom waters showed stable, low phosphate at high salinity, consistent with removal via calcium phosphate precipitation under alkaline, high-calcium conditions. The Cole River exhibited decreasing phosphate with increasing salinity, indicating terrestrial input, while the Lee River consistently had the lowest phosphate across depths. Kickemuit River phosphate peaked at Depth C, possibly due to sediment influence. Conductivity data from filtered samples supported these trends. Mill Pond had the highest conductivity, indicating strong ionic input. Mt. Hope Bay and the Taunton River showed dynamic mixing patterns, whereas the Cole and Lee Rivers remained more stable. Kickemuit showed moderate ionic enrichment compared to Cole and Lee. Phosphate-to-iron and phosphate-to-manganese ratios in filtered Mt. Hope/Taunton samples were 3:1 and 37,000:1, respectively. Iron appeared well-mixed and conserved in the water column. Comparison of ICP and XRF phosphate data suggests some phosphate may be matrix-bound and undetectable by XRF. XRF analysis revealed elevated mercury (Hg) in Mt. Hope and Taunton River samples, absent in other rivers. Hg peaked at sites 2M–4M, plateaued at 4M–6M, then declined, consistent with legacy industrial discharge from Brayton Point Power Plant and tidal flushing.

Investigating the Specificity of Azo Bond Reduction in the Human Gut Microbiome

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The bacteria of the human gut microbiome can metabolize drugs, often causing unintended side effects. The uniqueness and variability of each individual's microbial composition, coupled with our limited understanding of specific enzyme functions, make the metabolic outcomes of these therapeutics difficult. Azoreductase enzymes are of particular interest due to their ability to reduce azo bonds, which are often found in drugs and food dyes. Azo dyes can also be reduced nonenzymatically by hydrogen sulfide, a bacterial metabolite produced during sulfate and cysteine metabolism. The goal of this study is to examine the specificity and relative kinetics of both enzymatic and nonenzymatic reduction of azo compounds by synthesizing and characterizing a library of 25 structurally diverse azo-bonded molecules with varying electronic properties. These compounds fall into three main groups, each of which is designed to test our proposed azoreductase mechanism. We hypothesize that azoreductases do not directly reduce azo bonds but instead reduce quinone-like tautomer of azo compounds. Out of the 25 compounds, 16 have been synthesized, and the reduction potential of 9 has been measured. The reduction potentials ranged from -1.138 V to -0.724 V among the phenylazophenol derivatives and from -0.911 V to -0.711 V for the benzenesulfonic acid-based azo compounds, highlighting clear electronic effects on reduction behavior. Other members of our research group are determining the enzymatic rate of reduction of these compounds. These findings broaden our understanding of microbial azo reduction, helping to develop safer therapeutics for treating diseases of the large intestine and supporting future personalized medicine efforts.

Effect of pH on Drug Modification in Gut Bacteria by 20-Hydroxysteroid Dehydrogenases

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The gut microbiome is home to trillions of microorganisms, many of which have been shown to metabolize xenobiotics such as drugs or food dyes. However, as the metabolic potential of many of these microorganisms is unknown, our goal is to help characterize these microorganisms' activities. Specifically, we want to characterize the metabolism of 20-hydroxysteroid dehydrogenases, which are shown to metabolize cortisol and other corticosteroids at the carbon-20 position. Specifically, the enzymes Ad20β and Ba20β found in the organisms *Agathobaculum desmolans* and *Bifidobacterium adolescentis*, respectively, were shown to metabolize cortisol, prednisone, and prednisolone at both pH 5 and pH 7. We were interested in studying the kinetics at pH 5 and pH 7 because of a reported pH rate profile, suggesting the Ba20β enzyme had maximal activity at pH 5. We discovered substrate inhibition only at pH 7, not pH 5, explaining the different rates at pH values. Kinetic constants were determined (KI, kcat, kcat/KM) using either Michaelis-Menten or substrate inhibition kinetic models. At pH 7 with Ad20β and substrates cortisol, prednisone, and prednisolone, kcat values were determined to be 0.065, 0.116, and 0.052 1/s respectively; KI values were determined to be 300, 80, and 500 µM respectively; and kcat/KM values were determined to be 6000, 50000, and 5000 1/M *1/s respectively. Hopefully, understanding the metabolism of these gut microorganisms will have implications for personalized medicine, in which doctors potentially would be able to prescribe different drugs based on patients' unique gut microbiomes.

Microneedle Patch Design for Directional Fluid Pumping and Intracellular Fluid Delivery/Sample Collection via Piezo-Generated Acoustic Energy

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Statement of the Problem/Background:
Traditional drug delivery and fluid sampling methods, such as hypodermic injections, are invasive, painful, and lack precise fluid management. Transdermal microneedle systems offer a minimally invasive alternative, but current designs are typically unidirectional and rely on passive diffusion or manual pressure-driven techniques. To address these limitations, this research integrates acoustic streaming via piezoelectric elements into microneedle patches to enable programmable, bidirectional fluid transfer for both intracellular sampling and precise drug delivery.

Research Question/Hypothesis:
Can a piezo-driven microneedle array enable precise, bidirectional fluid handling through the conversion of electrical energy into acoustic waves for minimally invasive transdermal applications?

Research Design/Methods Used in the Investigation:
This study will employ high-resolution 3D printing to fabricate biocompatible resin microneedles, each with hollow structures optimized for bidirectional fluid transfer. Acoustic streaming parameters, including frequency (34 kHz), amplitude, and power, will be modeled via finite element analysis (FEA) and validated using in vitro fluid flow experiments. Preclinical in vitro tests on tissue models and initial in vivo studies will assess fluid transfer efficacy and safety. Fluid trajectories will be analyzed using fluorescence and spectrophotometry to correlate geometry and acoustic parameters with performance.

Results/Summary of the Investigation:
Initial results indicate that microneedle dimensions and acoustic streaming parameters significantly influence fluid transfer efficiency. While some patch designs demonstrated partial fluid movement, limitations in 3D printing caused blockages in the hollow microneedles, preventing full transfer. Future iterations to the fabrication process will address these blockages to optimize patch performance.

Interpretation/Conclusion of the Investigation:
The integration of piezoelectric acoustic streaming into microneedles offers significant potential for programmable, minimally invasive drug delivery and sampling systems. Although initial results

Investigating CXCR4-Driven Stemness in Chordoma

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Chordoma is a rare malignant bone tumor arising from remnants of embryonic notochord that fail to regress during development forming tumors in the brainstem, spinal cord, and sacrum —making it difficult to treat. Recurrence and resistance to therapy highlight the need to target genes driving tumor survival.CXCR4, a chemokine receptor, is involved in stem cell migration and immune cell trafficking, it is linked to cancer stem-like cells (CSCs) and possibly supports chordoma progression. This study investigates the functional role of CXCR4 via siRNA-mediated silencing, assessing gene/protein expression, cell viability and proliferation. We further explored how it may influence Chi3l1, a key mediator of tumor microenvironment and immune suppression given that they share similar downstream pathways. Primary (UCH12, UCH7) and recurrent (UCH1) chordoma cell lines were transfected with CXCR4-targeting siRNA for 48 hours to allow for effective gene knockdown. RNA extraction, RT-PCR, and qPCR was performed on untreated cells for a baseline gene expression of CXCR4. All data points were analyzed relative to GAPDH expression. Protein was extracted from UCH12, UCH7, and UCH1 cell lines that were siRNA treated, followed by Western Blotting to probe for CXCR4 and β-Actin as a loading control. A Chi3l1 ELISA was conducted on supernatants from UCH1, UCH12, and UCH7 following CXCR4 knockdown for Chi3l1 protein quantification. Parallel supernatants from Chi3l1-targeted siRNA knockdowns were prepared under identical concentrations and transfection conditions for comparative ELISA analysis.

Preliminary qPCR revealed low baseline expression of CXCR4, with UCH1 seeming to have more expression relative to GAPDH. Western Blot showed minimal presence of CXCR4 protein in UCH7 and UCH1. Protein-level analysis by Western blot suggests more effective CXCR4 knockdown than was detected at the mRNA level by qPCR. In UCH1, CXCR4 knockdown showed decreased viability and proliferation, suggesting CXCR4 supports cell survival and growth in recurrent chordoma. Chi3l1 ELISA demonstrated UCH1 and UCH7 had no differences in Chi3l1 expression, while the UCH12 cell line had elevated expression levels. Preliminary data indicates low CXCR4 expression at the mRNA level. Protein expression demonstrated to be more effective at CXCR4 knockdown visualization. Preliminary viability and proliferation assays suggest that CXCR4 appears to be functionally relevant in recurrent chordoma.

CLEC7A Deficiency Affects Cerebellar Microglia Development and Purkinje Cell Axon Myelination

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Proliferative region-associated microglia (PAM) are a subpopulation of microglia in the white matter region (WMR) of the brain during postnatal development. This type of microglia transiently and highly expresses a specific group of genes that includes *Clec7a*, *Spp1*, and *Apoe*. Expression of these genes is not found in healthy adult microglia. However, these genes are re-expressed in activated microglia associated with neurodegeneration. In the current project, we are studying CLEC7A deficient mice (*Clec7a-/-*) to investigate the role of this protein in the differentiation, maturation, and function of microglial cells during the postnatal development of the cerebellum. Our results showed that at postnatal day 7 (P7), when myelination is normally starting in the cerebellum, the number of WMR microglia was decreased along with the decreased proliferation (Ki67+ microglia) of these cells in *Clec7a-/-* mice compared to wild-type (WT) mice. The morphology of CLEC7A deficient microglia was not different from WT cells, however IBA1 immunoreactivity was higher in *Clec7a-/-* mice. To identify gene expression changes in cerebellar PAM cells from P7 CLEC7A deficient mice, probes for Spp1 and Apoe were used to perform RNAscope experiments. Interestingly, in the WT and *Clec7a-/-* mice, not all the PAM cells co-expressed *Spp1* and *Apoe*. Furthermore, the majority of Spp1+ cells had lower levels of *Apoe* expression. We also found that the number of Spp1+ PAM cells and the fluorescence intensity of *Spp1* and *Apoe* were significantly reduced in *Clec7a-/-* mice compared to controls. Importantly, myelination of Purkinje cells (PC) axons was significantly decreased in P10 *Clec7a-/-* mice. Since the refinement of Purkinje cell (PC) axonal collaterals occurs during early postnatal development (P7-P15) and is critical for proper myelination, we investigated whether this process is disrupted by the absence of CLEC7A in microglia. We observed a greater number of unmyelinated axons in *Clec7a⁻/⁻* mice compared to wild-type controls. Additionally, *Clec7a⁻/⁻* mice exhibited motor deficits in the ladder rung walking task, suggesting that microglial CLEC7A contributes to neuronal function. Ongoing studies are focused on analyzing microglial interactions with these axons to determine whether CLEC7A is involved in axonal refinement. Together, our findings indicate that CLEC7A deficiency in microglia impairs not only microglial maturation but also the myelination of PC axons

A *C. elegans* Model of Fanconi Anemia Neurological Syndrome (FANS)

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Fanconi Anemia (FA) is an extremely rare genetic disease caused by biallelic mutations in any of the twenty-three FA genes. FA is characterized by an increased risk of bone marrow failure, congenital abnormalities, cancer and reduced life span. The FA proteins are involved in DNA damage repair and maintaining chromosomal stability.

Recent clinical observations describe neurological symptoms among patients with FA. These include cerebral and cerebellar lesions, seizures, irregular brain MRI's and early-onset cognitive decline. The term Fanconi Anemia Neuroinflammatory Syndrome (FANS) encompasses every neurological symptom caused by FA suggesting an underexplored role of Fanconi Anemia in the nervous system.

To uncover the underlying molecular mechanisms of FANS, we have turned to the nematode *Caenorhabiditis elegans*. *C.elegans* offers many advantages as a model organism, like its transparent body, well characterized genome, and short life cycle with a high reproduction rate. The *C.elegans* nervous system is simplistic, being composed of 302 neurons, and its entire neural network has been mapped.

In this study we have focused on the role of *fcd-2* and *fnci-1*, orthologs of human *FANCD2* and *FANCI*, respectively, in nervous system development and function. To assess the presence of the phasmid neurons, four sensory neurons in the tail of the worm, we performed dye-filling assays under unchallenged conditions and following exposure to hydroxyurea (HU) during neurogenesis. Data was collected from animals at different ages: 1 day-old, 4 day-old and 7 day-old. Mutant strains expressing GFP in all ciliated neurons were generated in our lab to determine if the loss of *fcd-2* and *fnci-1* was affecting the development of the neuronal bodies or the development of the cilia. Behavioral assays were also performed to assess the functionality of these neurons.

Our results suggest that the loss of *fcd-2* and *fnci-1* affects the development of the sensory system *in C. elegans*, specifically non-motile cilia development. Significant differences in the number of dye-filled phasmid neurons show that FA worms are more susceptible to replication stress and age faster than wildtype worms. Furthermore, our newly generated GFP mutant strains and the osmotic avoidance assay performed suggest defects in the structure and function of non-motile cilia in FA worms.

Environmental Factors and the Arc of Resettlement for Unaccompanied Children in the United States

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Unaccompanied minors are children under 18 years old, who have migrated to the United States (US) and are without a guardian. Recent research shows a significant number of unaccompanied minors arriving to the US, mainly migrating from Guatemala, Honduras, and El Salvador. In 2024, the Office of Refugee Resettlement (ORR) reported 98,356 unaccompanied minors arrived in the US (ORR, 2025). Unaccompanied children face trauma across migration stages, which research has shown is closely linked to severe mental health distress (Berger Cardoso et al., 2017). This exploratory mixed-methods study aims to address a gap in research on the relationship between environmental factors and immigrant integration. Data was collected using a survey with the Sense of Community Index (SCI), various demographic variables (e.g. age, sex, country of origin), and semi-structured in-depth interviews. All data was collected in partnership with a Rhode Island nonprofit organization, Dorcas International, between February 2024 and June 2025. The unaccompanied children who completed the survey were all receiving case management services from Dorcas International. The SCI is a 24-item instrument that measures one's sense of community with a four-point Likert-style scale (0=Not at all; 3=Completely). The SCI includes four subscales: meeting needs, influence, membership, and shared emotional connection (McMillan & Chavis, 1986). The sample included n=68 unaccompanied children. The mean SCI score was M=36.29 (SD=20.09), and the average length of detention was M=25.68 days (SD=20.20). A Spearman's rank correlation test revealed a negative and weak relationship between SCI needs and length of time in detention (r= -0.27) ($p < 0.05$). This finding suggests that individuals with higher SCI needs tended to spend less time in detention. Thematic analysis revealed two key themes: (1) Family support enhances an unaccompanied child's sense that their needs are met, and (2) Cultural alignment (e.g. language) strengthens an unaccompanied child's shared emotional connection with their community. The results can inform the development of clinical services that help facilitate integration in the US. For example, children who experience forced migration may benefit from psychoeducation on the importance of community involvement. Future research should focus on continued qualitative data collection to deepen thematic analysis.

Psychological and Somatic Distress: Elucidating the Clinical Consequences of Trauma in Adult Refugees

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Over the past three decades the U.S. has provided asylum to over 3 million refugees (UNHCR) escaping war, violence, and persecution. Pre, during, and post migration adversity and trauma manifests into psychological distress which has been linked to frequency in physical disorders such as cardiovascular and inflammatory disease (Polcher et al., 2016). Common diagnoses during preliminary refugee screening include PTSD, anxiety, and depression (Hollifield et al., 2012). In Rhode Island, Dorcas International (DIIRI) is a non-profit that provides social services for immigrants, including refugees. This study analyzed administrative data shared by Dorcas International. The dependent variable is mental distress. Mental distress is measured with the Refugee Health Screener-15 (RHS-15), a 15-item instrument that measures mental distress using a five-item Likert-style scale (0=not at all; 4=extremely). The independent variable is somatic distress (0=No; 1=Yes). This was measured based on analysis of clinical case notes. The sample includes a total of n = 329 refugees. Refugees were resettled from a variety of countries, including Syria (18.90%), Democratic Republic of Congo (20.73%), Afghanistan (23.78%), and Guatemala (10.98%). The average age of a participant is M= 34 years old (SD= 12.7%). Among refugees in the sample, 45.43% reported somatic distress. The country of origin with the highest percentage of somatic distress is Afghanistan (63.64%). A Mann-Whitney U-Test revealed that refugees who reported somatic distress had higher rates of mental distress (M= 11.4; SD=9.8) compared to refugees with no reported somatic distress. There is overwhelming evidence of a high burden of psychological distress for refugees upon arrival. Emphasizing the need for mental health screening once arriving in the U.S. to lay the foundation for the patient's preventative care in the future.

Evaluating the Role of PPARα on Bile Acid Regulation to Treat Cholestatic Liver Diseases

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Hepatic bile acid secretion and bile formation are essential functions of the human liver. Cholestatic liver diseases, including primary biliary cholangitis (PBC) and primary sclerosing cholangitis (PSC), result from an impairment or disruption of bile flow, leading to the accumulation of bile acids and subsequent bile acid toxicity. Bile acids are endogenous compounds synthesized from cholesterol in the liver, and their primary function is to facilitate the absorption of lipophilic compounds, e.g., fatty acids, and to aid in digestion. However, the accumulation of bile acids during cholestasis causes liver injury and potentially organ failure.

The peroxisome proliferator-activated receptor-alpha (PPARα) is a nuclear hormone receptor predominantly expressed within the liver that regulates and maintains the homeostasis of bile acids, cholesterol, and lipids. In particular, PPAR regulates the transcription of genes that are responsible for bile acid synthesis and metabolism. Fenofibrate is a PPARα agonist which, upon the activation of PPAR, transactivates several genes involved in bile acid metabolism. Importantly, fenofibrate is FDA-approved to reduce elevated cholesterol and, in recent years, it has been used off-label as adjunct therapy for adults with PBC and PSC. This study is part of a larger ongoing project that investigates the hypothesis that activation of PPARα transcriptionally regulates the hepatic multidrug resistance-associated protein 3 (MRP3), an efflux transporter located along the membrane of hepatocytes, to reduce bile acid toxicity and liver injury during cholestasis. In this study, western immunoblotting techniques were used to measure the protein expression of PPARα, cholesterol 7α-hydroxylase (CYP7A1, the rate-limiting step in bile acid synthesis), and MRP3 in a human hepatocyte cell line (HepG2) ± fenofibrate or DMSO (vehicle control). Additionally, the analysis of serum bile acid levels in adults with PBC and PSC treated ± fenofibrate using liquid chromatography-tandem mass spectrometry methodology that has been developed in Dr. Ghonem's laboratory is ongoing.

Investigating Functional Interchangeability of POLQ Loop Domains Through Cross Species Engineering

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DNA polymerase theta (POLQ) is a low fidelity polymerase essential for maintaining genome integrity, particularly in the context of DNA damage tolerance and repair. Its polymerase domain has unique insertion loops not found in other A-family polymerases that are presumed to display distinctive traits in POLQ; such as micro-homology-mediated end joining (MMEJ) and translesion synthesis. Building on previous studies, we investigated zebrafish POLQ as a comparative model to human POLQ, focusing on differences in the loop regions. While much of the polymerase domain is conserved, the loop sequences differ significantly between species, raising questions about their functional interchangeability.

To explore this, we engineered two types of constructs using PCR-based loop deletion and stitching techniques. The first set involved targeted deletions of individual zebrafish loops to assess whether their removal affects polymerase function. The second involved human-zebrafish chimeras, in which human loop domains were inserted into the zebrafish backbone to test for cross-species functional compatibility.

Our goal was to determine whether zebrafish POLQ loops retain the ability to support key repair functions and to assess the utility of zebrafish as a translational model for studying DNA repair mechanisms. For future work, we aim to express the modified proteins and conduct functional assays to evaluate the impact of these loop alterations on polymerase activity, and understand the role of these domains in DNA repair. This work lays the foundation for understanding how species-specific loop structures influence POLQ function and supports the broader use of zebrafish in DNA repair research.

Changes in Information-Processing Speed and Uncertainty Computations in High-Impulsivity Participants Integrating Perceptual and Conceptual Uncertainty

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Anxiety and impulsivity can impact human decision making by changing our underlying uncertainty computations. In an online study of 121 participants, we tested how anxiety and impulsivity impact perceptual ("what am I seeing?") and conceptual ("how does this fit into my knowledge of the world?") uncertainty, when both types of uncertainty are presented together. Participants were asked to classify and rate their confidence on 35 naturalistic hybrid animal images with varying degree of perceptual and conceptual uncertainty (e.g. 50% deer – 50% goat vs. 20% moose-80% penguin). Higher impulsivity scores correlated with more uncertainty in ratings under most uncertainty conditions, as well as with stimuli that have low plausibility. A drift-diffusion (DDM) model predicting people's task ratings and reaction times based on different types of uncertainty showed how impulsivity and anxiety impact uncertainty computations in mixed perceptual-and-conceptual uncertainty settings, by updating and leveraging conceptual beliefs to estimate the reliability of the estimated perceptual category response in the DDM.

Using Machine Learning to Understand and Predict Attitudes Toward AI Adoption in Mental Healthcare Settings

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Exponential growth in artificial intelligence (AI) continues to transform technological capabilities across sectors, enabling the development of tools that assist with tasks more efficiently. In healthcare, however, this rapid advancement is met with both excitement and skepticism. While some clinicians and patients express optimism about AI's potential to enhance care, others raise concerns regarding its implications for clinical decision-making, patient–provider relationships, data privacy, and ethical standards. The current study examines these varying attitudes by surveying both clinicians and patients on their perspectives regarding the implementation of AI in healthcare. Understanding these opinions is essential to designing educational resources and implementation strategies that address common concerns and promote responsible integration. This study used a dataset of 367 responses and applied machine learning techniques to identify predictors of openness to AI. We trained multiple classifiers using MATLAB's Classification Learner to predict whether a respondent would be open to implementing AI in their work, with answer categories of "Yes," "No," and "Maybe." The most successful model, a Kernel Naive Bayes classifier, achieved 70% overall accuracy, including 89% accuracy for the "Yes" category. Key predictors included the level of interest in learning more about AI (positive), agreement that clear procedures exist for AI use in their workplace (positive), and whether the individual is involved in research design or execution (negative). Additional statistical analysis revealed significant differences in willingness to adopt AI based on job title. The findings emphasize the importance of educating both clinicians and patients on how AI will be implemented in practice, while also acknowledging and addressing legitimate concerns. These results contribute to a growing body of research that seeks to guide ethical, efficient, and evidence-based integration of AI into clinical settings.

Flow-Mediated Dilation in Response to Leg Heating, Exercise, or Combined Treatments

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Flow-mediated dilation (FMD) is a technique known to be a reliable indicator of blood vessel (endothelial) health. Exercise training and chronic heat exposure have been recognized to improve endothelial function, as measured by FMD. Acute bouts of exercise or heat may also improve FMD in clinical populations; however, the acute impact of the combined exercise and heat treatments is unknown. Purpose: to assess changes in endothelial function, as measured by FMD, following aerobic exercise, leg heating, or their combination in prehypertensive individuals. Methods: 13 individuals with elevated blood pressure (>120/80 mmHg) took part in 4 randomized trials consisting of aerobic exercise (30 minutes of treadmill walking at moderate intensity) followed by 45 minutes of leg heating (42°C water; ExHT), aerobic exercise followed by 45 minutes of sham leg immersion (33°C water; Ex), leg heating alone (45 minutes in 42°C water; HT), or control conditions (no exercise or heat exposure; CON). All FMD measures were taken post-treatment in the prone position using the popliteal artery. Vessel diameter and blood flow were measured for one minute at baseline and for two minutes after release of the cuff. Percent dilation was calculated as (peak diameter [post-release] - baseline diameter) / baseline diameter. Results: All participants had an increase in blood flow post cuff release. Flow increased +174 ± 31.0 ml/min from baseline to peak and was not significantly different between groups. Percent dilation tended to be higher after ExHT (6.3 ± 0.7) and HT (6.6 ± 0.8) compared to CON (5.1 ± 0.9) and Ex (5.0 ± 0.6) conditions. Conclusion: Leg heating alone or in combination with exercise causes an acute increase in endothelial function. These findings suggest that heat therapy may serve as an alternative or complementary strategy to improve endothelial function in individuals with elevated blood pressure.

Clinicians' Confidence in Assessing Suicide Risk

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Mental health providers often work with patients at risk for suicide, but little is known about the effectiveness of the measures they take, how well their own training has prepared them, and how their attitudes shape their decisions (Wakai et al., 2020). Study 1 examined providers' knowledge, attitudes, beliefs, and prior experiences with suicide assessment and intervention using Survey Monkey. Study 2 extended these findings by examining providers' risk evaluation, treatment plans, and confidence levels in response to validated "moderate" and "high" suicide risk case studies presented in Qualtrics. Study 1 revealed that providers highly prioritize suicide risk assessment and express confidence in their assessment abilities, but also exhibit less comfort when encountering high risk clients. Providers reported a strong desire for assessment training and notable uncertainty in certain clinical decisions regarding approaches and methods to treating patients at risk of suicide. Study 2 showed that clinicians accurately rate acute and chronic risk of suicide when prompted by validated case studies portraying moderate and high risk. Providers had more confidence in their assessment of the high risk patient and chose actions like hospitalization and calling 911 more frequently than they did for the moderate risk patient, who received more diverse selections for interventions like safety planning. Providers reported similar levels of confidence in their plans for both case studies despite having more confidence in evaluating the high risk patient. These findings provide reassurance about providers' ability to accurately evaluate and treatment plan for patients at risk of suicide, but also suggest a need for further training among clinicians reporting uncertainty in their decisions.

Mathematical Modeling for Optimizing Biochemical Oriented Neurotherapies for Parkinson's Disease

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Transcranial Electrical Stimulation (TES) continues to showcase tremendous benefit for individuals suffering from neurodegenerative disorders. For example, TES is known to help mitigate the movement and cognitive impairment symptoms typically prevalent in Parkinson's Disease. Recent advancements in the disciplines of mathematical modeling and computational simulation have helped enhance TES treatment sessions by providing a means for predicting and visualizing patient-specific electrical energy distribution prior to treatment. In doing so, stimulation dosage, electrode placement, and therapeutic parameters can be dialed in a prior. A limitation of these simulations, however, is the non-incorporation of the variability of cranial conductivity values that exist among different individuals; since these conductivities directly impact mathematical modeling parameters and associated simulations, incorporating them properly is necessary for optimized simulation results. To address this limitation, a stochastic mathematical model of TES has been implemented. The model is based upon Laplace's Equation, with boundary conditions that model clinical TES electrode operation. The model is then numerically solved using the finite element method. Stochasticity is incorporated by executing 10,000 Monte Carlo experiments on an MRI-derived three dimensional head geometry, for three TES electrode configurations routinely used in treating Parkinson's Disease. Results demonstrate the importance that incorporating conductivity variability has on TES simulation results. Finally, our computational approaches and software framework will be shown to be flexible and generalizable, and its adaptability to alternative TES montages, and therefore alternative neurological conditions, will be highlighted.

In-Class CBT Skills for College Students

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College students commonly report symptoms of depression, anxiety, and academic stress. Individual and group cognitive-behavioral therapy (CBT) is effective for students seeking help, but little research has been done on non-help seeking students. This study assessed the effects of in-class CBT training on students' mental health and wellbeing. Students in two course sections of Psychopathology (N = 50) completed questionnaires at the beginning and end of the semester. One section received typical instruction about CBT (n = 25), while the other section (n = 25) practiced behavioral activation and cognitive restructuring skills during four class sessions. Students in the CBT skills section were also provided with activity scheduling and thought record worksheets, typical tools used in CBT for home practice. Questionnaires on Qualtrics assessed positive and negative affect using a quantitative measure (the PANAS) at the beginning and end of the course. Quantitative analyses showed the CBT skills class reported a significant increase in positive affect during the semester while the traditional class demonstrated a significant decrease. There were no differences in negative affect. Students in both sections also answered an open-response question about perceived impacts from the course. Coding of qualitative data was done by thematic analysis, using a codebook to categorize open-ended responses. Results from thematic analysis showed many similarities between the traditional and CBT-skills sections. Across both instructional formats, students consistently reported a heightened sense of self-awareness and insight into their mental and emotional lives. A marked distinction emerged in how students described the practical application of what they learned. Students in the CBT-enhanced condition more frequently reported using specific strategies to regulate emotions, monitor symptoms, or address unhelpful behaviors. In contrast, while traditional-section students also reported feeling better or having improved emotional regulation, their descriptions were often broader and lacked specific mention of tools or methods. However, a handful of students in the CBT section reported "no or limited impact," which was less frequently reported in the traditional section. While quantitative results suggest in-class CBT training may be beneficial for increasing positive affect among students, results from qualitative data suggest the influence of CBT on non-help seeking students m

Understanding the Relationship Between Desiccation Stress and Oxidative Damage in *hsod1 Drosophila* Mutants

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Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease marked by the progressive degeneration of motor neurons and can be associated with mutations in superoxide dismutase 1 (*sod1*). The SOD1 enzyme scavenges superoxide radicals. In initial experiments, we fortuitously found increased desiccation sensitivity in *sod1* mutant flies. This raises the question whether the physiological pathways regulating water homeostasis involve SOD1 and what role desiccation or dehydration stress may play in ALS. To begin investigating this question we assessed the role of oxidative damage in desiccation sensitivity. We first measured SOD1 enzymatic activity levels in humanized *sod1* mutants (hA4V, hH46R, hD83G, hH71Y) compared to *hsod1+ Drosophila* using native gel analysis. We found that hA4V, hH46R , hD83G, and hH71Y mutants all showed decreased enzymatic activity relative to *hsod1+ Drosophila*. To determine whether SOD1 enzymatic activity is important for water retention, we evaluated desiccation sensitivity in mutants with and without enzymatic activity (hH46R, hA4V, hH48R, hD83G, hG85R), compared with *hsod1+ Drosophila* controls. These experiments were conducted as lifespan assays under dehydrated conditions. We found that sod1 mutants can be arranged as an allelic series for desiccation sensitivity: hH46R > hA4V > hH48R > hG85R > hD83G > *hsod1+*. These results suggest desiccation sensitivity does not correlate to SOD1 enzymatic activity between mutants. We then evaluated other representative mutants with known oxidative damage sensitivity (sting, catalase, and withered) for desiccation stress using lifespan assays. Interestingly, not all mutants showed signs of desiccation sensitivity. The mutants withered and catalase showed mild desiccation sensitivity (62% and 51% lethality at 15 hours and 9 hours, respectively), while sting mutants were desiccation resistant. Finally, we used lifespan assays to evaluate *sod1* H71Y mutants administered incrementally stronger concentrations (0, 2, 5, 10, 30mg/ml) of the antioxidant N-acetylcysteine (NAC) throughout development. We found that desiccation sensitivity was not ameliorated by reducing oxidative damage. H71Y mutants fed NAC concentrations of 2 and 5mg/ml showed no difference in desiccation sensitivity compared to control (0mg/ml) with <20% survivability at 5 hours. Concentrations ≥10mg/ml were lethal. Based on the preliminary data, desiccation stress appears unlinked to SOD1 enzymatic activity or oxidative damage.

Characterizing Rapid Molecular Changes in a Dehydration Sensitive *sod1* Mutant Model of ALS

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Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease resulting in the gradual deterioration of motor neurons. Mutations in the superoxide dismutase 1 (*sod1*) gene is a genetic cause of ALS. In the course of evaluating drug treatments, we found that *Drosophila melanogaster sod1* mutants appeared to be dehydration sensitive and further experiments confirmed this sensitivity. The molecular changes associated with dehydration in animals have not been well studied, therefore, we evaluated transcriptional changes for selected genes by quantitative PCR (qPCR). We used *sod1* mutants exposed to dehydration conditions for 4 hours and compared to hydrated controls. The preliminary qPCR dataset showed an upregulation of genes involved in the unfolded protein response and oxidative damage including *thor*, *gstd1*, and *gstd2*. The data also showed a downregulation in genes involved in the innate immune response including *metch* and *dipb*. This data suggests that there are rapid transcriptional responses to dehydration stress which overlap with molecular pathways associated with disease.

Breast Cancer-Derived POLQ Variant E2307K Experiences Altered DNA Repair when Exposed to Common Chemotherapeutics

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DNA Polymerase Theta is an enzyme encoded by the human gene *POLQ*. It plays a crucial role in DNA repair. Pol Theta is an error-prone enzyme, resulting in about 2.4 incorrect nucleotide insertions per 1000 bases. Its error-prone nature results in mutations, destabilizing the genome, and potentially developing into cancer. In past studies, upregulation of Pol Theta has been found to be connected to breast cancer with poor clinical outcomes in patients. It has also been demonstrated that patients with deficient tumor suppressor genes, such as *BRCA*, experience increased genomic instability due to insufficient Pol Theta repair, which becomes the dominant pathway for double-strand breaks. Taken together, this suggests a more predominant role in Pol Theta and tumorigenesis. To better understand this link mechanistically between Pol Theta-mediated repair, this project looks at biochemically characterizing a variant of Pol Theta identified from the cBIO portal. The patient was diagnosed with stage 2 invasive breast cancer, which later spread to the bones and chest walls despite prior cancer treatment. Despite not having a *BRCA* mutation, the patient harbored a point mutation E2370K in Pol Theta. We hypothesize that this E2370K mutation could cause even further reduced DNA repair abilities, leading to more DNA instability and cancer progression. To fully understand the DNA repair capabilities of the variant, we expressed and purified E2370K from *E. coli* cells and biochemically characterized its ability to bypass 8-oxo-G and Cisplatinated DNA lesions. We have found that Pol Theta E2370K has reduced ability to extend past damaged DNA in comparison to wild type, which suggests increased genomic stability, especially in the presence of a common breast cancer therapeutic.

Acute Sodium Arsenite Exposure Disrupts Nucleocytoplasmic Transport in HEK-293 Cells

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The pathophysiology of neurodegenerative diseases like frontotemporal dementia (FTD) and amyotrophic lateral sclerosis (ALS) has been linked to disruptions in nucleocytoplasmic transport (NCT), the process regulating the movement of proteins and RNAs between the nucleus and cytoplasm. While the molecular mechanisms initiating such defects remain unclear, it has been shown that oxidative stress acutely impairs NCT. In our study, we used acute sodium arsenite (NaArs) treatment to induce oxidative stress, and we monitored NCT immediately after stress and during the recovery period using fluorescence reporters. One of three mCherry-based reporters—mCherry (diffuse control), mCherry-3xNLS (predominant nuclear localization), or mCherry-NLS/NES (nucleus-cytoplasm shuttling reporter)—was used to transfect the cells. After an hour of treatment with 0.5 mM NaArs, transfected cells were either fixed right away (0h recovery) or given time to recover in standard media for either 1 or 4 hours prior to fixation. Cells that were not treated with NaArs were used as controls. To evaluate nucleocytoplasmic transport dynamics, fluorescence microscopy was used to measure nuclear/cytoplasmic mCherry fluorescence ratios. These results provide mechanistic insight into how environmental or toxic stressors may contribute to neuronal dysfunction and degeneration. Understanding how acute oxidative stress with NaArs disrupts nucleocytoplasmic transport chronically will allow us to better understand the pathophysiology of neurodegenerative diseases such as ALS.

Hyoid Depressor Muscles Coracohyoideus and Coracoarcualis

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A comparative analysis of musculoskeletal structures and functional mechanics involved in hyoid depression during feeding reveals both convergent and divergent traits between two shark species: the obligate suction feeder *Chiloscyllium plagiosum* (white-spotted bamboo shark) and the more generalist feeder *Squalus acanthias* (spiny dogfish). While the overall morphology of the primary hyoid-depressing muscles—coracohyoideus (CH) and coracoarcualis (CA)—appears largely conserved between the two species, their mechanical function differs significantly. In *C. plagiosum*, the onset of hyoid depression is characterized in-lever nearly at zero, unlike in *S. acanthias*. This mechanical distinction arises due to the near-linear alignment of the CH and CA muscles with the articulation between the hyomandibular and ceratohyal. As a result, these components may act together as a form of a dynamic catch mechanism, possibly enhancing power output during suction feeding events in *C. plagiosum*. Additionally, a four-bar linkage analysis applied to the cranial elements of *C. plagiosum* supports a functional connection between jaw and hyoid movements, facilitated by the lateral hyoidiomandibular ligament. This linkage likely contributes to more efficient force transmission during suction, in contrast to the decoupled system seen in *S. acanthias*, which lacks this integration. Together, these findings suggest that while both species share similar musculoskeletal components, the feeding mechanics in *C. plagiosum* reflect a specialized adaptation for enhanced suction performance—demonstrating a complex mix of evolutionary convergence and divergence.

Dynamic Jaw Mechanics and a Revised Anatomy of the Adductor Mandibulae Complex in *Squalus acanthias*

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The adductor mandibulae complex (AMC) plays a critical role in jaw closure and protrusion during feeding in cartilaginous fishes. In the spiny dogfish (*Squalus acanthias*), a commonly used model in comparative anatomy, visualizations of AMC architecture have varied widely despite its prevalence. The muscle divisions, insertions, and even presence between species of cartilaginous fish is not well understood. This study combines anatomical investigation and biomechanical analysis to provide a revised understanding of AMC structure and function in *S. acanthias*, with comparisons to the suction-feeding species *Chiloscyllium plagiosum*. Using dissections of fresh and fixed specimen and three-dimensional scans of the head musculature in *S. acanthias*, we identified previously undescribed features within the AMC, including a novel muscle division and unique tendonous insertion associated with the quadratomandibularis (QM) complex. Our assessments revealed that the various divisions of the AMC exhibit differential force transfer characteristics depending on gape angle. Specifically, the preorbitalis (PO) demonstrates high force transfer efficiency at maximum gape, while certain QM divisions become more effective near full jaw closure. This dynamic shifting of mechanical advantage allows for stable bite force across the entire range of gape, with the superficial QM maintaining a constant insertion angle and force output. Comparative analysis with *C. plagiosum* reveals contrasting mechanisms for achieving force stability. In *C. plagiosum*, reduced gape and minimal changes in muscle insertion angles enable a more stable force transfer, optimized for suction feeding. In contrast to this, *S. acanthias* exhibits a more versatile jaw mechanism suited to a generalist feeding strategy, facilitated by variable insertion geometries and specialized muscle divisions within the AMC. As a result of this research, we propose a revised visual representation of the AMC in S. acanthias for use in future comparative anatomy education and research.

Investigating the Role of CedA in Coordination of Nucleoid Segregation and Cell Division

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In *Escherichia coli*, cell division begins with elongation of the cell and the duplication and segregation of the genetic material. The protein FtsZ, a tubulin homolog, localizes to the cell center and assembles into a large protein structure called the Z-ring. This ring serves at the recruitment site for other division proteins, such as FtsN, that stimulate the synthesis of new cell walls. In *E. coli*, cell division is tightly regulated by a complex interplay of proteins that coordinate growth, DNA replication, and cell wall synthesis. The non-essential protein CedA has previously been implicated in preventing cell filamentation, suggesting that it may regulate division. CedA has also been shown to interact with proteins involved in transcription and energy metabolism; however, the precise role of CedA in cell cycle progression is still not understood. The goal of my project is to define the role of CedA in bacterial cell cycle progression and nucleoid segregation. To do this, I deleted the *cedA* gene from the *E. coli* chromosome and characterized the mutant strain for growth and morphology defects. I visualized nucleoids in intact cells by fluorescence microscopy and measured nucleoid compaction in wildtype and *cedA* deletion strains. To determine if deletion of *cedA* leads to altered Z-ring assembly, I monitored localization of FtsZ and FtsN, each fused to green fluorescent protein. Finally, to determine if CedA interacts directly with cell division proteins, I cloned the *cedA* gene into an expression plasmid designed for use in a bacterial two hybrid system and screened it against a library of constructs containing cell division genes. Together, our results will help elucidate the role of CedA in the coordination of nucleoid segregation and cell division.

The Fan-Shaped Body Mediates Alcohol-Induced Locomotor Activity in *Drosophila melanogaster*.

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Alcohol Use Disorder (AUD) is a debilitating disorder that effects 28.9 million people in the United States (NIAAA). Maladaptive behaviors associated with AUD often stem from intense cravings to consume alcohol, which can significantly disrupt a person's daily life and overall well-being. It is thought these cravings are triggered by alcohol-associated memories, which reinforce the desire to drink. However, it remains unclear why these memories are so enduring. An understanding of the neural mechanisms underlying alcohol-associated memories and their relationship to alcohol cravings has been hindered by the complexity of the human brain. Thus, many researchers have turned to model organisms to better understand these processes. *Drosophila* are a powerful model organism for investigating the neural mechanisms of alcohol-associated behavior due to their well-characterized nervous system, complex behavioral responses, and similar behavioral responses to alcohol intoxication. Further, like mammals, *Drosophila* form enduring alcohol reward memories for intoxication experiences (Kaun et al 2011). More recently, the precise neural circuits important for the acquisition and retrieval of alcohol reward memories have been identified. Further, it was demonstrated that the fan-shaped body (FSB) is intimately connected with these circuits (Scaplen et al 2020; Scaplen et al 2021). The FSB has an established role in regulating arousal and sleep, however, it is unclear what role it plays in the context of alcohol. Interestingly, many of the dopamine neurons that are important for alcohol reward memory acquisition, receive input from the FSB, and also regulate alcohol induced locomotor activity (Caldarone and Song et al unpublished). Given the role of the FSB in regulating arousal, we hypothesized that FSB activity may maintain arousal in the context of alcohol. To test this hypothesis, we used the flyGrAM, a group activity monitor (Scaplen 2019) and the GAL4/UAS binary system to reversibly inactivate neural transmission in subsets of FSB neurons. Preliminary findings suggest that inactivation of two different subsets of the dorsal FSB neurons do not significantly impact group activity response to alcohol. Future studies will continue to screen through dorsal FSB neurons to determine whether any FSB subsets modulate responses to alcohol. Further we will also investigate the role of FSB in the acquisition and/or retrieval of alcohol reward memories.

Alcohol Induced Locomotor Activity in *Drosophila* Serotonin Transporter Mutants

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Serotonin is a neuromodulator involved in a wide range of physiological processes and is known to regulate mood, behavior, and memory in mammals. Interference either in the production or regulation of serotonin at the synapse is linked to a litany of behavioral dysregulation and psychiatric disorders, including Alcohol Use Disorder (AUD). AUD represents a significant public health crisis, affecting 28.9 million individuals yearly, and one of the leading causes of death and disability worldwide (SAMHSA, NIAAA). AUD is frequently comorbid with depression highlighting potential shared neural mechanisms (Chen et al 2025). In *Drosophila*, serotonin has an established role in modulating of sleep, hunger, mating, and motor control responses. Specifically, flies lacking the serotonin transporter protein (dSERT) exhibit increased sleep and locomotor activity, as well as reductions in feeding and courtship behaviors (Hidalgo et al., 2017, Knapp et al 2022). However, the role of serotonin in the development of alcohol associated behaviors in *Drosophila* remains unclear. Preliminary data, from the lab demonstrates, in a five-day two-choice assay, that flies lacking the serotonin transporter protein (dSERT) consumed more sucrose and ethanol compared to wildtype flies and developed ethanol preference faster (Gul et al unpublished). The present study sought to further explore the role of serotonin in alcohol induced locomotor activity. We hypothesized that dSERT mutants would show significant increases in alcohol induced group activity. To test this, the research team utilized the flyGrAM, an automated real-time group activity monitor. Preliminary data suggests that dSERT mutants significantly increase their group activity during baseline, or prior to the presentation of alcohol, as well as during exposure to alcohol. This research offers an opportunity to establish a foundational understanding of how serotonergic function influences arousal and locomotor activity, while also providing insight into the role of serotonin in alcohol-associated behaviors. It serves as a basis for future experiments investigating the relationship between depression and AUD.

A Slow Breathing Rate Alters Heart Rate Variability Metrics in Females and May Give a False Indication of Increased Stress and Overtraining Syndrome

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The variability in beat-by-beat heart function (heart rate variability: HRV) is commonly used clinically and in sports science to manage stress and training volume. HRV monitors are being incorporated into wearable devices (smart watches) and used by many individuals including athletes to monitor training and recovery. A small study on male athletes suggest that HRV may be influenced by breathing frequency (bf), but this has not been explored in females. This study compared HRV metrics in nine females (5 sedentary; SED, 4 athletes; ATH) at normal bf (~12 breaths per min) as well as increased and slower Bf (15 and 6 breaths per minute, respectively). Differences between SED and ATH were compared using Student T-Tests and changes in HRV across Bf was analyzed using a 2-way repeated measures ANOVA. The groups were not different in age (SED: 21±2 y vs ATH 19±1 y, p=0.248), body mass index (SED 22.1±1.9 vs ATH 21.0±2.2 kg·m^{-2}, p=0.440), lean mass (SED 38.0±5.1 vs ATH 43.0±4.0 kg, p=0.162) but SED had lower VO$_2$ peak (SED 42.1±7.1 vs ATH 50.8±2.7 ml·kg^{-1}·min^{-1}, p=0.049) and higher fat mass (SED 18.7±5.7 vs ATH 10.5±0.5kg, p=0.016). Resting heart rate during normal breathing was higher in SED (65±7) compared to ATH (49±10 BPM; p=0.025) but the root mean square of the standard deviation of the R-to-R interval (RMSSD) (SED 86±41vs 101±39 ms; p=0.570) was similar. Breathing at a slower rate increased the ratio of low frequency (LF) to high frequency (HF) band HRV (p=0.001) primarily by increasing the LF band measures (p=0.010). Additionally, there is a trend for this increase to be higher in ATH than SED females (p=0.144). The LF/HF ratio has been identified as a reliable measure of stress/autonomic balance and over training with elevated values positively correlated with increased stress. Therefore, this examination suggests that a slow breathing frequency may falsely indicate a high level of stress. This may be an important consideration as endurance trained athletes typically have slower breathing frequencies than non-athletes and some HRV applications control breathing frequency.

Comparative Cell Classification Using Single-Cell Sequencing and Computational Annotation of Pediatric Processed Blood

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Medulloblastoma (MB) is the most common malignant pediatric brain tumor, accounting for nearly 20% of all central nervous system cancers in children. To better understand MB, we plan to isolate blood from pediatric MB patients and process it using a state-of-the-art microfluidics device for single-cell RNA sequencing (scRNA-seq). While scRNA-seq has revolutionized our ability to profile cell types, its application to pediatric blood samples remains limited and determination of each cell type is biased due to biological knowledge and time intensive.

To accurately identify cell populations in pediatric processed blood, we first used a highly curated list of blood-specific marker genes to assign cell types. To validate these annotations, we further employed two computational platforms: CellTypist, a machine learning based tool trained on annotated reference datasets, and ScType, which uses known gene markers for high-confidence cell type identification. Using these tools in combination with single-cell transcriptomic data from pediatric patients treated at MGH, we aim to construct a comprehensive cellular map of blood samples in medulloblastoma patients, providing the basis for future non-invasive treatment monitoring through liquid biopsy.

Medial Prefrontal Cortical Ensembles Direct Behavior in Response to Competing Needs

Madison Rohr, Francesca Schaub, Kaelin McCaffrey, Alonie Ashley, Olivia Belt, Claire Kelly, Emma Morley & Ryan Post

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Neural circuits that drive survival behaviors (e.g., food seeking) when animals face a single, specific need (e.g., hunger) are highly conserved and well-characterized. However, when animals face multiple concurrent needs, behavior selection is a result of the integration and weighting of information related to the most pressing need. While the neural circuits that direct behavior under a singular pressing need are well-defined, the mechanisms by which the brain prioritizes action in response to competing motivations (e.g. hunger and threat avoidance) is not fully known. The medial prefrontal cortex (mPFC) plays a pivotal role in action selection, and our previous work indicates that two competing stimuli—environmental threat and food—are reflected by activity in largely segregated mPFC ensembles in hungry mice. In this study, we used awake-behaving mouse models to evaluate the sufficiency of these ensembles to influence behavior in environments in which the motivations are in conflict with one another. To investigate this, we used targeted recombinase in active populations (FosTRAP) in combination with chemogenetics involving designer receptors exclusively activated by designer drugs (DREADDs) to excite specific subsets of mPFC neurons that are responsive either to the predator odor trimethylthiazoline (TMT) or the presence of food following food-deprivation. After allowing three weeks for DREADD expression, both cohorts of mice underwent a series of counterbalanced behavioral assays in which subjects received an intraperitoneal (i.p.) injection of either the DREADD receptor ligand clozapine-N-oxide (CNO) to activate their specific (i.e., TMT- or food-responsive) neural ensembles or vehicle as a control. Most notable of these assessments is our predator odor assay, in which food-deprived mice enter a dual-chamber apparatus with food secured adjacent to TMT. We found that activating TMT-responsive mPFC ensembles decreased food consumption on this assay, and that activating food-responsive ensembles increased food consumption. Activation of both ensembles decreased locomotion in an open field, and neither ensemble influenced food consumption in the absence of predator odor. These findings demonstrate that when discrete motivations are in competition, mPFC ensembles representing these motivations may bias an animal's behavior toward one need at the expense of another.

Hunger-Sensing Hypothalamic Neurons Drive Food Consumption Despite Environmental Threat

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Survival in a dynamic world requires processing information about environmental challenges and integrating it with an animal's internal state. To better understand how the brain processes competing motivations, our project explores how hunger-sensitive neural circuits influence food-seeking when food is only available in the presence of stimuli of environmental threat. Agouti-related peptide (AgRP) neurons in the arcuate nucleus of the hypothalamus are critical regulators of food intake. To activate AgRP neurons during behavior, we expressed the light-sensitive ion channel channelrhodopsin (ChR2) in AgRP neurons and implanted a fiber optic above the arcuate nucleus. Replicating prior results, we found that increasing stimulation frequency of AgRP neurons from 0-20 Hz gradually increases food consumption in a neutral chamber. To test how these neurons regulate food intake in the presence of environmental threat, we similarly activated AgRP neurons during the looming stimulus assay, in which food is only available directly beneath a rapidly enlarging disk presented on an overhead monitor. Though low frequency stimulation elicits food intake in a neutral environment, we found that food consumption only occurs in the looming stimulus assay at the highest stimulation frequencies. We observed a similar effect in the predator odor assay, in which food is only available adjacent to an olfactory threat stimulus. Because AgRP neurons inhibit postsynaptic partners, we hypothesized that AgRP projections might inhibit neurons in the periaqueductal gray (PAG)—a hindbrain region that responds to visual threat stimuli–to facilitate food consumption when hunger and stimuli of such threat are in conflict. To test this hypothesis, we expressed ChR2 in AgRP neurons and implanted a fiber optic over the PAG to selectively stimulate the AgRP-PAG projection during the looming stimulus assay. Data collection in this experiment is ongoing, as it is in an experiment stimulating AgRP neurons projecting to a forebrain target as a comparison region. Collectively, our results suggest that AgRP neurons are critical regulators of hunger and competing survival needs, though understanding how AgRP circuits accomplish this regulation requires further study.

Mutations of *Thermus aquaticus* Affecting the Ribosome

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Ribosomes are composed of ribosomal RNA (rRNA) and ribosomal proteins (r-proteins) and carry out all protein synthesis in all cells. As a critical cellular component, the ribosome is the target of more than half of all antibiotics. Resistance to antibiotics can result from mutations in the ribosome, either in the rRNA or r-protein components. Such antibiotic-resistant mutants are powerful genetic tools for investigating ribosome structure, function, and evolution. My project's primary goal was to identify antibiotic-resistant mutants of the extremely thermophilic bacterium *Thermus aquaticus*. I successfully selected spontaneous mutants resistant to either Streptomycin or Kanamycin. I was not able to isolate mutants resistant to Hygromycin B. I was able to use genomic DNA from Streptomycin-resistant or Kanamycin-resistant mutants to transform the related species *Thermus thermophilus*. These results demonstrate that exchange of ribosomal genes between *T. aquaticus* and *T. thermophilus* is possible and can produce functional ribosomes. Future efforts will be aimed at defining the sequence alterations leading to resistance.

Targeting Quiescent *E. coli* for Prevention of Recurrent Urinary Tract Infections

Madelyn Homer[1], Emma Torres[1], Thalyta Pereira[1], Jodi Camberg[2] & Susan Meschwitz[1]

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Roughly 11 million urinary tract infections (UTIs) are accounted for each year in the US, the majority of which are present in women. Over 50% of women will be diagnosed with a UTI, 27% of which are reported to develop a recurrence within 12 months. The uropathogenic E. coli (UPEC) responsible for initial and recurring UTIs are able to survive antibiotic treatment by entering a quiescent state in bladder epithelial cells. These quiescent UPEC have been discovered to detect and utilize surrounding cues such as metabolites succinate, and methionine and lysine, as well as peptidoglycan-derived stem peptides to resume proliferation, becoming susceptible to antibiotics again. We tested various synthesized peptides for their ability to reverse quiescence. In previous experiments, tetra (Ala-Glu-Lys-Ala) and penta (Ala-Glu-Lys-Ala-Ala) stem peptides were found to have the greatest effect on the bacteria. Thus, we focused on various tetra and penta synthesized peptides including tetra, penta, tetra-3-cys, penta-3-cys, and fluorescent labeled (Fl) tetra-3-cys. These peptides were introduced to low density, quiescent UPEC and observed for potential growth after 24 and 48 hours. Tetra and Fl-tetra-cys demonstrated the most consistent and prominent bacterial growth observed after both 24 and 48 hours of incubation. Future testing must be done on these peptides to ensure consistent results as well as further experiments to determine the molecular characteristics required to reverse quiescence. This research will help to discover peptides that could lead to new treatments for recurrent UTIs and reversal of quiescence.

Monocyte-Targeted Lipid Nanoparticles for siRNA Delivery and Cancer Immunotherapy

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Lipid nanoparticles (LNPs) represent a promising platform for the delivery of nucleic acids and immunoregulatory agents in cancer therapy. While their role in tumor-targeted delivery has been widely explored, their potential to engage monocytes in antitumor immunity remains underexplored. Monocytes are precursors to tumor-associated macrophages (TAMs) and dendritic cells. Their selective targeting may enhance immune engagement within the tumor microenvironment and support long-term immunotherapeutic response. In this study, we evaluated and optimized a range of LNP formulations for monocyte delivery by assessing cellular uptake and viability across two dosing conditions.

THP-1 monocytes were treated with LNP formulations at low (200 ng) and high (500 ng) doses. The low-dose group included 11 formulations and the FDA-approved Onpattro. The high-dose group included 15 formulations, Onpattro, a comparative control, and untreated cells. Cellular uptake was measured using a fluorescence-based assay, and viability was assessed using green fluorescence cell trackers.
At 500 ng, several formulations demonstrated strong, dose-dependent increases in uptake. Fabrication 9 achieved the highest internalization with a 17% increase compared to untreated cells. Fabrications 1 and 2 followed with increases of 14% and 13%, respectively. Overall, 12 of 15 formulations outperformed Onpattro in uptake efficiency.

At 200 ng, similar trends in internalization were observed. Fabrications 9, 10, and 5 showed uptake increases of 1.17%, 1.09%, and 1.06%, respectively. In addition to uptake results, we analyzed our viability data from the 200 ng group. In this group, all formulations preserved or improved cell survival. Fabrication 10 exhibited the highest viability at 109%, while fabrication 11 also maintained strong viability at 98%.

Together, these results demonstrate that specific LNP formulations can enhance monocyte uptake without compromising cell health. This dual optimization supports the development of monocyte-targeted, non-cytotoxic delivery systems as a flexible and clinically relevant platform for advancing cancer immunotherapy. Our research lays the foundation for LNP formulation and application that should be further explored for future experiments and use within the medical field.

Construction of Gene Signature Matrices for Deconvolution of Heterogeneous Cell Populations

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Tissue samples contain many cell types, making it difficult to determine which cells express specific genes when analyzing a tissue sample. Additionally, despite the simplicity of analyzing a whole tissue, researchers may be interested in the composition of cells in the tissue. Deconvolution is a computational method that estimates cell-type proportions from bulk gene expression data. A gene signature matrix serves as a reference, showing gene expression patterns unique to each cell type. These matrices guide deconvolution by defining what each cell type "looks like". Understanding cell-type composition is crucial for studying diseases. While single-cell RNA sequencing (scRNAseq) provides detailed resolution, it is expensive and time-consuming. Deconvolution provides an efficient alternative, but its accuracy depends on high-quality signature matrices. To support a deconvolution pipeline for liquid biopsies from childhood brain cancers, we generated a signature matrix from scRNAseq data of healthy pediatric blood. These samples provide a reliable reference of healthy immune cell expression without confounding effects of disease or age-related changes.

We created over 36 signature matrices, representing 12 different input gene amounts and three different normalization techniques. Our study highlights the importance of gene selection and data normalization in constructing effective reference matrices for cell type deconvolution. Heatmaps of normalized expression data showed clearer patterns across cell types compared to raw counts. Log and VST normalization led to consistently higher LDA accuracy, emphasizing their importance in building reliable deconvolution models.

POSTER SESSION B
11:00 AM – 12:30 PM

Fascitelli Center for Advanced Engineering, 1st Floor
1-B to 25-B

Fascitelli Center for Advanced Engineering, Ground Floor
26-B to 49-B

Paramaz Avedisian '54 Hall, College of Pharmacy
50-B to 73-B

Best Practices of Communicating Coastal Resiliency to the Community

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Biology, Rhode Island College, Providence, RI

As climate change accelerates, communities are increasingly impacted by flooding, storms and other extreme weather events. These disruptions highlight the need for flood risk awareness and environmental education, especially in coastal communities. To build this increased awareness of coastal resiliency, we need to create effective communication strategies that make complex environmental issues easy to understand and accessible to many community members. The goal is to develop approachable ways to inform the community on what is happening in the rivers and oceans in their community while highlighting the effects of climate change, particularly flooding and water pollution. We have developed a short diatoms activity that we have implemented during the Woonasquatucket River Watershed Council (WRWC) paddle event held on Thursday evenings at Riverside Park (Providence RI). The guided activity introduces participants to diatoms as microscopic algae that serve as indicators of water quality. Using guides and visual reference sheets (in English, Spanish, Portuguese) community members can compare diatoms images to determine if the water contains diatoms species that are associated with clean or polluted environments. This activity can help community members make connections between microscopic organisms and broader environmental issues in their waterways. The activity sparked strong interest at the WRWC paddle event. Most community members had never seen a diatom or understood their role as indicators of water quality. By removing common barriers to environmental education (like scientific literacy and language), we created an inclusive hands-on experience that made a scientific topic easy to understand for community members. This shows that simple, hands-on activities can spark real curiosity and environmental learning. Community members were able to walk away with a better understanding of water health and awareness of the condition of their community's environment.

Comb Jellies: Combing Through the Truth on Microplastics

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The contamination of microplastics has become an evolving issue worldwide for local ecosystems. There is little research illustrating the damage it causes to coastal systems and animals that inhabit coastal waters. *Mnemiopsis leidyi*, a species of comb jelly, prey on zooplankton, consuming large numbers of prey per hour; however, little is known about this species. Investigating feeding behavior and mechanics of comb jellies in the presence of microplastics in a controlled lab setting will help understand how microplastics can affect invertebrates living in Narragansett Bay. Specimen collection was performed by searching through water where comb jellies were visible, and scooping jellies into beakers. In total 18 comb jellies were harvested from the tidal salt marsh estuary of 100 Acre Cove in Barrington, Rhode Island. Comb jellies were transported to Rhode Island College and housed in a cylindrical tank and fed daily on live brine shrimp. We used two treatments– 76-93μm silver-coated ceramic beads for non-plastics and 75-90μm polyethylene beads. The comb jellies were subject to feeding trials with the species Artemia. The displacement, velocity, and acceleration of the lobes and digestive system were tracked using Kinovea kinematics software and machine learning tracking with sleap.ai. Particle image velocimetry (PIV), where a laser is shined to illuminate water particles and determine flow, was also used to determine differences in feeding in the presence or absence of microplastics. PIV videos were then analyzed with PIVLab. During feeding on Artemia, combs jellies spread the lobes away from the mouth and partially fold themselves, creating a flow field that will drive Artemia along the lobes and into the mouth. During non-plastic trials, comb jellies had the ability to ingest ceramic beads, thus suggesting that beads of the same size will also be ingested along with food. Comb jellies are one of many species impacted by microplastics. By researching comb jellies, we can understand more about this important Narragansett Bay planktonic species and overall, about the growing threat microplastics pose to the local coastal ecosystem.

Development and Fabrication of Silicone Rubber and Graphite Skin Phantoms for the Terahertz Frequency Range

Madison Marcello, Keira Quadros & Allison Marn

Engineering, Roger Williams University, Bristol, RI

Terahertz radiation, electromagnetic radiation with wavelengths between the microwave and infrared regions, is highly attractive for skin imaging and sensing applications due to its noninvasive and non-ionizing nature and sensitivity to water content. The development of imaging systems for skin applications requires objects, phantoms, that mimic terahertz optical properties of human skin. Skin phantoms are useful in the calibration and testing of these imaging systems, providing stable, consistent, and reliable results without the variability of human samples. Here we present the development of easy-to-fabricate, inexpensive, and water-free skin phantoms composed of silicone rubber, with added graphite powder to tune the optical properties. The terahertz optical properties of the skin phantoms were theoretically analyzed using the Bruggeman Model of effective medium theory. Based on the results of this model, skin phantoms were fabricated with 0%, 2.5%, 5%, 7.5% and 10% graphite to create multiple phantoms with optical properties in the range of healthy human skin at 0.420 THz, the operation frequency of our terahertz imaging system. The samples will then be analyzed using terahertz time-domain spectroscopy to determine their terahertz optical properties to confirm the validity of the fabricated samples as skin-mimicking phantoms.

Retention Time of Microplastics in the Purple Sea Urchin *Arbacia punctulata*

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Around 8 million metric tons of plastic enter the ocean every year ("Plastics in the Ocean"). Larger pieces of plastic weather to smaller microplastics (≤5mm) that marine organisms might consume (Suckling, 2021). Sea urchins physically alter their ecosystem through their grazing habits and are an integral part of marine food webs (Abrahams, 2021). Urchins can accidentally consume microplastics on the seafloor while grazing on ocean sediment (Suckling and Richard, 2021, Feng et al., 2021). This research aims to understand the residence time of microplastics in the stomach of sea urchins. To accomplish this, Atlantic Purple Sea Urchins, Arabacia puntulata, was fed a formulated feed that contained microfibers and microbeads of various sizes. The urchin's stomach was dissected 24 hours, 3 days, and 7 days after initial exposure to understand if the sea urchins consumed the particles and how long microplastics were retained in the stomach. It is predicted that the microfibers will be retained for the longest period of time, due to their long, thin shape, and that microbeads will quickly pass through the digestive tract since they are smooth and round. Understanding how sea urchins are interacting with, consuming, and retaining these particles could have further ecological implications, such as the tropic transfer of microplastics throughout the food web.

Diel Activity Patterns and Foraging Behavior of *Arbacia punctulata* at the Northern Limit of Their Geographic Range

Nikolai Johnson & Carla Narvaez Diaz

Biology, Rhode Island College, Providence, RI

Sea urchins play critical ecological roles through their grazing behavior, functioning as both beneficial herbivores that control algal growth on coral reefs in tropical systems and as destructive grazers that can create urchin barrens in temperate kelp forests. This study examined the diel activity patterns of *Arbacia punctulata* collected from Fort Wetherill, Rhode Island, representing the northernmost extent of this species' geographic distribution. Limited research has documented the behavioral ecology of *A. punctulata* in temperate ecosystems, particularly regarding temporal feeding patterns.

Based on field observations during SCUBA surveys and previous studies conducted on *A. punctulata* at lower latitudes, we hypothesized that this urchin exhibits preferential nocturnal foraging behavior, sheltering in crevices during daylight hours and emerging at night to feed. To test this hypothesis, we conducted controlled laboratory experiments using a simulated 18:6 hour light:dark photoperiod. Twelve experimental replicates were established, each containing three size classes of urchins: large (40 mm average test diameter), medium (30 mm), and small (20 mm). Following a 24-hour acclimation and starvation period, each replicate group was placed in a 20-L experimental tank equipped with infrared recording capabilities.

The experimental design included a PVC shelter positioned on one side of each tank and 20 g of locally harvested algae (frozen and thawed in seawater prior to use) attached to a rock substrate on the opposite side. Urchin movement patterns were documented using time-lapse photography (one frame every 5 minutes over 24 hours) and analyzed using ImageJ tracking software. Movement data was quantified to determine activity levels during light and dark phases.

Preliminary results support our hypothesis, indicating that *A. punctulata* remain cryptic during daylight hours and exhibit increased activity during dark periods. These findings suggest that diel behavioral patterns observed in southern populations persist at the northern range limit, despite different environmental conditions. Data collection continues to strengthen statistical power and shows potential to examine size-specific behavioral differences. Understanding temporal activity patterns of *A. punctulata* provides insight into their ecological impact in temperate New England ecosystems and may inform predictions about range expansion under changing climate conditions.

Observation in Science & Art Mentorship Program

Dana Rodriguez, Georgia Michael, Gregory Del Sesto, Kaitlin Rioux, Malachi Gray, Troy Robishaw, Zoe Walsh, Avagail Cabral, Mags Champagne & Brianna Borrelli

Community College of Rhode Island, Warwick RI

In this Mentorship Program, Art & Design students and Biology students collaborated to create and exhibit original art and design projects. Student art and design work completed in this program was showcased in a public exhibition in June 2025.

This program focuses on the overlap between artistic figure drawing and the scientific study of human anatomy. Students participated in workshops in the Biology Department's Anatomy Lab led by Associate Professor Sabine Moritz (Biology), and workshops in the Nature Lab at Rhode Island School of Design. Based on these workshops, students followed a design process and created original artwork for display in a final exhibition. Students were encouraged to experiment, follow their creative ideas, and use materials and processes of their choosing. Associate Professors Tyler Vouros and Daniel O'Neill (Art, Art History & Design) provided guidance and mentorship throughout the semester.

This program is structured around two concepts shared by art and science: observation and interpretation. An artist or scientist interprets their observations as art, design solutions, or scientific theories. The process of creating art from observation requires looking closely at a subject, determining what information to include, and interpreting this information as form and material.

Strain-Sensing Microfibrous Textiles via SWCNT-Embedded Electrospun Polymers for Optical, Wireless, and Wearable Applications

Carlos Estrada Rosa, Melissa Schneider & Daniel Roxbury

Chemical Engineering, University of Rhode Island, Kingston, RI

The development of wearable, non-contact optical strain sensors is a promising advancement in smart textile technology, particularly for applications requiring comfort, flexibility, and wireless readout. This research focuses on creating a mechano-optical "smart textile" by embedding single-walled carbon nanotubes (SWCNTs) into electrospun core-shell polymer fibers. The SWCNTs, which exhibit near-infrared (NIR) fluorescence that shifts under strain, are dispersed using sodium deoxycholate (SDC). The core consists of a polyvinyl alcohol (PVA) matrix encapsulating the SDC-SWCNT complex, while the shell is composed of polyacrylonitrile (PAN), selected for its mechanical durability and spinnability. The fibers were fabricated via optimized electrospinning parameters and characterized using scanning electron microscopy (SEM), Raman spectroscopy, X-ray diffraction (XRD), differential scanning calorimetry (DSC), and Fourier-transform infrared spectroscopy (FTIR). Mechanical testing, including stretch-to-break and cyclic tensile testing on an Instron machine, demonstrated the textile's durability and flexibility. Environmental testing showed resilience in high-moisture conditions, though mechanical properties and fluorescence sensitivity decreased slightly after prolonged water exposure. Optical strain sensing was verified by monitoring the shift in NIR fluorescence peaks under mechanical deformation in the 0–2% strain range, with a clear and repeatable correlation between strain and spectral shifts. These findings confirm the textile's ability to detect strain in a non-contact, remote-readable format. Future directions include scaling production using a multi-needle electrospinning system, refining methods for consistent thickness control, exploring the creation of woven yarns, and collaborating with textile engineering departments for garment integration. Ultimately, this work lays the foundation for wearable health monitoring devices, such as smart bandages, capable of tracking mechanical strain in real-time through optical feedback.

Introducing Defects on Carbon Nanotube Surface to Enhance Tunable Fluorescence Properties

Jayden St. Louis, Raodatullah Abodunrin & Daniel Roxbury

Chemical, Biomolecular & Materials Engineering, University of Rhode Island, Kingston RI

Single-walled Carbon Nanotubes (SWCNTs) have emerged as promising potential candidates for diverse biomedical applications due to their distinctive fluorescence properties. Their environmentally sensitive optical properties in the near-infrared (NIR) region make them particularly effective for biosensing. In addition to noncovalent functionalization with an amphiphilic wrapping agent, several methods have been employed to covalently modify SWCNT nano sensors to further tailor their intrinsic fluorescence. Aryldiazonium chemistry has been used to generate sp3 defects on the SWCNT surface, generating a new emission peak around ~1150nm. This work explores two separate reaction pathways to introduce sp3 quantum defects and functionalize SWCNTs using single-stranded DNA (ssDNA). To investigate how these different pathways affected SWCNT excitonic photoluminescence, various spectroscopic methods were used to characterize samples. Through these methods, the optical and physical properties of SWCNTs can be tuned not only by the wrapping agent, but also through covalent modification. In the future, these nano sensors could be candidates for cell studies, as well as conjugation of biological recognition units to create analyte-specific sensors.

Fish Community Dynamics South of Block Island: Insights from Baited Remote Underwater Video (BRUVs)

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This study examined environmental drivers of fish community structure south of Block Island using Baited Remote Underwater Video (BRUVs), a non-invasive, fisheries-independent survey method. BRUVs were deployed from June 2021 to June 2025 at six sites around Block Island, encompassing a range of depths, sediment types, and water temperatures. Video analysis (n=148) recorded fish species richness and relative abundance using the MaxN metric. Scup, black sea bass, and smooth dogfish were among the most frequently observed species. Two-way ANOVAs showed significant effects of site and month on MaxN and richness, with interactions indicating location-specific seasonal patterns. Multivariate analyses (PCO and PERMANOVA) showed clear structuring of fish communities along both spatial and seasonal gradients. Spatially, sites with deeper waters and coarser sediments were associated with offshore species such as striped bass, little skate, and spiny dogfish, whereas warmer, shallower sites with finer sediments supported species like scup, cunner, and black sea bass. Seasonally, a succession in community composition was apparent: cooler-water species dominated early in the summer, while warmer-water species became more dominant in later months. These findings underscore the combined effect of habitat and seasonality on nearshore fish assemblages and further demonstrate the value of BRUVs for monitoring ecological change. Continued sampling through the BRUVs program will support management efforts and improve our understanding of fish community responses to environmental shifts in the Northwest Atlantic.

Nudging U.S. Consumer Willingness to Pay for Microplastic Mitigation Technology

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Synthetic microfibers represent one of the most prevalent sources of marine microplastic pollution, with much of the pollution linked to the laundering of synthetic-fiber based clothing. Many environmental pollution problems offer limited opportunities for consumers and households to play a material role in mitigating pollution; however, with new sustainable laundry technology (i.e., water filters, washing bags, laundry balls), consumers can significantly reduce their household microfiber emissions through various cost effective, low effort products. Currently, consumer adoption of such products remains low. It is well established in the behavioral science literature that informational nudges and message frames are effective tools for promoting behavioral change across several domains. Few studies exist linking nudges and microplastic-generating behaviors, and, to date, no known study applies nudges to laundering behavior in a microplastic context. This study evaluates how informational nudges and message framing affect (1) consumer's intent to purchase, willingness-to-pay, and preferences for sustainable laundry products and (2) how individuals value municipal wastewater treatment improvements to reduce microfiber pollution at the societal level, as measured by a contingent valuation question. An online survey instrument will provide subjects with varying levels of information about microplastic pollution, as well differing message frames, before assessing key intention and willingness measures for laundry products. This study provides both hypothetical product choices, based on current market options, and market-like choices. The study aims to generate evidence on how non-coercive behavioral interventions can encourage individual action and collective support for products and policies mitigating the ecological and human health effects of microfiber pollution. A survey pre-test is ongoing, and results are forthcoming.

Improving Degraded Microplastic Identification Using FTIR-Based CNN Modeling

Helen Ly[1], Maria Geidel[2], Liyuan Gong[3], Md Iftakhar Khan[4], Erfan Eskandari[4] & Yang Lin[4]

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Every day, plastic waste finds its way into our environment, gradually breaking down and altering its chemical composition. While traditional spectroscopic techniques such as Raman and Fourier-transform infrared (FTIR) spectroscopy are effective for detecting pristine plastics, they often struggle to classify degraded microplastics. This poses the question of how scientists can accurately identify these weathered plastics even after these changes. In this work, we developed a one-dimensional convolutional neural network (CNN) trained on FTIR spectroscopy data to improve the classification accuracy of weathered plastics, as it is more sensitive to the oxidation process that polymers undergo during degradation. Our dataset includes spectra from both the FLOPP and FLOPP-e libraries (De Frond et al.), as well as experimentally aged microplastics created through ball milling and UV degradation in aqueous conditions. The study focuses on common polymer types, including polystyrene (PS), polypropylene (PP), polycarbonate (PC), polyethylene (PE), polyurethane (PU), polyvinyl chloride (PVC), nylon (PA), polyethylene terephthalate (PET), and polyester. Initial results show that the CNN trained on the FLOPP and FLOPP-e dataset achieved a classification accuracy of 74%. Continued expansion and refinement of the dataset are expected to further improve performance. This approach demonstrates the potential of FTIR-based deep learning tools to support more accurate identification of microplastics, particularly in environmental samples where degradation complicates analysis.

The Role of Particle-Particle Collisions and Photoweathering in the Fragmentation of Glitter Microplastics

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Microplastic pollution in freshwater environments poses growing ecological and public health risks. However, key transformation processes—such as fragmentation driven by particle-particle collisions—remain poorly understood. This study investigated the role of hydraulic shear forces and microplastic interactions in the formation of secondary microplastics and nanoplastics from primary particles. Using glitter as a model microplastic, we examined how particle concentration, size, and UV-induced aging affect fragmentation rates. Glitter particles were photoweathered in a UV aging chamber for four weeks. Both pristine and weathered glitter flakes were then suspended at different concentrations in simulated wastewater and subjected to agitation, generating water shear and promoting collisions. Weekly specimens were collected up to 4 weeks, and filtered through membranes of varying pore sizes to separate particles by size. Optical microscopy of the filters was used to quantify particle size distributions and monitor morphological changes over time. Raman spectroscopy and X-ray fluorescence (XRF) were employed to characterize the chemical composition of pristine glitters and to assess changes following UV exposure. Additionally, microindentation was used to measure the elastic modulus and hardness of particles to investigate how material properties influence fragmentation behavior. The experimental design addressed theoretical models predicting that collision frequency increases with both particle concentration and shear rate, and that fragmentation is influenced by particle brittleness and size. By advancing our understanding of how secondary microplastics are generated and transformed under dynamic flow conditions, this work contributes to improved modeling of microplastic transport and informs risk assessments and regulatory decisions regarding freshwater quality and pollution mitigation.

Effects of Crab Bioturbation on Sediment Accretion and Carbon Accumulation in Succotash Salt Marsh

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Salt marshes provide many ecosystem functions, two of the most notable being carbon sequestration and long-term carbon storage. Here, we examine the effects of fiddler crab bioturbation on sediment accretion and carbon sequestration, as well as sediment and carbon resuspension. Succotash salt marsh, a backbarrier marsh located in East Matunuck, RI, serves as a long-term monitoring site for the Narragansett Bay National Estuarine Research Reserve, and is a candidate for a thin-layer sediment placement restoration project. As sea levels rise, an increased amount of allochthonous sediment is deposited in marshes with each tidal cycle, meaning that the sediment accretion rate of Succotash Saltmarsh should be approximately equal to the rate of sea level rise in Rhode Island, which is 2.97 mm/yr ± 0.16 mm/yr. Atlantic fiddler crabs, *Minuca pugnax*, are ecosystem engineers that burrow up to two feet into the surface of salt marshes. Sediment mixing can alter the stratification of sediment within a marsh, and by extension, redistribute 210Pb. Four sediment cores were taken at four sites within Succotash Salt Marsh, with varying levels of crab activity. Cores from sites three and four, which were determined to have the highest and lowest crab activities, respectively, were analyzed for 210Pb activity, dry bulk density, cumulative carbon mass, and organic matter content. Sediment traps were used to determine the flux of allochthonous mineral matter. Mineral fluxes were greatest at the site with the highest crab activity and lowest at the site with the least crab activity. These results suggest that fiddler crabs increase the amount of sediment resuspension in salt marshes. Sites with higher crab activity were also found to have a higher organic matter content, meaning the sediment is less dense, and therefore, easier to disturb, than sites with higher mineral matter content.

Investigating Probiotic Potential of *Pseudoalteromonas rubra* for Treatment of Multiple Aquatic Species

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Vibrio coralliilyticus is a known pathogen in several ecologically and economically significant aquatic animals, including oysters, and it has been implicated as a potential component of infectious diseases devastating tropical corals. As bacteria in the genus *Vibrio* have been observed to proliferate in warm waters, the environmental impacts of ocean warming risk increasing the frequency and range of *Vibrio* outbreaks. Discovery and application of probiotic treatments provides promising options for addressing marine diseases and climate stress in vulnerable animals. Two strains of the bacteria *Pseudoalteromonas rubra* (KB1 and CH007) were isolated from seawater and crustose coralline algae in the temperate coral (*Astrangia poculata*) culture systems in the Roger Williams University Wet Lab. Previous research indicates that *P. rubra* produces prodiginines, which have been associated with anti-bacterial protection and larval settlement for tropical corals. Our isolates, *P. rubra* KB1 and CH007, inhibit growth of several species of *Vibrio*, including known coral, finfish, and shellfish pathogens. To further explore the probiotic potential of *P. rubra*, we conducted challenge and rescue assays using larvae of the eastern oyster (*Crassostrea virginica*) and the model anemone *Exaiptasia diaphana*. Initial assays on *C. virginica* larvae have strongly indicated that *P. rubra* prevents oyster larval mortality from *V. coralliilyticus* when utilized as a pretreatment. Survival of *C. virginica* larvae exposed to *V. coralliilyticus* (105 cells/ml) was 0%; however, when pre-treated with *P. rubra* cultures (105 cells/ml), the survival rate reached up to 99%. Exposure assays on *Tisochrysis lutea*, a microalgal feed commonly used in oyster larval culture, did not significantly impact algal culture cell density, indicating a compatibility of *P. rubra* with larval culture methods. Initial results indicate *P. rubra* also reduces *V. coralliilyticus*-induced mortality in the anemone *E. diaphana* when applied subsequent to *V. coralliilyticus* exposure, and ongoing work focuses on repeated trials with this anemone. These early-stage assays indicate that *P. rubra* may support development of an effective probiotic treatment, and/or a useful research tool for exploring *Vibrio* pathogenesis in aquatic animals. Future work will expand on assays to include non-model cnidarian organisms and additional species of aquacultured organisms and assess *P. rubra* effectiveness against different species of *Vibrio*.

Spatial Distribution of Microplastics in the Narragansett Bay Watershed and Correlations with Water Quality

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Microplastic pollution is an increasingly widespread concern in Rhode Island due to the state's high urban land use and the significance of marine life and ocean health to the local economy. The main goal of this project was to better understand the spatial differences in microplastic concentrations along major rivers that drain to Narragansett Bay. Freshwater microplastic data were collected from seven sample sites on three major rivers: the Blackstone River, the Woonasquatucket River, and the Pawtuxet River. These sites were selected based on their accessibility, urban and industrial river history, as well as their proximity to wastewater treatment plants and USGS stream gauges. Three samples per site were collected using a flow-through trawl method (330 µm phytoplankton sampler) by wading in the river or by a bridge for deeper water. The samples were digested using 1M KOH to remove organic matter, heated and stirred at 60 rpm and 40°C for 24 hours. Samples were then filtered through a 1.6 µm glass fiber filter and stained with Red Nile dye. Visual analysis was performed using a retrofitted stereo microscope with blue light to induce fluorescence. Additionally, grab samples from each sample site were analyzed for turbidity, TDS, pH, and specific conductivity to explore potential correlations between these parameters and microplastic concentrations. By comparing turbidity with microplastic concentrations, possible relationships between water clarity and plastic pollution can be identified, to help understand the potential use of water quality indicators to quantify and determine the distribution of microplastics in freshwater systems. Data thus far do not indicate a significant difference in microplastic concentration downstream of wastewater treatment plants. Current data does not reveal a relationship between microplastic concentration and turbidity for each river; however, a trend may emerge as data continues to be collected. The relationship between river flow and concentrations shows a negative trend, with greater microplastic concentrations during lower flows. This project is part of a broader long-term microplastic sampling initiative involving undergraduate researchers, aiming to develop a comprehensive database of freshwater microplastic data. The findings will enhance understanding of microplastic distribution across the state and support the development of effective solutions and technologies to address this escalating global and local problem.

Analyzing Behavior of D-Stage Larval Oysters Exposed to *Margalefidinium polykrikoides*

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Eastern oysters are known to have susceptibility to rust tide, a Harmful Algal Bloom (HAB) caused by the dinoflagellate *Margalefidinium polykrikoides* (Mp). While adult eastern oysters seem to withstand exposure to rust tide blooms, the reaction of larval populations has not been studied. In this project, D-stage larval oysters were exposed to *M. polykrikoides* at 5K, 10K, and 15K cells/mL concentrations. Tiso, a food source for larval oysters, was included along with the *M. polykrikoides* concentrations in a separate experimental group to mimic a natural environment. Oysters were collected immediately post exposure, as well as 24-hours and 48-hours post-exposure to record behavior via microscopy. The behaviors observed include irregular swimming, helical swimming, the time spent swimming, and time spent with an exposed velum. After observation, oysters were fixed in 10% Davidsons in seawater for histological evaluation. Results indicate that larval oysters spent less time swimming when exposed to concentrations of *M. polykrikoides*. A similar pattern was observed for the percent of time the oysters spent with their velum exposed. Not only does Mp reduce time spent swimming, but it also reduces the amount of observed oysters swimming helically. However, oysters exposed to Mp with Tiso spent more time swimming, with their velum exposed and a larger proportion swam in a helical pattern than the Mp alone treatments. This experiment has revealed that the D-stage larval life cycle of the of the Eastern Oyster is susceptible to various concentrations of Rust Tide.

Characterizing Platinum and Rhodium Concentrations in Environmental Samples Across Narragansett Bay, Rhode Island

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Several species of macroalgae have been shown to accumulate platinum group elements (PGEs) both in vitro and environmentally (Abdou, et al. 2023; Pinto, et al. 2021). As these critical elements increase in demand (Tang, et al. 2023) and as there is a growing understanding of the threat that PGEs may pose environmentally (Ravindra, et al. 2004), the ability to detect, characterize and recover these elements is becoming more of a priority for many different stakeholders (Mudd, et al. 2017). Here, two genera of macroalgae (*Ulva* and *Gracilaria*) were used to begin to characterize the concentrations of Platinum and Rhodium in Narragansett Bay at different latitudes. Anthropogenic release of PGEs has many potential sources, including runoff from catalytic converters in automobiles and in the manufacturing of pharmaceuticals, diesel fuel, and jewelry (Bluteau, et al. 2025). To study a potential geographic PGEs environmental gradient, samples were taken from six sites across Narragansett Bay, with *Ulva* found at all of the sites and *Gracilaria* found at the four most northern sites. The samples were processed for elemental analysis using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) (i.e., washed, frozen, freeze-dried, pulverized, acidified, and diluted). To complement this experimental approach, a systematic literature review was conducted to establish findings and consensus of the sorption of PGEs by marine primary producers and to find gaps in this emerging field of interest. From an initial search of 208 papers, exclusion criteria were applied, resulting in 53 papers for analysis. Of the included papers, 73.6% were studies conducted in vitro and 15.1 % were environmental studies. 18.9% focused on recovery of PGEs, 11% focused on the effects of incorporating PGEs, 22.6% focused on the mechanism of sorption, and 15.1% focused on using marine primary producers as a bioindicator of environmental PGEs concentration. The studies examined a great range of taxa, with 43.4% of studies including results on species of macroalgae, of which 43.4 % included samples in *Ulva*, and only one article included samples of *Gracilaria*.

Solvent and Temperature Effects on the Stability of Polymer-Grafted Nanoparticles with Varying Polymer Molecular Weights

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Polymer-grafted nanoparticles (PGNPs) exhibit thermo-responsive behaviors that make them useful in sensing and detection applications. In this study, we investigate how polymer molecular weight affects the stability, aggregation, and color change of gold PGNPs in a poor solvent. Gold nanoparticles (AuNPs) were grafted with thiol-terminated polystyrene (PS-SH) of two molecular weights: 27 kDa and 61 kDa. After functionalization in tetrahydrofuran (THF), the particles were transferred into cyclohexane, a poor solvent, to trigger temperature-dependent aggregation.

As temperature decreases, the solvent quality worsens, leading to polymer chain collapse and particle aggregation, with a corresponding red-to-grey color change of the sample. This transition is marked by the upper critical solution temperature (UCST), which shifts higher with increasing polymer molecular weight. Dynamic Light Scattering (DLS) showed that the hydrodynamic radius (R_h) decreased above the UCST and increased sharply below it due to clustering. UV-Visible spectroscopy (UV-Vis) showed redshifts and peak broadening below the UCST, which indicated increased aggregation as temperature decreased.

Despite the difference in UCST values, both 27 kDa and 61 kDa PGNPs followed similar aggregation kinetics, quantified by a power-law exponent $\alpha \approx 1/3$. This contrasts with faster aggregation rates seen in traditional colloidal systems ($\alpha \approx 0.55$), highlighting the unique behavior of polymer-grafted systems. These results demonstrate that polymer molecular weight provides a simple yet powerful way to tune the UCST, depending on the temperature range at which PGNPs aggregate and color change. This tunability is essential for designing colorimetric sensors that respond to specific thermal or environmental conditions. By controlling when the visual signal appears, such systems can be tailored for applications in contamination detection, diagnostics, and smart materials.

Reviewing Recycled Marine Fishing Gear Plastic-Sand Construction Blocks with Fused Calcification

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The shellfish industry has evolved from wooden and metal fishing gear to primarily plastic, due to practicality. Nowadays, it makes up most marine plastic waste yet goes un-recycled in part because of calcified shells encrusted to the surface of the plastic. This study examines the structural, environmental, and occupational impacts of recycling HDPE fishing gear with and without cleaning, focusing on small-scale recycling systems. Fishing gear waste from Rhode Island's Commercial Fisheries Foundation was mechanically recycled into two HDPE-sand composite blocks: one with 70% sand, and another with 46.5% sand and 23.5% calcified shells. Shell composition was analyzed by XRF. Airborne particulates during processing were characterized using SEM-EDX and ImageJ. Compressive strength (ASTM C109), creep (at 45% load), and leachate tests were performed to assess structural and environmental impacts. Shells contain 71-96% Calcium, and small amounts of Zn, Ti, Mn, Fe, Cr, and Al. Extruding produced more particulate emissions than shredding, with sizes up to 10μm. Particulate materials generated in both processes contained C, O, Na, Si, Al, Fe, and K. Mn was present only present during extrusion, while particles from shredding have a unique signature of Mg. N, S, and Ca only present when processing calcified material. Leachate analysis for feedstock revealed Ca, 142,000 ug/l, to be the highest in concentration with an 80,733.33 ug/l reduction when calcification is removed, followed by Manganese, 2,460 ug/l when calcified and 980 ug/l when removed. There was a significant presence of Ti, Zn, Al, and Fe. The compressive strength values obtained were 32.2 ± 0.9 N/mm2 for the plastic/sand block and 32 ± 0.6 N/mm2 for plastic/sand/shells. Creeping of the samples was 2.42 ± 0.21 mm plastic/sand block and 1.79 ± 0.07 mm for plastic/sand/shells, enduring a prolonged load. This study shows that calcified fishing gear waste can be repurposed into durable construction composites without compromising strength, offering a promising reuse strategy for marine plastic waste. The added shell content improved creep resistance, though elevated particulate emissions and metal leaching raise occupational and environmental concerns. Further research is needed to optimize processing and ensure safe, efficient integration into small-scale recycling systems.

Designing a Multisensory End Effector for Enhanced Virtual Human-Drone Interaction

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Physical human-drone interaction (PHDI) enables applications such as cooperative payload transport and autonomous delivery services. However, conducting human-subject studies with physical drones poses significant safety and control challenges. While virtual reality (VR) offers a safe and controllable platform for simulating drone interactions, it needs integration with a tactile platform like a robotic arm to enable user-drone force exchanges. In the ICRobots lab setup, a robotic arm repositions itself to follow the motion of the virtual drone, but it lacks additional physical sensory cues like the rotor wind and motor sounds essential for immersive and realistic PHDI studies.

To address this gap, we developed an end effector for the robotic arm that delivers real-time wind and audio feedback based on the virtual drone's position. It utilizes an Arduino Nano ESP32 microcontroller, a DC motor equipped with a propeller for wind generation, and a DFPlayer Mini MP3 module with a speaker for audio output. The VR environment computes the drone's position in real-time and transmits the data via Wi-Fi using Transmission Control Protocol. The ESP32 processes this data to generate appropriate pulse-width modulation signals for fan speed control and adjusts the volume of the audio playback.

We have tested our system by measuring the volume and wind speed generated by the end effector with the virtual drone at varying distances. Results confirm that both audio and wind speed intensity decrease with increased virtual drone distance, verifying the system's ability to provide accurate sensory feedback to the user.

This system enhances the realism of VR-based drone simulations. Future developments will include the integration of force sensors for physical interaction studies, tuning the volume and wind speed to more accurately mimic a real drone, and utilizing the speakers integrated in the VR headset to reproduce the audio.

Evaluating the Viability of Live Microalgae Concentrates as a Feed for Quahog (*Mercenaria mercenaria*) Larvae in the Shellfish Hatchery

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The production of live microalgae as a feed in shellfish hatcheries is a boon to livestock, but requires substantial investment (as much or greater than 60% of operational costs) and staffing. It also comes with risk, as failed cultures can endanger livestock production and revenue. One solution to these problems is the use of commercially available microalgae pastes, such as those sold by Reed Mariculture, either as the primary source of nutrition or as a supplement to/backup for live culture. Such pastes have the advantage of convenient storage in a refrigerator, but they tend to be non-viable, which may limit their nutritional quality and ingestion by bivalves. An understudied yet promising method of concentrating live microalgae involves dewatering via micro- and ultrafiltration, which produces a cell-dense output with reduced shearing damage. In preliminary testing, the PIs in Roger Williams University's Aquaculture and Aquarium Science Lab successfully concentrated several species used as shellfish feeds including *Tetraselmis* spp., *Tisochrysis lutea*, *Chaetoceros muelleri*, *Thalassiosira weissflogii*, *Rhodomonas salina*, and *Pavlova lutheri* using this method. While the cost of specialized pump and membrane equipment is quite high, which could limit its adoption by other hatcheries, the PIs achieved these results using lower-cost alternatives. And while live microalgae concentrates have high potential for streamlining hatchery operations, their serviceability depends on whether they perform well as feeds for shellfish livestock. This project investigated the efficacy of the aforementioned live microalgae concentrates as a feed for Eastern oyster (*Crassostrea virginica*) and quahog (*Mercenaria mercenaria*, the subject of this presentation) larvae in the Luther H. Blount Shellfish Hatchery at Roger Williams University. Experimental trials for each species tested for effects of a 2-level microalgae diet treatment (unconcentrated, viable concentrated) on larval bivalve survival and growth. Microalgae species selected for the trials included T. iso and *C. muelleri*, feeds were standardized to cell count, and cell counts as well as the proportion of diatom fed were increased daily as larvae grew. Larvae were cultured between 48 hrs post-fertilization and settlement (14 days for oysters, 8 days for quahogs) in 4 L buckets in a 7x-replicated design (totaling 14 experimental units) before sampling for survival and growth analysis.

Optimization of Foraminiferal Extraction Methods from Coastal Sediments

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Rhode Island's coastal salt marshes, providing critical services including coastal defense, water filtration, and carbon sequestration, are imperiled by accelerating sea-level rise. Local rates in Newport are 2.97 mm/year (±0.16) (NOAA, 2024), and projections indicate a catastrophic loss of over 52% of the state's marsh habitat with a three-foot sea-level rise, and 87% with a five-foot increase (RI CRMC, 2015). To enhance resilience, restoration strategies like thin-layer sediment placement (TLP) are being increasingly implemented, necessitating scalable biomonitoring tools (Raposa et al., 2022; Raposa et al., 2023). Foraminifera, single-celled microeukaryotes whose community composition and vertical zonation are sensitive to environmental conditions, are ideal for such assessments. Paleo-ecological studies analyze the fossilized tests within the sedimentary record to reconstruct historical climates and sea levels (Prazeres, 2019). Modern biomonitoring assesses the living populations by applying environmental DNA (eDNA) metabarcoding to characterize contemporary ecosystem health (Pawlowski et al., 2016). However, the efficient extraction of sufficient amounts of high-quality DNA from their calcareous tests within inhibitor-rich sediments remains a critical methodological bottleneck (Girard et al., 2022). While established protocols using genetic markers like cytochrome c oxidase I (COI) and 18S ribosomal RNA (18S) demonstrate utility, they face limitations including primer bias and incomplete reference libraries (Macher, J. et al., 2022; Holzmann et al., 2024). This study addresses this gap by evaluating two procedures for community DNA extraction, which involve adding a Proteinase K enzymatic digestion step (55°C, 2 hours) before standard mechanical bead-beating lysis to improve DNA yield from coastal sediments. Samples (n=5) were collected from a mudflat adjacent to the Succotash salt marsh. The two extraction approaches were compared by examining the PCR amplification efficiency of 18S and COI markers across replicate samples. Our comparison did not reveal a clear improvement in PCR amplification efficiency for the protocol modified with Proteinase K. This study suggests the standard mechanical lysis workflow is adequate and cost-effective for routine foraminiferal metabarcoding, a finding that can help streamline analysis for the scalable biomonitoring of climate adaptation efforts in Rhode Island's marshes.

Algae and Diatom Growth and Identification for the Culture of Benthic Foraminifera from Rhode Island Salt Marshes

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Benthic foraminifera are an important bioindicator of marine environments, however due to uncertain genomic assemblages their use on shorter time scales has been limited (Seears & Wade, 2013). The need to use living benthic foraminifera to interpret how ecosystems are responding on shorter time scales is becoming critical due to rapid environmental changes, including coastal acidification, climate change, and sea level rise. The establishment of laboratory cultures is desired in order to facilitate full genome sequencing of foraminifera. To facilitate growth, benthic foraminifera need to be stimulated with a food source, the most established of which is unicellular algae (Arnold, 1954). In our experiment, foraminifera specimens of the genera *Quinqueloculina* and *Haynesina* were picked from sediment samples obtained from Quonochontaug and Succotash marshes in Rhode Island. Individual specimens were placed in separate wells of six-well plates containing F/2 media. Plates were incubated on a diel cycle (12hr light/dark cycle) at room temperature, ~23°C. After 24 hours, culture plates were observed using an inverted microscope to qualitatively analyze the feeding of various foraminiferal morphotypes based on imagery of pseudopodia movements. Results suggest that foraminifera specimens show signs of active feeding in the F/2 media, which could indicate potential growth of algae and diatoms associated with foraminifera that can be used as a food source in laboratory cultures. Moving forward, the foraminiferal taxa and algal/diatom species will be identified based on the sequencing of molecular barcodes. Our identification of the natural food sources of benthic foraminifera will provide insights into the coastal food web near Rhode Island's salt marshes and provide a pathway for cultivating these species in laboratory settings.

AI-Guided Terahertz Fiber Sensor Design for Microplastic Detection in Aqueous Samples

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In this project, Terahertz (THz) fiber sensor designs are proposed to detect microplastics in aqueous samples, such as water and ethanol. THz spectroscopy is a powerful tool in nondestructive analysis of small particles. Microplastic contamination poses a growing risk in environmental contexts, where THz spectroscopy could serve as a promising method in its detection. Through the theoretical and numerical design of the proposed sensors, machine learning (ML) techniques are extensively utilized to determine the optimal geometrical features. The generated numerical data for large sets of design parameters are engineered with physics-informed ML algorithms to achieve an effective inverse sensor design. To further improve sensor performance, multiphysics simulations were utilized to simulate hollow-core negative curvature fibers through parameters such as core and tube diameters, and strut thickness to increase light interaction within the sample. We developed various ML models that can be used to predict the sensor performance, which would take a fraction of the time otherwise. To gain an understanding of the significance of each feature in, LASSO, Ridge, and Elastic Net regression models were utilized along with more complex ML models including Gaussian process regression (GPR), regression trees, support vector machines, and multi-layered neural networks (NNs). Our most effective ML models predicted sensor performance results with R2 values exceeding 0.87 for the whole operational frequency range of 0.4 THz to 4 THz. From optimized sensor designs, both the sensitivity and selectivity features are extracted for different fraction ratios spanning between 0.05% and 0.20% up to 97% sensitivity. To determine whether terahertz spectroscopy can accurately predict the presence of microplastics in a sample, a terahertz time domain spectroscopy (THz-TDS) setup with a remote controlled sample stage and nitrogen purging is established, and the samples placed within the light path to record transmission spectra. The preliminary experimental results have been obtained for the THz fiber designs as well as the optical properties of analytes. The experimental results confirm the sensing mechanism through the low loss transmission windows of the designs. This approach aims to support the development of Terahertz technology in microplastic detection in environmental context as microplastics become a focal point within the scientific community.

Application of Manganese Oxide-Coated Media for Reagent-Free Oxidation of BPA

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Bisphenol A (BPA) is a polymer used in the production of polycarbonate plastics and epoxy resins, but it is also a potent endocrine disruptor. As these products degrade over time, BPA can leach into and contaminate water sources. Manganese oxide (MnOx)-coated media is known to oxidize BPA, however, this approach requires the feeding of chemicals for surface regeneration, which is impractical for small-scale or isolated systems. This study explores reagent-free electrochemical regeneration of MnOx-coated media for the oxidative removal of BPA from drinking water. Bench-scale column experiments were done on MnOx-coated media regenerated both chemically and electrochemically. Column tests were run with 0.5 mg/L influent BPA in a synthetic raw water background. BPA concentration was quantified by absorbance at 276 nm, measured by spectrophotometer. BPA was passed through MnOx-coated media in a 3-cm diameter column under both regeneration conditions until effluent and influent concentrations were equivalent, at which point the media was considered fully expended. Chemically regenerated media oxidized up to 40% of influent BPA, while electrochemically regenerated media oxidized up to 60% of influent BPA. These preliminary results suggest that oxidative removal of BPA is a promising application of electrochemically regenerated MnOx-coated media, demonstrating a potential treatment option without the need for chemical inputs.

Synthesis and Characterization of Heusler Alloys: Co$_2$NiSn, Ni$_2$CoSn, and CoNiSn at the Nanoscale

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An investigation of the Heusler alloy family: Co$_2$NiSn, Ni$_2$CoSn, and CoNiSn was performed for characterization of the material and to observe their magnetic abilities at the nanoscale. Synthesis of the materials was achieved using microwave irradiation (300W, 175°C, 5 mins). Successful synthesis was characterized by XRD and XRF analysis. The materials presented with magnetic behavior in the presence of an applied field. Additional shelling studies were done with the CoNiSn@Co core@shell compound presenting high coercive behavior.

Microwave Synthesis and Characterization of Fe$_2$PtGe nanoparticles

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Heusler alloys are intermetallic compounds, with the formula X$_2$YZ, known for their diverse and unique physical properties. This study focuses on the synthesis and characterization of nanoscale Fe$_2$PtGe. The material was synthesized using microwave heating (175ºC, 5 mins) and characterized through XRD, XRF, and UV-Vis spectroscopy. XRD shows cubic particles, but more importantly exhibits sample displacement during the measurement. While the particles appear to exhibit slight fluorescence under UV irradiation, current UV-vis measurements have proven inconclusive due to poor solubility of the product. The initial Fe$_2$PtGe particles are weakly magnetic at reduced temperatures, but exhibit room temperature ferromagnetism upon annealing at 600°C for 3 hrs.

Synthesis of Iron Oxide Magnetic Nanoparticles for Antibacterial Treatment

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Magnetic nanoparticles (MNPs) are small particles of magnetic materials that can be actuated at a distance using magnetic fields. Hydrothermal synthesis is one of many methods to create magnetic nanoparticles (MNP). MNP synthesis presents reproducibility challenges. In this project, we study how minor variations in the hydrothermal process change characteristics such as particle cluster size, ideal magnetic excitation frequency, heating ability and magnetic response. In this procedure, we used an iron(II) salt as metal source, polyethylenimine as surface coating, and ammonium hydroxide as a base to synthesize iron oxide MNPs by the hydrothermal method. We showed that minor experimental details such as initial mixing time and method, can affect the magnitude of the generated heat and synthesis yield, but not the optimal excitation frequency. MNP washing process did not affect the characteristics of the MNP. These MNP with a positive surface charge can be used to target bacteria, which are usually negatively-charged. The MNPs can then be subsequently activated through alternating magnetic fields to heat up bacteria and drive cell lysis to remove bacterial biofilms.

Leveraging Magnetic Seperation for Particle Removal in Martian Water Reuse

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Inhabiting Mars by 2030 will require innovative technologies, especially for securing a sustainable water supply through reuse and low-power purification methods. Martian soil, which may contaminate water systems during Mars inhabitation, contains magnetic iron oxide that could be targeted for removal using magnetic filtration. This project explores the use of permanent magnets to create in-flow magnetic filters that are energy-efficient and resistant to clogging. By testing various filter designs and evaluating their effectiveness in removing particles and possibly organic matter, the study aims to identify optimal solutions for water purification on Mars. We have built a magnetic in-line filter combining a commercially-available filter housing and a strong NdFeB permanent magnet. A custom adapter was designed and stainless steel wool was added to hold the magnet in place and to maximize suspended particle exposure to strong magnetic field gradients, leading to increased magnetic particle removal. Overall, our method resulted in a reduction of magnetic iron oxide in the water but more work is needed to reach a safe level for consumption.

What's the Vibe? Understanding the purpose of a Vibe Check in Needle Ant Colonies

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The impressive organization and cooperation of social insect societies is thought to be largely a result of the ability for the individuals within colonies to communicate with each other, exchanging and processing information. Ant communication uses chemical, mechanical, and visual modalities and often involves interaction through antennal contacts. While observing the Rhode Island population of needle ants (*Brachyponera chinensis*), we observed a novel interaction behavior. To understand the purpose of this interaction we call the "vibe check", we set up an experiment with different variables to see if the amount of interactions increase with specific stimuli. In this experiment we separated ants into two different treatment groups and after a period of time we let them interact with each other and observed how frequent the vibe check interactions were. The highest vibe check interaction frequency (12 interactions per ant) was found in our control groups. The lowest vibe check interaction frequency (3 interactions per ant) was found in the treatment group in which one set of ants had been exposed to their queen and brood. Intermediate vibe check interaction frequencies (6.9-8.5 interactions per ant) were found in treatment groups exposed to the queen or brood separately. These data suggest that ants engage in vibe checking behavior more when they are effectively more isolated from the social milieu of their home nest.

Exploring the Relationship Between Cerebral Palsy and Alzheimer's Disease

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Cerebral palsy (CP) is the most common motor disability in childhood affecting about 17 million people worldwide. CP is most often a result of perinatal inflammation from hypoxic and ischemic injuries. Studies have shown adults with CP are at a greater risk of developing Alzheimer's disease (AD). Whether this is due to CP pathology or the resulting health complications arising from a more sedentary lifestyle is uncertain. We hypothesize neuroinflammation from perinatal hypoxia ischemia (HI) injury increases glial activation in response to a high cholesterol and copper water diet (which serves as a diet-induced animal model of AD). Early life neural injury may lead to a long term increase in neuroinflammation and an increased susceptibility to AD later in life. To test this hypothesis, we combined the rabbit model of CP with a rabbit model of AD. Between 70 and 80% gestation, pregnant female rabbits either receive an HI surgery or a sham surgery. The HI surgery is performed by inserting a balloon catheter to block blood supply to the uterine horns. At postnatal day (P) 31, rabbits are weaned and fed either a normal diet with distilled water for drinking (ND) or a high cholesterol diet with copper added to their drinking water (HCD). At P45, novel object location and novel object recognition assays were performed, and tissue was collected around ~P65 after completion of trace eyeblink conditioning. The HI HCD rabbits had a lower discrimination index compared to the sham ND in novel object recognition, however there were no differences between groups in novel object location. Gliosis was examined by measuring GFAP and IBA1 protein levels using western blots. Indirect free floating immunofluorescence was performed to collect representative images as confirmation of our western blot data. In the hippocampus, GFAP expression showed an upward trend in HI rabbits compared to sham, and Iba1 expression was elevated in HI rabbits relative to sham across both diets. In the cerebellum, there was a trend towards increased GFAP expression in HI rabbits, and Iba1 expression was higher in HI HCD rabbits compared to sham ND. This data suggests that perinatal HI injury accelerates cognitive decline and increases glial activation. In the future, we will examine markers of AD (e.g. Aβ plaques and hyperphosphorylated tau), neurodegeneration, and other markers of inflammation,and we will repeat these experiments in older rabbits.

Cell Size Control Under Changing Environments

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Cells maintain their size to function properly within their ecological and organismal contexts. While environmental factors are known to influence cell size across both unicellular and multicellular organisms, the molecular mechanisms that allow cells to adapt their size under changing conditions remain poorly understood. In fission yeast, cells divide at a threshold size due to size-dependent activation of cyclin-dependent kinase (Cdk1). Recent work suggests that this control is achieved through scaling of mitotic activators with distinct aspects of cell size or growth: Cdr2, a Wee1 inhibitory kinase, accumulates with surface area; Cdc25, a mitotic phosphatase, accumulates with cell volume; and Cdc13 (mitotic Cyclin) scales with cell cycle time. Previous studies have primarily focused on these pathways under nutrient-rich conditions. Here, we investigate how these cell size control pathways contribute to size adaptation under environmental stress. Using high-throughput image analysis, we quantified the geometry of dividing cells grown under osmotic stress, oxidative stress, and low-glucose conditions. To test the contributions of surface area, volume, and time-sensing pathways, we modulated the protein levels of Cdr2, Cdc25, and Cdc13, respectively. Our preliminary data show that wild-type cells increase their surface area-to-volume (SA:Vol) ratio under low glucose conditions but decrease it under oxidative or osmotic stress. We find that the volume-sensing pathway (Cdc25) is required for proper size adaptation under oxidative and osmotic stress, while the time-sensing pathway (Cdc13) is necessary for size adaptation in low glucose and osmotic stress. The surface area-sensing (Cdr2) mutants do not increase their surface area to volume ratio like WT cells. These findings reveal how distinct cell size control pathways contribute to environmental adaptation and highlight the modularity of cell size control systems.

The Impact of Exercise in the Heat on Thermoregulation and Lactation Performance in Lactating Women: Preliminary Findings

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Background: The lack of clear guidelines on exercising in heat leads many lactating women to avoid it, fearing impacts on milk production. Purpose: To evaluate the impact of acute exercise heat stress on thermoregulation and lactation performance in lactating women. Methods: Two of ten participants (SUB1: 33yrs;body mass[BM]:67.8kg; infant age:24weeks; SUB2: 33yrs; BM:63kg; infant age: 40 weeks) completed the study. Participants were eligible if they were currently breastfeeding (6- week- 12-month infants), aged 18-45 years old, delivered between 37 and 42 weeks. The study was a randomized, cross-over design with three visits: 1) baseline and metabolic heat production; 2) acute exercise in a hot condition (HOT; 36°C, 40% relative humidity), and 3) acute exercise in a thermoneutral condition (THERM; 20°C, 20% relative humidity). Metabolic heat production per body weight (W/kg) was calculated to prescribe exercise intensity during trials. Participants were asked to walk on a treadmill at 8W/kg production (3.5 [SUB2] and 4.1 mph [SUB1]) for 60 minutes. Core temperature(T_{core}), Heart rate(HR), and fluid intake were monitored during exercise. Lactation performance was measured by logging lactation frequency and total 24-hour milk production before (PRE24) and after (POST24) each trial using an infant scale. Descriptive statistics are presented as individual data points and pre-post differences. Results: Max T_{core} was 39.06(HOT) and 37.55°C(THERM) for SUB1 and 37.89(HOT) 37.63°C(THERM) for SUB2. Max HR was 172(HOT) and 161bpm(THERM) for SUB1 and 115(HOT) 101bpm(THERM) for SUB2. Fluid intake for SUB1 was 3,814(PRE24,HOT), 3,548(PRE24,THERM), 1685(POST24,HOT), and 1,301(POST24,THERM) and SUB2 fluid intake was 2,690 (PRE24,HOT), 1,981(PRE24,THERM),2,658(POST24,HOT), and 3,252(POST24,THERM). For lactation performance, lactation frequency was 6 (PRE24, HOT), 7 (POST24, HOT), 6 (PRE24, THERM), 6 (POST24, THERM) for SUB1. For SUB2, lactation frequency was 6 (PRE24, HOT), 7 (POST24, HOT), 6 (PRE24, THERM), 5 (POST24, THERM). Total breastmilk production was higher POST24 in HOT trial (difference[D]:547mL) and lower POST24 THERM (D:99mL) compared to PRE24 for SUB1. For SUB2, total breastmilk production was lower following both trials (HOT D:476mL; THERM D:221mL). Conclusion: TCORE and HR were higher in HOT for SUB1 and SUB2. It does not appear that heat negatively impacts lactation performance or fluid intake; however, more participant data is required.

Developing Protocol to Study Ant-Caterpillar Interactions in a Rare Lycaenid

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Lycaenid caterpillars, including the rare frosted elfin, engage in symbiotic relationships with ants that protect them from predators in exchange for nutritive sugar secretions, but the costs and benefits of this interaction remain unclear. Using the common gray hairstreak (*Strymon melinus*) and *Tetramorium* ants as a model, we developed lab protocols to study the nutritional composition of caterpillar sugar rewards and assess potential delayed reproductive costs of secreting such a reward. Protocols developed in this study will be used to examine this interaction in the rare frosted elfin, and guide future research and management strategies aimed at promoting butterfly persistence in the face of environmental change. Research was done on how, where, and when to find these butterflies, as well as how to take care of them in captivity.

Comparative Morphology of Tube Foot Disc Rosettes in Sea Urchin Species

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Echinoids employ specialized tube feet equipped with adhesive and de-adhesive secretions to facilitate temporary substrate attachment, enabling critical functions including resistance to hydrodynamic forces and foraging behavior. Each tube foot consists of a proximal extensible stem and a distal adhesive disc with an internal calcified rosette structure. The rosette comprises ring-arranged ossicles with stereom architecture characterized by solid trabeculae and interconnected pores. Previous research suggests that ossicle morphometric parameters vary interspecifically and may reflect habitat-specific adaptations.

This study quantified rosette morphology across four echinoid species to examine relationships between structural characteristics and potential adhesive function. We analyzed *Mesocentrotus franciscanus* (red urchin), *Strongylocentrotus purpuratus* (purple urchin), *S. droebachiensis* (green urchin), and *S. pallidus* (white urchin). Morphometric analyses included ossicle area measurements in horizontal and vertical orientations (mm²), ossicle skeletal density (%), ossicle number per disc, and total disc surface area (mm²).

Tube foot discs were chemically treated with sodium hypochlorite to expose internal rosette structures. Individual ossicles were mounted on aluminum stubs for scanning electron microscopy (SEM) imaging in horizontal and vertical orientations. Morphometric data were extracted using ImageJ software with standardized measurement protocols.

Results revealed a significant negative correlation between ossicle number and individual ossicle size. Species with large ossicles (*M. franciscanus* and *S. purpuratus*) exhibited fewer ossicles per rosette, while species with smaller ossicles (*S. droebachiensis* and *S. pallidus*) revealed higher ossicle densities per disc. Skeletal density showed no significant interspecific variation, suggesting consistent biomineralization patterns across taxa despite morphological differences.

These findings show that tube foot adhesive performance depends not solely on biochemical secretions but also on the mechanical properties conferred by rosette architecture. The inverse relationship between ossicle size and number suggests alternative structural strategies for optimizing adhesive function, potentially reflecting different ecological pressures or substrate preferences. Future studies of echinoid adhesion should incorporate rosette morphological assessment alongside biomimetic adhesive development.

Evaluating the Seeding and Netting Method for *Mya arenaria* on the Great Salt Pond, Block Island, RI

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Research has shown a steep decline in the soft-shell clam (*Mya arenaria*) population along the North Atlantic coast caused by climate change and invasive green crab (*Carcinus maenas*) predation. Studies indicate that the "seeding and netting" method, a process of planting juvenile clams into 5' x 8' intertidal plots and protecting them with a cover of mesh screening, is effective in protecting vulnerable populations of soft-shell clams from the green crabs. While researchers have already tested this method in Northern New England (e.g. coastal Maine), the effectiveness of this method for Block Island, Rhode Island, has yet to be investigated. Here, we have begun a multi-year monitoring program, the goal of which is to survey clam population abundance and determine clam density inside and outside of nets designed to exclude green crab predators in the Great Salt Pond, Block Island. On May 27th, 2025, we compared clam density inside and outside of nets to see if the "seeding and netting" method is suitable for restoring the soft-shell clam population on the Great Salt Pond. Four plots outplanted in 2023 and four plots outplanted in 2024 were selected for sampling, and five cores from each plot were collected. Then, four more unnetted locations were randomly chosen in close proximity to the netted plots, and 5 cores from each outside plot were collected. A total of 168 *Mya arenaria* were collected from all plots. 110 were found in the 2023 plots, 57 were found in the 2024 plots, and 1 was found in the outside plots. Statistical analyses revealed that there were significant differences between the *Mya arenaria* population density from within the 2023 and 2024 outplant years compared to the outside plots (Tukey HSD Test: p adj. = <0.001 and 0.02, respectively). Further, the clams were measured at their longest dimension from the anterior to posterior end of their shells, and showed the expected result that the 2023 *Mya arenaria* were significantly longer in shell length than their 2024 counterparts (Tukey HSD Test: p adj = <.001, 95% C.I. = -15.15, -5.72). This research immediately serves to confirm the current "seeding and netting" project being conducted by the Block Island Shellfish Commission is successful in protecting the *Mya arenaria* population from green crab predation, and may be a useful tool in future conservation efforts towards bolstering soft-shell clam populations on Block Island.

Conductive Liquid Crystal Elastomers for Soft Actuators

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Liquid crystal elastomers (LCEs) are shape-changing polymers uniquely suited for a broad range of soft matter applications, including use as soft actuators in prosthetic and therapeutic devices. In this project, we develop conductive LCEs using a thiol-acrylate Michael addition and thermal polymerization method, incorporating carbon black into the polymer matrix to allow for electrically conductive; resistive heating-based actuators. By utilizing resistive heating, we aim to change the external stimuli from thermal to electrical. This enables the creation of a more compact and integrated actuator system (compared to more traditional methods i.e. pneumatic or mechanical) while still being able to mimicking the mechanical behavior of the natural tendons/ muscles.

Hallucinogen Use: Identifying the Prevalence, Disparities, and Mental Health Comorbidities Over Time

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Objective: While hallucinogens are now being used in mental health treatment, research examining recreational hallucinogen use over time, especially in relation to mental health comorbidities and demographic disparities, remains limited. This study aims to examine hallucinogen use trends over time among young adults, with a specific focus on demographic disparities and mental health comorbidities. Methods: This was an analysis of the 2022 and 2024 Rhode Island Young Adult Surveys, cross-sectional, self-report surveys administered to n=2,030 adults aged 18-25 who live in Rhode Island for at least part of the year. Hallucinogen use was assessed by the question, Have you ever used hallucinogens (i.e., LSD, PCP, ketamine, ecstasy, Molly, mushrooms)? Multivariable logistic regressions were used to (1) assess disparities in hallucinogen use by time, age, sex and/or gender, race/ethnicity, and social ladder, and (2) assess for significant comorbidities, one at a time, controlling for all sociodemographics.

Results: Among the 2,030 respondents, 9.9% (n = 200) reported hallucinogen use. The prevalence increased from 7.1% in 2022 to 12.7% in 2024, reflecting a statistically significant rise in use over time (p < 0.001). Respondents in 2024 had nearly twice the odds of hallucinogen use compared to those in 2022. Significant disparities emerged by age and sex and/or gender. Adjusted odds of hallucinogen use increased with age (AOR = 1.26, 95%CI: 1.17, 1.35). Compared to cisgender heterosexual males, cisgender heterosexual females had significantly lower odds of use (AOR = 0.40, 95% CI: 0.24,0.66), while those identifying as sexual and/or gender minorities had significantly higher odds (AOR = 1.60, 95% CI: 1.06,2.42). Hallucinogen use was also associated with increased odds of multiple mental health and substance use outcomes. Specifically, users had higher adjusted odds of depression (AOR = 1.56, 95% CI: 1.14,2.15), suicide ideation (AOR = 1.76, 95% CI: 1.21,2.58), cannabis use disorder (AOR = 7.65, 95% CI: 5.41,10.82), alcohol use disorder (AOR = 5.43, 95% CI: 3.32,8.88), prescription drug misuse (AOR = 6.97, 95% CI: 4.70,10.34), and over- the- counter drug misuse (AOR = 5.38, 95% CI: 3.48,8.32).

Conclusions: Patterns of use suggest a need for targeted, demographically informed public health interventions that address the increasing recreational use of hallucinogens and the mental health implications. Strategies that integrate substance-specific mental health support and address shifting perceptions of risk will be essential for effective prevention and outreach.

Characterizing Neural Responses in the P300 Matrix Speller Brain-Computer Interface Task

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The P300 Matrix Speller is a brain-computer interface (BCI) system that lets users spell out words using only their brain activity. This creates new opportunities for communication, which is especially important for individuals with severe motor impairments. In this task, participants focus on a specific letter within a 6×6 matrix of characters, while rows and columns are briefly highlighted one after another in a random sequence. When the highlighted row or column contains the target letter, the brain produces a distinctive electrical response called the P300, which occurs about 300 milliseconds later and can be detected with electrodes placed on the scalp. This signal is central to accurately determining the user's intended letter and is a key feature in BCI technology. We analyzed brainwave data (EEG) recorded from 64 locations on the scalp while participants used the speller to type out prescribed words, focusing on one character at a time. The sequences of illuminated rows and columns were repeated several times for each letter to ensure reliable detection of the brain's response. For every flash, we examined nearly a second of brainwave activity to capture the P300 signal and other possible responses. To better understand how the brain differentiates between desired and irrelevant characters, we compared responses to "target" flashes containing the user's chosen letter against "non-target" flashes. We measured how strongly these responses differed over time and across scalp locations, creating visual maps and plots to show where and when the P300 signal was strongest. These analyses help reveal the brain's attention and recognition processes during the task, and provide guidance for improving future BCI systems, such as making spelling faster or more accurate for users. In this poster, we present our data processing methods and results, highlighting what our findings reveal about how people use brain activity to select letters and interact with the speller. Our results show the potential of brain-computer interfaces to help people communicate and improve assistive tools.

Characterizing Pollution and Pore Deposition in the Taunton River Under Tidal Influence from Mount Hope Bay: Sediment Core Water Analysis

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This study investigates pollutant deposition and mobility in the lower part of Taunton River, a tidal estuary influenced by Mount Hope Bay, with a focus on legacy and ongoing contamination from urban and industrial sources in Fall River, Massachusetts. Sediment cores were collected in the Taunton River with gravity cylindrical cores samplers. Pore water was extracted from the sediment with Rhizon tubes (2mm) at various depths to evaluate the mobile fraction of analytes, nutrients and metal ions at each level. The sediment was extruded and sectioned by depth (5cm, ~700 cm^3 per section) to assess the vertical distribution of nutrients, metal contaminants, granular size, and organic carbon. Nutrient concentrations were determined by HACH spectrocolorimetric testing, metals by ICP-OES, XRF, sieving garnered granular separation, and carbon content by loss upon ignition. Results revealed stratification of contaminants are linked to estuarine salinity hydrodynamics, with elevated nutrient and metal concentrations occurring in zones of low salinity or salt wedge formation. Going from cite 1 (bottom of Taunton River) to cite 5 (top), there is a 4% decrease in salinity levels of the water and an estimated 200% increase of PO43- in the sediment. Deeper core layers near Fall River exhibited enrichment of phosphate and redox-sensitive metals (Pb, Zn, Zr, Cu), with average rates of 0.41 ppm PO_4^{3-}/cm and 6.63 ppm Zn/cm as you go down, indicating both legacy pollution and ongoing diagenetic processes. However, Fe and Mn showed opposite trends, as they were more abundant towards the shallower core layers, with average rates of -12,553 ppm Fe/cm and -200 ppm Mn/cm as you go down. Pore water analysis showed similar trends with depth for PO_4^{3-}, Fe, and Mn, with average rates of 0.42 ppm PO_4^{3-}/cm, -0.10 ppm Fe/cm, and -0.009 Mn/cm. However, there were no observed depth trends with the other redox-sensitive metals. These findings highlight the interplay between tidal forcing, sediment dynamics, and pollution persistence, emphasizing the need for integrated sediment and pore water analysis in estuarine monitoring and remediation strategies.

Following the Chemical Trail: Dual Insights into Metals and Organics in Estuarine Suspended and Filtered Phases

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A comprehensive series of transects were conducted from a southerly to northerly direction thru Mt. Hope Bay into its primary freshwater inflows—Kickemuit, Cole, Lee, and Taunton Rivers—to investigate spatial and vertical variability in water composition. At each sampling site, water was collected from three distinct depths (surface, mid-water, and near-bottom) to capture potential stratification and depth-related differences in chemical and physical properties. The collected water samples were subject to detailed analysis of suspended solids and turbidity levels, aiming to characterize the distribution and concentration of particulate matter throughout the estuarine system. To determine the surface adsorption of the filtrate, two complementary spectroscopic techniques were employed: Raman spectroscopy and DRIFTS spectroscopy. Raman spectroscopy did not yield conclusive results; however, DRIFTS-FTIR analysis identified spectral features consistent with phosphate (3400 cm^{-1}) indicating the presence of nutrient-associated compounds in the solid fraction. Iron filtrate concentrations were also quantified using XRF analysis and normalized to the dry mass of solids collected (58-381ppm/mg solid). The solid fraction retained on pre-weighed filters was further processed undergoing acid digestion, followed by elemental analysis by ICP-OES spectroscopy. ICP analysis identified the presence of several trace elements from the filtrate, including copper, zinc, phosphorus, and iron. These values were compared against the salinity gradient across sites, revealing an inverse relationship: phosphate was found to be more abundant in surface waters of lower salinity. Aqueous phosphate ion concentrations were determined by a Hach® spectrophotometric test (0.005-1.1ppm). Together, this data provides a multi-dimensional view of microfauna, debris, trace metals, and nutrients within the Mt. Hope Bay and its tributaries.

Abundant and Ubiquitous Drug- and Dye-modifying Azoreductase Activity in the Human Gut Microbiome

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The human gut microbiome is composed of trillions of microorganisms that are responsible for producing enzymes that can metabolize various types of xenobiotics we consume. Understanding the mechanisms and rates of these enzymes can improve health outcomes and treatment for various gut diseases, including colitis and cancer. One of the most prototypical examples of gut bacterial drug metabolism is by a family of enzymes known as azoreductases (AzoRs), which are responsible for reducing the nitrogen-nitrogen double bond found in certain xenobiotics. However, research on these proteins has primarily focused on those from model organisms, such as *E. coli*, while not characterizing those most commonly found in the human gut microbiome. Using a bioinformatic analysis of this family, we identified candidate azoreductases that are found in most individuals and in high abundance. We screened multiple of these AzoRs for solubility and activity. We then determined the kinetic parameters of those active enzymes by monitoring the change in absorbance over time, analyzing the reduction of various dyes and drugs. We kinetically characterized an AzoR from *Alistipes* sp. CHKCI003 (UniProt ID: A0A143XFE8, ACAzoR) with the food dyes amaranth and indigo carmine, the pH indicator ethyl red, and a quinone-like molecule, phenol blue. Indigo carmine exhibited the greatest catalytic efficiency with ACAzoR, with a kcat/Km value of 593,989 $M^{-1}s^{-1}$, followed by ethyl red with a catalytic efficiency of 307,080 $M^{-1}s^{-1}$, phenol blue followed with a kcat/Km of 203,720 $M^{-1}s^{-1}$, and amaranth was the least catalytically efficient with our enzyme with 9,511 $M^{-1}s^{-1}$. We have recently obtained a soluble and active AzoR from *Bacteroides xylanisolvans* and are further pursuing AzoRs from *Faecalibacterium prausnitzii*, Clostridium symbiosum, and Agathobacter rectali, representing the last set of commonly found AzoRs from the human gut. Characterization of these abundant and ubiquitous AzoRs can enable us to predict how their orthologs will react, while focusing on the most abundant and ubiquitous gut microbial proteins provides insight into reactions occurring in most people, which has the potential to aid personalized medicine.

Screening Azobenzene Derivatives to Determine Effects of Electronics on Azoreductase Mechanism

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Azo compounds constitute more than two thirds of all dyes synthesized for food, drug, and cosmetic purposes. Innate human enzymes have difficulty metabolizing these compounds, thus most synthetic azo dyes are not reduced until they encounter the human gut microbiome, which contains trillions of microbes that are able to modify both biotic and xenobiotic compounds using millions of different metabolic enzymes. The identity and relative abundance of bacteria in every human gut microbiome vary greatly between individuals and over time, further complicating how an individual may respond to a given therapy. Azoreductases (AzoRs) are a family of enzymes which reduce the azo double bond between two nitrogen atoms. Our group is working to synthesize 25 synthetic azobenzene compounds to test the mechanism behind how these bacterially-derived AzoRs reduce azo compounds.
First, we used UV-Vis spectroscopy to observe changes in concentration over time to identify a candidate azoreductase enzyme capable of reducing our library of synthetic azo compounds. After testing with 14 different dyes, we identified a Firmicute (now Bacillota) AzoR identified from metagenomic data with the UniProt ID R5RX41, that is capable of reducing each type of azo structure we intend to study. Next, we conducted kinetics testing with R5RX41 with three azo dyes, and we are analyzing how changes in the relative donating and withdrawing character affects these relative rates. By studying the mechanism behind how azo compounds are reduced by enzymes in the gut microbiome, we can begin to model what metabolites will be formed in these reactions and understand the role of azo compounds in gut health outcomes and overall impact on the human body.

Quantifying the Ability of the CF$_2$H Group as a Hydrogen Bond Donor

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The CF$_2$H group can act as a hydrogen bond donor, serving as a potential surrogate for the OH or SH groups but with a weaker hydrogen bond donation ability. Hydrogen bonding interactions are ubiquitous non-covalent forces in chemistry and biology. In canonical hydrogen bond (HB) donor-acceptor pairs, the donor typically comprises an electronegative heteroatom, such as oxygen, nitrogen, or sulfur, and a positively charged hydrogen atom, which interacts with a lone pair on the acceptor. Apart from these common heteroatom-containing hydrogen bond donors, certain carbon–hydrogen moieties can also act in this way, although in a substantially weaker capacity. Of particular interest is the difluoromethyl group, CF$_2$H, which exhibits hydrogen bond donating character due to the highly polarized F$_2$C–H bond. This functional group is often used to mimic hydroxy or thiol groups, but exhibiting slower acid dissociation and different lipophilicity. For these reasons, it is an attractive synthetic target and an important bioisostere in drug design and biochemical studies. Despite the value of these applications, few experimental studies have been conducted to quantify the thermodynamics of CF$_2$H group-mediated hydrogen bond interactions. Here, we describe a series of CF$_2$H group-containing moieties that facilitate strong hydrogen bond interactions. Experimental mechanistic studies and theoretical calculations of these constructs provide quantitative information about the strength of these interactions. We anticipate that this chemistry will be valuable for designing functional molecules for chemical biology and medicinal chemistry applications.

Investigation of G-protein Coupled Receptor Localization in the Primary Cilia

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The primary cilia are non-motile cellular structures that protrude from almost all eukaryotic cells. The cilia function in detecting and transducing extracellular signals, primarily via activation of G-protein coupled receptors (GPCRs) localized to these structures that evoke downstream cellular responses (Wachten, et al., 2021). Defects in these signaling pathways result in ciliopathies such as obesity, kidney disease, neurodevelopmental disorders, and others. Despite the prevalence of ciliopathies, there is not much known about the localization and trafficking of ciliary proteins. Melanocortin 4 receptor (MC4R) signaling in the brain is critical for the body's energy homeostasis. MC4R has been shown to be localized to the cilium, and disrupting its localization leads to obesity and hyperphagia (Wang, et al., 2023). Previous results from our lab showed that opsin 3 (OPN3) and the orphan G-protein coupled receptor 85 (GPR85) both interact with and modulate MC4R signaling (Haddad, et al. 2024). The goal of my project was to test the hypothesis that OPN3 is the negative regulator of MC4R in the cell membrane, while GPR85 is the negative regulator of MC4R signaling in the cilia, by investigating the cellular localization of OPN3 and GPR85 when expressed alone or together with MC4R. In this poster we confirm that SSTR3 (our positive control) localizes to the cilia while OPN3 (our negative control) does not. These preliminary findings will be the starting point for us to begin investigating where GPCR85 is located in relation to the cilia. I used NIH3T3 cells (immortalized mouse embryonic-derived fibroblasts) – a known cell model for cilia localization – to express our receptors of interest tagged with the fluorescent protein, mCherry. To investigate the subcellular localization of the GPCRs, cells were immunostained with antibodies against the common ciliary protein Arl13b and an antibody against mCherry to amplify the signal. Cells were visualized using fluorescent microscopy. As a positive control, I used SSTR3, a GPCR known to localize to the cilia (Berbari, et al., 2008). My preliminary results suggest that OPN3 is not localized to the cilia, while the localization of GPR85 is inconclusive. Future experiments will investigate how coexpression of MC4R with either OPN3 or GPC85 changes their cellular localization in NIH3T3 cells and immortalized hypothalamic neurons (GT1-7).

Mapping the Corticospinal Tract in a Neonatal Rabbit Using Pyramidal Tracer Injections as a Tool for a Better Understanding of Cerebral Palsy

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Cerebral palsy (CP) is a common motor disorder in children with approximately 1 in 345 children being diagnosed in the US. Among the known risk factors for cerebral palsy, hypoxic-ischemic (HI) injury has been extensively studied as a potential cause. HI injury during the perinatal period can disrupt the development and organization of descending motor pathways, particularly the corticospinal tract (CST).

The CST, which originates in the primary motor cortex and projects through the brainstem to the spinal cord, is critically involved in voluntary motor control and is commonly disrupted in CP. Despite its frequent involvement in CP, the precise alterations between the CST and spinal interneurons following HI injury are poorly understood. To study this question, we use a neonatal HI rabbit model, a well-established CP model that recapitulates key features of the human disorder. However, the trajectory and cortical origins of the CST remain poorly defined in neonatal rabbits. This anatomical gap limits our ability to investigate CST-specific contributions to motor deficits in CP.

In this study, pregnant rabbits undergo a surgical procedure that induces hypoxic-ischemic injury in developing kits. Following birth (P1), kits undergo perfusion fixation, after which brains and spinal cords are collected. Post fixation, we perform ventral injections of lipophilic dyes (DiO, DiD) directly into the pyramids of the medulla (where CST axons converge). These dyes are chosen for their ability to integrate into axonal membranes and travel bidirectionally along the tract over time, even in postmortem tissue. The goal is to trace the CST both rostrally to the primary motor cortex and caudally to the spinal cord.

Mapping the CST is essential for identifying the precise location of the primary motor cortex in neonatal rabbits; this is yet to be done at this age in this CP model. Knowing where the CST neurons are located allows us to modulate their activity and elucidate their role in modulation of spinal reflex circuits. In summary, our study establishes a critical neuroanatomical framework for studying CST organization and impairment in a translationally relevant neonatal rabbit model of CP.

Design of Surface-Modified Nanoparticles for Enhanced Brain Drug Delivery Across the Blood Brain Barrier

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The blood brain barrier (BBB) is a protective layer of endothelial cells that regulates substances transported into the brain. Although the BBB is an effective defense mechanism against toxins and harmful substances, it can be an obstacle to treating brain tumors as it can limit the amount of drug that is delivered to the affected area. Engineered nanoparticles (NPs) are a promising approach to crossing the BBB, as such particles have been shown to be effective carriers for chemotherapeutics. Drug-loaded NPs can be coated with a variety of substances, resulting in the modification of NP properties, such as their surface charge and particle size. Poly(ethylene glycol) (PEG)- and poly(vinyl alcohol) (PVA)-coated curcumin (CUR)-loaded NPs have the potential of crossing the BBB, as shown in previous studies. In this study, CUR was encapsulated as a model drug due to its fluorescent properties, allowing for ease in its detection for in vitro experiments. PEG and PVA were chosen as coatings due to their specific factors. PEG was chosen due to its ability to transport NPs across the BBB, while PVA was chosen primarily as a control factor due to its widespread use in similar research. The resulting NPs were shown to be approximately 200 nm in size, with zeta potential values corresponding to their coatings (-16.503 mV for PEG-coated NP and -5.112 mV for PVA-coated NP). CUR was also successfully loaded into both NP systems. Future work will evaluate the ability of the NPs to cross an in vitro BBB cell model to elucidate the impact of NP coating on their ability to effectively deliver drugs to the brain.

The Role of Social Factors in the Relationship Between Financial and Mental Distress Among U.S. Refugees

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Refugees are immigrants who migrate after facing government persecution or violence due to their nationality, religion, race, political opinion, or membership in a particular social group. Millions of refugees have resettled in the United States (US), including 100,034 who resettled in 2024. The US refugee resettlement program has helped meet the basic human needs of refugees who resettle in the US. Yet, it doesn't provide enough to support the comfortability of refugees. By year 20 of refugee resettlement, it's estimated they pay $21,000 more in taxes than they do in benefits (Evans & Fitzgerald, 2017). Emphasizing while refugees make significant contributions to the country, they only receive limited financial assistance needed to adjust to a new life in a new country, besides basic government assistance such as welfare, SSI, food stamps, etc. (Evans & Fitzgerald, 2017). Leaving refugees with financial burdens and stress. This quantitative study analyzed data shared on Excel by a nonprofit organization located in Rhode Island. The dependent variable being mental distress, which was measured with the RHS-15 surveys—including 14 separate items that measure mental distress using a five-item Likert-style scale (0=not at all; 4=extremely). The independent variable measured is financial stress (0 = No; 1 = Yes). Researchers analyzed clinical case notes that indicated financial stress. The sample includes n=328 refugees. The mean age is M=34 (SD=12.7). Among respondents, 54.6% identify as male and 45.4% identify as female. A chi-square test revealed more male refugees report financial stress (63.37%) compared to female refugees (36.63%) ($p<0.05$). Financial stress was prevalent for refugees from Nicaragua (81.82%) and Venezuela (69.23%). A Mann-Whitney U-test revealed female refugees report greater mental distress (M=11.47; SD=10.70) compared to male refugees (M=7.93; SD=8.01) ($p<.05$). A Mann–Whitney U-test revealed refugees who report financial stress report greater mental distress (M=10.4; SD=9.1) compared to refugees who did not report financial stress (M=9.2; SD=9.6) ($p <0.05$). The results suggest that financial stability may be a buffer for mental distress and that male refugees experience greater financial stress compared to female refugees. One possible explanation for this finding is the social and cultural expectations that influence gender dynamics within family systems and who is responsible to provide for their family, either here in the US or back in

Modulation of Intracellular Fluorescence using a Biomolecule DNA- SWCNT Corona Complex

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When entering a biological system, nanoparticles and carbon nanotubes will absorb proteins and biomolecules to its surface. The selective binding of proteins to nanomaterials is governed by molecular properties, such as charge and hydrophobicity, rather than abundance. This process forms a biomolecular corona complex, that alters uptake, fluorescence, and intracellular processing of DNA wrapped single walled carbon nanotubes (DNA-SWCNTs). To understand how individual proteins contribute to the intracellular fate of DNA-SWCNT, this study was designed to simulate the in vivo environment containing hundreds of complex biomolecules, each with differing functions such as cellular signaling and endosome trafficking. We control the biomolecular corona using select proteins, such as Bovine Serum Albumin and Ubiquitin, and observe fluorescence changes and retention based on protein type. This allows us to observe how the corona complex contributes to the intracellular processing and internalization of DNA SWCNTs.

Small Molecule Modulation of AP Endonuclease 1

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Apurinic/apyrimidinic endodeoxyribonuclease 1 (APE1) is a multifunctional enzyme essential in maintaining genomic stability by responding to oxidative stress. Its primary roles include DNA damage repair, specifically through the Base Excision Repair (BER) pathway, and transcription regulation via redox control of key transcription factors. Within the BER pathway, APE1 functions as both an endonuclease of apurinic/apyrimidinic (AP) sites and a 3'-5' exonuclease. APE1 is frequently overexpressed in cancer cells, where it can counteract the effects of treatment-induced DNA-damage which contributes to drug resistance. Therefore, sensitizing cells through inhibition of APE1 poses potential chemotherapeutic applications. This study focuses on the 3'–5' exonuclease activity of APE1, a nominally-defined function believed to contribute to proofreading during the BER pathway. Specifically, we report the modulation of APE1 by the small organic molecules (2E)-2-[(4,5-Dimethoxy-2-methyl-3,6-dioxo-1,4-cyclohexadien-1-yl)methylene]-undecanoic acid (E3330) and dimethyl sulfoxide (DMSO). While E3330 is marketed as selectively inhibiting APE1's redox activity without affecting its DNA repair function, previous structural and biochemical evidence suggests otherwise. A fluorescence assay using dual-labeled DNA beacons was developed to monitor and quantify APE1 activity under optimal reagent conditions. APE1-mediated digestion of the beacon from the 3' end separates the quencher (Dabcyl) from the fluorophore (FAM), resulting in an increase in fluorescence. In the presence of E3330, fluorescent signal was significantly reduced; indicating inhibition of APE1's exonuclease activity. This is consistent with reports that E3330 binds within the active site while not interacting with catalytic residues. In contrast, DMSO enhances APE1 activity, theoretically through denaturing the intrinsically disordered domain which could increase access to the active site. These findings challenge current claims regarding the specificity of E3330 and suggest that DMSO may act as a positive modulator of APE1 exonuclease activity.

Expression and Purification of Recombinant Human APE1 for Biochemical Analysis

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Oxidative stress arises from an imbalance between the generation and detoxification of reactive oxygen species (ROS), leading to cellular and tissue damage. This condition is implicated in the pathogenesis of various human diseases, including cancer. A critical component of the cellular response to oxidative DNA damage is apurinic/apyrimidinic endodeoxyribonuclease 1 (APE1), a multifunctional enzyme predominantly localized in the nucleus. APE1 plays a central role in the base excision repair (BER) pathway and is also involved in redox regulation, RNA processing, and gene expression modulation of genes directly regulated by transcription factors. This study reports the expression and purification of recombinant human APE1. The APE1 gene was cloned into the pDEST17 expression vector (ThermoFisher Scientific), which contains an N-terminal 6X-His epitope tag, and transformed into *E. coli* strain C41(DE3) (Millipore Sigma). Cultures were grown to mid-log phase (OD_{600} = 0.4–0.8) at 37°C, followed by induction with 0.5 mM IPTG and incubation at 20°C for 18–20 hours. Recombinant APE1 was purified using nickel-nitrilotriacetic acid (Ni-NTA) affinity chromatography, followed by optional size-exclusion chromatography for further purification. The purity, molecular weight, and enzymatic activity of the protein were evaluated using SDS-PAGE and fluorescence-based assays. The results confirmed the successful production of a functionally active and highly pure APE1 preparation, suitable for downstream biochemical and structural studies.

Modeling of Synaptic Degeneration Predicts Stage Specific Cognitive Markers in Dementia

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Dementia-related disorders are a common form of neurological condition, with 10 million new cases reported a year. These diseases have associated risk factors specific to their pathologies, from extracellular protein deposits to genetic predispositions. All of these disorders are characterized by memory loss, with distinctions ranging from specific cognitive and social function impairments to motor issues. Disease progression and the degree of impairment can differ between disorders and individuals. Synaptic degeneration is currently seen as one of the mechanisms behind dementia disorders, specifically Alzheimer's. This synaptic degeneration can be used in the designing of simulation models used to look at the equations that mark the normal functioning of synapses (Grossberg's presynaptic rule and Hebb's rule, for instance). This study focuses on building a model used for creating a dataset filled with the data that comes from a simulated Alzheimer's memory study, looking at task completion at different stages of Alzheimer's Disease (mirroring dementia disorders in general). This was done in Python using different codes that defined the parameters of the model, mainly including the synaptic degeneration rates. It also worked to help define the different stages of Alzheimer's being looked at in the study and define ranges that model what is seen in the world when it comes to study participants. The model also accounted for random differences between the "users" or "participants" and used a constant for handling biological noise in order to maintain variability. Once the data sets were created, they were then taken over to Orange and run through different regression models, which were tested and scored based on their performances after being trained on and tested on the simulated data. Then a data set containing the information from participants from a separate dementia study was put through the model, which was able to, based on the simulated data set, accurately predict whether or not the participant in the study had dementia or not and assign them a specific stage of cognitive decline based on the simulated data.

Comparing Reinforcement Learning in Controlled and Naturalistic Contexts Using Eye-Tracking

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Reinforcement learning (RL) research often relies on probabilistic learning tasks to understand how humans acquire and adapt behaviors based on feedback. Traditionally, these tasks take the form of simple experimental games to facilitate data collection in controlled settings. However, observing how reinforcement learning can occur in natural settings requires tasks that simulate real-world decision-making. In this project, we compare performance on an RL task with the common experimental design and a second task meant to simulate a more realistic/naturalistic context to investigate how learning mechanisms differ across contexts. We collected eye-tracking data to further understand the cognitive and neural bases of these learning processes.

The first task uses a conventional experimental design in which participants choose among three colored shapes (e.g., red triangle, blue circle, green square), each offering outcomes of +1, 0, or -1 points. The reward contingency depends on either the color or shape and remains fixed across blocks of trials. The second task mirrors this structure but contextualizes participants in a more relatable setting, choosing among options in a cupcake-baking narrative choose-your-own-adventure story. Participants choose between different colored cabinets (orange, blue, green), different-shaped containers, different fridge shelf positions etc., with outcomes following the same reinforcement structure as Task 1. Both tasks include five sets of seven trials. We previously tested behavioral-only versions of both tasks in separate samples (N=35, N= 152) and we report here a pilot study (N=5) testing the joint design with participants completing both tasks sequentially.

Preliminary results showed learning in both tasks, with average accuracies significantly higher later in each game. Gaze and pupil data in the first task were consistent with faster decision times and less information seeking after learning. Ongoing data analysis comparing learning and gaze patterns across tasks may shed potential insight into how RL processes change in theoretical versus naturalistic settings.

Nighttime Blood Pressure Responses to Acute Heat and Exercise Exposure in Individuals with Elevated Blood Pressure

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Nighttime blood pressure (BP) is an important indicator of cardiovascular health. The overnight fall in BP, known as nocturnal dipping, is defined as the difference between mean daytime and mean nighttime pressures, where a 10-20% dip is considered optimal. Acute aerobic exercise causes a temporary decrease in blood pressure (post-exercise hypotension), and acute heat exposure results in a similar transient decrease in pressure. However, the impact of the combination of exercise and heat exposure on nighttime BP is unknown. PURPOSE: To examine the effectiveness of acute heat and exercise exposure on pre-hypertensive individuals in reducing nocturnal blood pressure. METHODS: 12 volunteers with elevated blood pressure (>120/80mmHg) took part in four randomized trials consisting of aerobic exercise (30 minutes of moderate-intensity treadmill walking) followed by leg heating (45 minutes in 42°C water; EXHT), exercise followed by sham leg immersion (45 minutes in 34°C water; EX), leg heating alone (45 minutes in 42°C water; HT), or control conditions (no exercise or heat exposure; CON). Before each treatment, baseline BP measurements were recorded, and volunteers were instrumented with an ambulatory BP cuff which measured BP hourly after each trial. Average nighttime BP was calculated from 12-4am for Systolic BP (SBP) and Diastolic BP (DBP). RESULTS: Daytime SBP was elevated (126±4mmHg) and decreased significantly during sleep in all trials. Larger decreases were observed following EX (-22±4mmHg) and EXHT (-22±4mmHg) compared to CON (-18±3mmHg) and HT (-16±3mmHg). Daytime DBP (72±3mmHg) decreased significantly during sleep in all trials, but nighttime DBP (62±2mmHg) did not differ significantly between groups. CONCLUSION: BP following EX and EXHT tended to decrease more during sleep, emphasizing the importance of exercise as an effective means of managing BP. In contrast, the smallest decrease between daytime and nighttime occurred following HT, suggesting that heat exposure is most effective in combination with exercise. Hourly patterns of overnight BP measurements may reveal differences in the pattern and duration of nocturnal dipping, requiring further analysis.

The Impact of Combined Exercise and Heat Exposure on Heart Rate Variability

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Heart rate variability (HRV) is a measure used to examine cardiovascular health and the function of the autonomic nervous system. It has been recognized that a bout of exercise or heat exposure can lower HRV short term, but exercise training or repeated heat exposure can increase (improve) HRV and cardiovascular function. It is unclear what effect post-exercise heat exposure has on HRV compared to either standalone treatment. Purpose: To examine the effects that acute heat and/or moderate exercise exposure have on HRV.

 Methods:14 adult participants with slightly elevated blood pressure (>120/80mmHg) underwent four separate trials where we measured cardiovascular responses to moderate aerobic exercise (30 minutes treadmill walking) followed by 45 minutes of leg heating in hot water (42C; ExHT), exercise followed by a 45-minute sham leg immersion in lukewarm water (35C; Ex), leg heating alone in hot water (45 minutes at 42C; HT), or control (no exercise or heat exposure; CON). After their designated treatment of the day, participants rested in the supine position while HRV and blood pressure was assessed during 5 minutes of paced breathing (12 breaths per minute), and analyzed using LabChart HRV analysis for mean R-to-R interval (RRI), root mean square of successive differences (rMSSD), and low-to-high frequency ratio (LF/HF). Results: There were no significant differences in RRI (CON=909.2±35.6, Ex=924.1±34, HT=927.8±32.7, ExHT=894.3±35.3), or LF/HF ratio (CON=0.40±0.07, Ex= 0.35±0.06, HT=0.50±0.08, ExHT=0.58±0.11) between the different treatments. In contrast, there was a slight increase in rMSSD (ExHT=106.4±28.8) compared to all other treatments (CON=82.3±15.6, Ex= 89.5±13.6, HT=75.0±12.0).

Conclusions: With no differences in RRI, data shows that the various treatments don't significantly impact heart rate. The increase in rMSSD in ExHT supports the idea that exercise followed by leg heating in hot water can improve HRV. In the future, we can continue to look at these differences across a larger tested population. Monitoring the effects on these variables for a longer period after the trials could also allow us to gain a better understanding of how these treatments impact HRV.

Mechanism of Ionic Transport in Transcranial Electrical Stimulation of Neurodegenerative Diseases through Computational Mathematical Modeling

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Parkinson's Disease (PD) is a highly prevalent neurodegenerative disease distinguished by distinct motor and non-motor characteristics including tremors, gait instability, and dysautonomia. Forms of neurostimulation, in particular transcranial electrical stimulation (TES), have been demonstrated to be an effective and promising non-invasive intervention to address PD symptoms. Despite demonstrating clinical efficiency, the underlying processes by which TES operates to remedy neurodegenerative symptoms remain largely unknown. To address this challenge, we have implemented a series of mathematical models as a way to investigate this domain using computer-based approaches and simulation techniques. Specifically, a Hodgkin–Huxley based model of the electrodynamic characteristics of PD and TES treatments was developed; this was achieved by incorporating calcium transmembrane transport, appropriate voltage-gated calcium channels, cellular conditions that emulate PD pathogenesis, and voltage properties of TES. By comparing simulations of these models to those of a healthy cell, results demonstrate that T-type calcium channels are predominately responsible for calcium transport resulting from TES. In addition, TES yields an influx of calcium-based current, and with proper controls, can resemble levels observed in healthy neurons. Finally, preliminary analyses suggest that alternative forms of neurostimulation, such as deep brain stimulation, operate primarily on different calcium channels, including N-type and L-type. Our aim has been to help identify cellular mechanisms influenced by TES therapies, and in addition, to provide an approach that supports in-silico experiments in the development of treatments for neurodegenerative disease.

Repetitive Negative Thoughts Meta-analysis

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Metacognitive beliefs refer to beliefs people have about their own thoughts. Metacognitive beliefs have been studied in relation to several forms of repetitive negative thought (RNT) associated with anxiety and mood disorders, including obsessions (OCD), worry (GAD), and rumination (depression). Metacognitive beliefs have traditionally been studied using disorder-specific measures, the most common of which are the Metacognitions Questionnaire (MCQ; worry and GAD), the Obsessional Beliefs Questionnaire (OBQ; obsessions and OCD), and the Positive/Negative Beliefs about Rumination Scale (PBRS/NBRS; rumination and depression). This study aims to see how strongly each type of thought (obsessions, worry, rumination) relates to each belief measured on the Metacognitions Questionnaire. The beliefs measured on the Metacognitions Questionnaire include positive beliefs about worry, uncontrollability and danger of thoughts, cognitive confidence, need to control thoughts, and cognitive self-consciousness.

A systematic literature review was conducted to find all studies reporting the correlation (Pearson's r) between the MCQ and any measure of obsessions, worry, or rumination. We completed a separate meta analysis for each thought type (obsession, worry, rumination) and belief on the MCQ, using Pearson's r as the effect size (weighted by the sample size of each study). Two-tailed p-values were calculated to find if the effect size differences were statistically significant between each type of RNT.

Results show the metacognitive belief of uncontrollability and danger most highly correlates to all thought types (obsessions, worry, ruminations) across all subscales. This result supports the idea that obsessions, worry, and rumination may share important metacognitive beliefs that can help to explain distress associated with these thought types, especially the idea that thoughts are uncontrollable and dangerous. This analysis on the MCQ is the first step in a larger meta analysis which will further investigate how strongly each type of thought is related to each belief assessed by the OBQ and PBRS/NBRS in addition to the MCQ. This will tell us which metacognitive beliefs are similar and different across the three thought types (obsessions, worry, rumination), and whether the relationship of RNT and metacognitions differs depending on which measure is used.

Uncovering the Chemical Footprint of *Phaeobacter inhibens* S4

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Bacteria are a vital component in modern medicine as they are the source of numerous medication discoveries. *Phaeobacter inhibens* S4, isolated from healthy adult oysters, is a probiotic marine bacterium that has shown promise to protect oyster larvae from bacterial infections. This bacterial strain produces quorum-sensing homoserine lactones and the antimicrobial tropoditiethic acid (TDA). The objective of this study is to identify additional biologically active metabolites to more fully understand the molecular mechanisms responsible for the probiotic activity of S4. *Phaeobacter inhibens* S4 was grown in YP30 broth for 8 days. The metabolites were separated from the bacteria by centrifuging the media, then isolated from the supernatant utilizing solid-phase extraction (SPE). Different compounds were eluted from the SPE cartridge using 10% and 50% acetonitrile in water, 100% acetonitrile, and then profiled using HPLC. Based on a particular interest, a metabolite in the 50% and 100% ACN extracts was isolated via HPLC. The isolated compound was analyzed using HPLC, and structurally elucidated using mass spectrometry, and nuclear magnetic resonance (NMR) spectroscopy. The compound was a solid crystal with an off-white color, and UV λmax of 262. Mass spectrometric analysis showed an m/z of 284.38 in the positive ion mode. The compound is currently being disreplicated through further analysis. Our findings are expanding the chemical library of the *Phaeobacter inhibens* S4. Moreover, they provide insight into the chemical ecology of the probiont.

Drosophila sod1 Mutants Show a Reduction in Lipid Storage

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ALS is a neurodegenerative disease that results in the progressive degeneration of motor neurons and can be caused by mutations in superoxide dismutase 1 (*sod1*). Although not well established, changes in lipid metabolism have been reported in individuals afflicted with the disease. To begin to characterize changes in lipid metabolism in ALS, we investigated lipid droplet content in a *Drosophila sod1* model of ALS. To characterize lipid content in *sod1* mutants, we used LipidTox staining and confocal microscopy to quantify lipid droplet characteristics in fat body cells. Results indicated a dramatic change in lipid content in the sod1 mutants, demonstrating 45% smaller and > 50% reduction lipid droplets compared to controls. We also notably found that *sod1* mutants are dehydration sensitive. To determine whether dehydration is also associated with changes in lipid metabolism we analyzed lipid droplet formation in other tissues in the presence and absence of dehydrative states. We observed lipid droplet formation in skeletal muscle of dehydrated sod1 mutants compared to the absence of lipid droplets in hydrated mutants. Our analysis of dehydrated *sod1* mutants further suggests changes in lipid metabolism in myocytes, a cell type directly impacted by ALS. These findings indicate changes in lipid metabolism are associated with mutations in *sod1* mutants, which are exacerbated upon dehydration stress.

Applying a Mathematical Model to Define Underlying Mechanisms of DNA Polymerase (POLQ) in DNA Replication and Repair.

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DNA is affected by numerous endogenous and exogenous factors commonly leading to genomic instability and disease. DNA polymerases play a critical role in mitigating such damage through replication and repair pathways. Structurally, DNA polymerases are composed of three subdomains, fingers, thumb, and palm, resembling a right hand gripping a rod. The fingers domain facilitates alignment and incorporation of the incoming nucleotide, the thumb stabilizes DNA binding, and the palm contains the active site where phosphodiester bond formation occurs. POLQ (DNA polymerase theta or Pol θ) is frequently over expressed in patients with melanoma and numerous point mutations have been identified in cancer patients in each of the protein's subdomain. Biochemical studies have revealed that polymerase variants often experience altered rates of polymerization as well as lower fidelity and further mutagenesis. To investigate functional mechanistic differences between wild-type (WT) Pol θ and its variants, we employed DNA labeled with 2-aminopurine (2-AP), a fluorescent base analog whose signal is quenched upon stacking and conformational changes such as finger domain closure. The labeled DNA was analyzed with Pol θ under varying nucleotide concentrations to further probe the biochemical mechanisms at the active site during incorporation in real-time using a stopped-flow instrument. This allows visualization of a change in fluorescence at the site of nucleotide insertion. Although differences between WT and mutant signals were apparent, the biochemical processes for these differences remained unclear. To understand what is physically occurring, we applied a mathematical model to identify potential steps during incorporation and quantify differences in functionality. A 3-parameter growth and decay logistic-sigmoid function was used to fit experimental data. Three parameters logistic functions have applications that span biology to machine learning. These three parameters are usually an asymptote, a rate parameter, and a time constant. A double logistic-sigmoid function is flexible and ideal for fitting our fluorescence signal that exponentially rises, plateaus, and then exponentially decays into a horizontal asymptote. We hypothesize that by fitting our data to a double logistic-sigmoid equation we can derive novel insights into the underlying properties of Pol θ and its variants that drive DNA repair and carcinogenesis.

Exploring the Biochemical Properties of Patient-Derived DNA Polymerase Theta Mutants via Site-Directed Mutagenesis in *E. coli* Bacteria

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DNA Polymerase Theta (known as POLQ or Pol θ) is an enzyme responsible for repairing damaged DNA. While it is relatively error-prone compared to other DNA polymerases, Pol θ is necessary for cell survival as the primary DNA polymerase in the microhomology-mediated end joining (MMEJ) pathway, a key method for repairing double-strand breaks. The enzyme is of considerable importance in cancer research as it has been shown to be upregulated in several cancers leading to poor prognosis in patients. A recent study identified key mutations in *POLQ* from patients with melanoma and biochemical studies suggest altered DNA repair. This study investigates two novel mutations in the *POLQ* gene, P2279S and R2228I, found in cBIOportal, a database of mutations found in cancer patients, following DNA sequencing. P2279S was found in a patient with serous ovarian cancer and R2228I was found in a patient with a colon adenocarcinoma. Because of the types of cancer and specific amino acid locations, these mutations were predicted to have considerable effects on the protein structure and resultant function. For this study, we generated the mutations using site-directed mutagenesis in *E. coli* bacteria with the ultimate goal of studying the DNA repair abilities of these Pol θ variants in an effort to understand the possible relationship of Pol θ on cancer through its altered DNA repair capabilities. Understanding the effects of these mutations will enhance understanding of the significance of Pol θ in certain cancer pathways and help improve cancer treatment.

Gene Expression in *Tetrahymena pyriformis* After Exposure to Cadmium

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Tetrahymena pyriformis is a ciliated protist found in nearly all freshwater ecosystems and often used in toxicology research. In this study we exposed *T. pyriformis* to varying concentrations of cadmium (0.4µM, 4.0µM, 40µM) for either 1 hour or 24 hours. We examined expression of several genes involved in metal homeostasis including metallothionein (*MT1* & *MT2*) and metal transport genes (*ZIP6* & *HM1*) to better understand how *T. pyriformis* responds to metal stress. Cells in log growth phase were exposed; RNA isolated, and quantitative PCR was used to amplify the genes of interest. After 1h cells exposed to 0.4µM Cd showed significantly higher *MT1* gene expression, while cells exposed to 40µM Cd showed significantly higher *MT2* gene expression. After 1h exposure there were no significant differences in *HM1* & *ZIP 6* expression. After 24h, cells exposed to all cadmium concentrations showed significantly higher *MT1* gene expression. After 24h cells exposed to 0.4µM Cd show significantly higher *MT2* gene expression. After 24h exposure, cells exposed to 0.4µM Cd show significantly higher *Zip* and *HM1* gene expression. Collectively this data shows a unique pattern of gene expression in response to cadmium, balancing sequestration of metals and metal export. This study illustrates how *T. pyriformis* maintains homeostasis in a stressed environment. Future work will examine other heavy metals, and combinations of abiotic stressors.

The Coracomandibularis and Its Impacts on Jaw Opening in *Chiloscyllium plagiosum* and *Squalus acanthias*.

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This research investigates the musculoskeletal morphology and mechanics associated with jaw opening in an obligate suction feeding shark, *Chiloscyllium plagiosum* and a species that is a feeding generalist (uses suction, ram and/or bite feeding), *Squalus acanthias*. The goal of this research is to better understand how the shape of the coracomandibularis (CM), which is the main jaw opening muscle, may influence force output to meet the power needs for suction capture. In both species, the fiber morphology is similar, yet in *C. plagiosum* the muscle cross-sectional area is significantly larger. This species can generate similar suction forces to other fish while seemingly using less muscle groups to do so. Of the potential ways to explain why this disparity exists, our data suggests that it is not simply increased muscle size, but a combination of that and changes in muscle leverage resulting from the hyoid arch pushing into the muscle during jaw opening to a much greater degree than in *S. acanthias*.

Mutagenizing the Antitoxin MqsA to Identify the Lon Protease Degron in *Escherichia coli*

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Bacteria use Toxin-Antitoxin (TA) systems to respond to and survive environmental stress. In Type II TA systems, under normal conditions an antitoxin binds to and sequesters a toxin to inhibit its effects. However, introducing stress induces proteases to degrade the antitoxin, releasing the toxin and disrupting cellular processes. Although TA systems have been implicated in being important for persister cell and biofilm formation, the mechanisms behind antitoxin degradation and toxin release are not fully understood. In *Escherichia coli*, the MqsRA Type II TA system is activated under stress. MqsR is a ribonuclease toxin that binds to MqsA, the antitoxin, near a zinc-coordinated tetracysteine motif. During stress, MqsA is degraded by the proteases ClpXP and Lon, and accessibility of the ClpX recognition motif, or degron, is dependent on zinc occupancy. To monitor MqsA degradation in vivo, we developed an antibiotic chase assay using a fast-folding variant of green fluorescent protein (Gfpuv3), fused to MqsA, to monitor degradation in real time. To identify residues important for proteolytic recognition and degradation by Lon, we performed site directed mutagenesis to introduce a mutation at phenylalanine 22 of MqsA, an aromatic residue potentially important for Lon recognition. A Gfp-MqsA variant containing the mutation will be evaluated for Lon-dependent turnover in vivo and in vitro. This work gives insight into how *E. coli* responds to stress, potentially informing the development of novel antibiotics.

Investigating the Effect of Phosphomimetic Mutation on StarD6 Function

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Alzheimer's Disease (AD) is characterized by difficulty with memory and impaired communication and motor skills in later stages. Although beta-amyloid plaques and tau tangles form in the brain in patients with AD, the underlying cause for these abnormalities has yet to be discovered, making research surrounding it extremely important. Recently, a SNP in the promoter region of the STARD6 gene has been deemed a risk factor for AD. StarD6, or StAR-related lipid transfer protein 6 is expressed in the nervous system of mice and rats, specifically increasing with age or after injury. Previous studies have suggested that StarD6 is phosphorylated at serine 36 (S36) and serine 40 (S40), both residues potential targets of the kinase protein kinase. C (PKC). We used NetPhos 3.1 to determine whether any additional serine or threonine residues are potential targets of PKC, and found the following residues: S30, T29, T34, T68, S37, T73, T91, T96, S100, S129, S210 . We hypothesize that phosphomimetic mutation of these residues will alter the binding affinity of StarD6 ligands such as testosterone. To test this hypothesis, we used site-directed mutagenesis to change the serine at position 30 (S30) to the negatively charged aspartic acid (D) to imitate natural phosphorylation. After purifying the protein, we used differential scanning fluorimetry to monitor ligand binding for both wild-type StarD6 and StarD6-S30D . Future studies will repeat this process for the remaining residues that are predicted PKC targets.

Investigating the Impact of Chronic Isolation on Alcohol Consumption

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Social interactions and the development of social bonds are considered a basic human need equivalent to the need for food, water, sleep, and shelter. The absence of social interactions can have significant mental and physical health consequences. For example, reports suggest that social isolation or loneliness in humans is associated with increased risk of depression, anxiety, suicide, premature death, and the development of alcohol use disorder. Understanding the impact of social isolation is particularly important in a post-pandemic world where millions of people have experienced chronic social isolation. Notably, the need for social interactions is not unique to humans; a multitude of organisms exhibit social behavior, ranging from humans to rodents and fruit flies. In humans and mice research suggests that social isolation induces activity in brain regions associated with hunger cravings. Similarly, chronic isolation disrupts sleeping patterns and increases the expression of genes that signal starvation in fruit flies. However, precisely how chronic social isolation impacts alcohol related behaviors are not well understood. Fruit flies are an ideal model organism to study the impact of social isolation on the brain and behavior because they have a simple nervous system that supports complex behaviors, they have a short life cycle, but reproduce in large numbers, and can be genetically modified in a variety of ways. Here we capitalize on the fruit fly to investigate the effects of chronic isolation on drinking behaviors. Specifically, we measured the effects of chronic social isolation following a rich social experience on consumption of either sucrose or alcohol. voluntary alcohol consumption. Flies were first provided with a rich social experience for 3 days and then either isolated for seven days or housed in groups. Subsequently, flies were placed in the Fly Liquid-Food Interaction Counter to continuously measure feeding behaviors for three hours or 24 hours. Preliminary data suggest that in the three-hour two-choice assay, socially isolated flies consume more sucrose and engage in significantly longer alcohol drinking bouts compared to controls. In the 24-hour two-choice assay, isolated flies also consume more alcohol overall and develop a preference for alcohol more rapidly. These findings offer valuable insight into how social isolation influences brain function and behavior, particularly in the context of alcohol.

As a Component of Aseptic Technique, Bunsen Burners Do Not Decrease Airborne Microbial Contamination

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When working with microorganisms, some researchers use a Bunsen burner to push contaminated air upwards and away from the workspace, theoretically creating a zone of sterility. This practice is suggested by published manuscripts and research institutions alike. Surprisingly, investigation of Bunsen burner usage in scientific literature has revealed a dearth of experimental evidence. We conducted a series of laboratory experiments to determine the efficacy of this method, hypothesizing that the flame will reduce airborne contamination. One day prior to experimentation, pre-sterilized shop towels were immersed in high-density *Gordonia rubripertincta* liquid cultures, then gently wrung out. Each towel was left to dry on the benchtop overnight for use in the next day's experiments. For each trial, a microbe-laden towel was shaken above a laboratory workbench for sixty seconds to disperse microbes in the air. Paired data were collected by situating, at the same workbench, an unlit Bunsen burner at a "control" station across from an active Bunsen burner at a "test" station. At the "test" station, the Bunsen burner was lit at the 0-minute mark and remained continuously on for the duration of the data collection period. Petri plates were positioned at a 10 cm radius from their respective Bunsen burners. Lids were removed for one minute to collect *G. rubripertincta* that were settling on the benchtop. This process was repeated at two-minute intervals over a total twelve-minute period, resulting in six data points per trial. Petri plates were then incubated at 30 ℃ for 72 hours, after which the colonies on each plate were counted. There is a positive correlation between contamination observed on flame and without flame plates. For a standard 1.8 cm Bunsen burner, the line of best fit has a slope of 1.02, 95% CI [0.93, 1.10], and is not statistically distinguishable from 1.00. For a large 3.9 cm Bunsen burner, the data are better fit by a nonlinear curve. For both burner sizes, the relative contamination rate (flame/without flame) is greater than 1 at low contamination levels, but as baseline contamination rates increase, the ratio becomes approximately 1. Neither Bunsen burner decreased airborne contamination for the majority of tested parameters. However, the large Bunsen burner may reduce contamination at high microbial loads. Therefore, we find little to no experimental evidence that Bunsen burners create an atmospheric zone of sterility.

Profiles & Peroxide: Transcriptional Program of Super Shed *E. coli* O157:H7 Results in Increased Resistance to Hydrogen Peroxide

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Enterohermorrhagic *Escherichia coli* (EHEC) serovar O157:H7 (Ec-O157:H7) is a shiga-toxin producing *E. coli* (STEC), the secretion of which is responsible for symptoms of its infection including bloody diarrhea and hemolytic uremic syndrome (HUS). Cattle serve as the primary and asymptomatic reservoir for O157:H7, which colonize their recto-anal junction (RAJ). While cattle typically shed EHEC at a rate of approx. 100 CFU/g of feces, super-shedders (SS) excrete more than 1.0×10^4 CFU/g. This SS phenotype greatly increases environmental burden and raises the risk of transmission. Two strains of Ec-O157:H7, an SS (SS17) and a non-SS (EDL933) attached to bovine RAJ squamous epithelial (RSE) cells were subjected to RNA sequencing (RNAseq) and comparative transcriptomics. The comparison of RSE cell-adherent SS17 and EDL933 transcriptomes revealed SS17 upregulates several genes involved in iron acquisition/metabolism, stress responses, and transport in comparison to EDL933. Genes that are downregulated in SS17 include those involved in metabolism, host interactions/virulence, and translation. Of particular interest was the observed upregulation of *katG*, a bifunctional catalase and peroxidase alongside the upregulation of iron acquisition genes and whether or not this change would result in an increased resistance to hydrogen peroxide. To test if this increased expression of *katG* and/or iron acquisition genes altered the isolates' response to oxidative stress, SS17 and EDL933 were grown in the presence of various concentrations of hydrogen peroxide. At 35mM hydrogen peroxide, SS17 showed resilience to cell killing by increasing in turbidity and cell viability, whereas EDL933 does not. Despite this breakpoint, both strains showed remarkable resistance to killing by H_2O_2 compared to the K12 lab strain, which exhibits cell death at 1mM. These results show yet another unique trait associated with the SS phenotype that also increases their survivability and potential for transmission, infection, and disease by being able to overcome a fundamental aspect of eukaryotic immunity.

The Impacts of Pregnancy, Maternal Experience, and Prenatal Stress on Motivated Behavior Amidst Environmental Threat

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All organisms must balance competing incentives to navigate dynamic environments. Pregnancy, nurturing offspring, and prenatal stress elicit remarkable changes to the nervous and endocrine systems, though how these changes affect the balance between competing motivations is less clear. In this project, we used a mouse model to ask how female mice prioritize the competing needs of hunger and fear in pregnancy and after delivery of the litter, and how prenatal exposure to predator odor affects motivated behavior across juvenile development. To assess the balance between these competing needs, we employed a predator odor assay in which hungry mice were placed in an apparatus in which food was only available adjacent to the predator odor trimethylthiazoline (TMT). Mated females were run on this assay in ad libitum fed and food-deprived conditions both once pregnancy was confirmed and again 10-15 days after delivery of the litter. Virgin controls were run at matching time intervals. We found that mated mice consumed significantly less food on this assay post-partum compared to during pregnancy, with no difference between the two phases in virgin controls. To explore how a third motivation–the presence of the dam's pups–affects the balance of competing motivations, we performed a second experiment in which the nest with pups was placed at the end of the chamber opposite the TMT and food. Each dam was paired with a virgin control to assess how maternity affected both food consumption and maternal behaviors in this assay. Although food consumption was similar between groups, virgin controls exhibited a greater degree of nurturing behaviors toward pups, suggesting that the presence of predator odor diminishes maternal behaviors in dams. In the third phase of this experiment we asked how the mated females' exposure to predator odor affects the motivated behavior of their offspring. Beginning at postnatal day (PND) 25 and every 15 days until PND 85, we ran juveniles exposed to TMT in utero and a group of stress-naive juveniles as a control on a series of assays assessing motivated behavior. While mobility in the tail suspension test and locomotion in the open field was largely similar between groups, non-significant trends suggested that in early juvenility prenatally stressed mice may exhibit hyper-responsivity to TMT in the predator odor assay. Collectively, these results suggest that pregnancy and post-partum care shift the balance between the competing motivation

Effect of Ionizable Lipids on the Characteristics of Lipid Nanoparticles

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Research into mRNA vaccine technology has gained popularity since the COVID-19 pandemic in hopes to create vaccines for various pathogens and cancers. Lipid nanoparticles (LNPs) are one of the most common delivery systems for mRNA, which allow mRNA to enter the cells through endocytosis. Ionizable lipids are a key component of LNPs because they promote RNA loading and facilitate endosomal escape of RNA. However, the effect of different ionizable lipids on LNP characteristics has not been systemically studied. The goal of our research is to develop and characterize LNP formulations using different ionizable lipids for mRNA vaccine delivery. We designed DNA plasmid sequences encoding antigens of interest and transformed DH5α bacterial cells to produce the plasmids. The sequences of the plasmids were confirmed by DNA gel electrophoresis and full plasmid nanopore sequencing. Next, we synthesized RNA from the plasmids through in vitro transcription. We formed LNPs by injecting lipids dissolved in ethanol into an RNA-containing aqueous phase on a vortexer, followed by dialysis in PBS at 4°C for 1 day to remove ethanol. The molar composition of the LNPs is 50 mol% ionizable lipid, 10 mol% DOPE, 38.5 mol% cholesterol, and 1.5 mol% DMG-PEG2K. Finally, we stored the particles in 10% sucrose at -20°C over time. We then analyzed LNPs by using dynamic light scattering to measure the size and polydispersity, as well as a Quantifluor assay to determine RNA encapsulation efficiency of the particles. The use of ionizable lipids SM-102, ALC-0315, Lipid 5, and Lipid A9 produced monodispersed LNPs of 60-110 nm in diameter, which is within the range for efficient cellular uptake. LNPs that were made using SM-102, Lipid A9, and Lipid 5 experienced minimal changes in size, polydispersity, and encapsulation efficiency after 7 days in storage compared to fresh particles. These results provide important information for future development of LNPs for mRNA delivery.

Engineering Interspecies Hybrid Ribosomes to Explore Co-evolution of rRNA and r-Proteins

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Ribosomes are the macromolecular machines responsible for protein synthesis. They are composed of ribosomal RNA (rRNA) and ribosomal proteins (r-proteins). While much of the ribosome is evolutionarily conserved, it is expected that rRNA and r-proteins co-evolve over time. The goal of my project was to ask if hybrid ribosomes could be constructed from components of different species, and thereby provide insights into the co-evolution of rRNA and r-proteins. Using gene replacement by transformation and homologous recombination, I have constructed strains of the extremely thermophilic bacterium *Thermus thermophilus* with ribosomes containing 16S rRNA from the related species *Thermus aquaticus*. These results indicate that at least some rRNA-r-protein interactions are conserved at the genus level, and that horizontal exchange of ribosomal genes between these species is possible. Further, these interspecies hybrid ribosomes provide the basis for future structural studies aimed at understanding ribosome evolution.

Gene Regulation of Bacterial Dormancy in Uropathogenic *Escherichia coli*

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Uropathogenic *Escherichia coli* (UPEC) are the leading cause of urinary tract infections (UTIs). Many UPEC strains, including the clinical isolate CFT073, can enter a metabolite-dependent, non-proliferative state in vitro termed quiescence. During infection, UPEC are thought to evade antibiotic treatment by forming quiescent intracellular reservoirs. At a low inoculation density, UPEC cells cultured on glucose minimal media enter quiescence. This quiescent state is reversible, and metabolites including succinate, lysine, and methionine reverse quiescence and promote proliferation. Additionally, peptidoglycan-derived peptides have also been shown to reverse quiescence. This study aims to analyze the mechanisms of dormancy reversing molecules, focusing on the use of peptidoglycan and succinate. A mini-transposon mutagenesis screen was employed in the UPEC strain CFT073 to identify mutants that fail to exit the quiescent state in the presence of peptidoglycan and succinate. Mutants with resuscitation defects help to identify relevant genes that are important for the reversal of quiescence by peptidoglycan and succinate. The phenotype of transposon mutants were further characterized via the quiescence assay, and arbitrary PCR was utilized to identify the transposon insertion site. Together, this strategy helps identify genes implicated in resuscitation of the quiescent state by succinate and peptidoglycan.

Temporal Trends in Antibiotic Use Among Pregnant Women Before and After the COVID-19 Pandemic (2012–2023)

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Background: The COVID-19 pandemic has altered the utilization pattern of antibiotics. Therefore, it is essential to understand antibiotic utilization patterns among pregnant women.

Objective: To identify temporal trends and changes in the prescription of antibiotics and specific antibiotic classes to pregnant women before and after the COVID-19 period.

Methods: This retrospective cohort study was conducted using health administrative data from private insurance plans in the New England region. The study cohort included pregnant women aged 12 to 55 who had a live delivery between 01/01/2012 and 12/31/2023. The pregnancy window and delivery were identified using a validated algorithm . The use of antibiotics was classified based upon drug generic names, NDC codes, and American Hospital Formulary Service classification codes in pharmacy claims. Comorbidities were identified using ICD-9/10 diagnosis codes from inpatient or outpatient insurance claims. Data analyses were conducted using SAS 9.4. To examine antibiotic prescribing trends, data was stratified into two periods: 2012-2020 (pre-COVID-19) and 2020-2023 (post-COVID-19) with the slopes, standard error, and p-values calculated using the Join Point version 5.4.

Results: A total of 31,395 pregnancies were identified, 7,582 (24.2%) filled 14,531 prescriptions of antibiotics during gestation. During the pre-COVID period, overall antibiotic use during pregnancy declined (slope   ± SE: -0.5% ± 0.2%, p = 0.009), particularly in the first trimester (slope ± SE: -0.3% ± 0.1%, p = 0.014), and third trimester (slope ± SE: -0.2% ± 0.1%, p = 0.025). In contrast, during the post-COVID period (2020-2023), there was a significant increase in first trimester antibiotic use (slope ± SE: 0.4% ± 0.01%, p = 0.001), but no significant changes in overall pregnancy antibiotic use or in the third trimester.

From 2012-2020, macrolide use decreased (slope ± SE: -3.4 ± 0.4%, p = 0.001) while cephalosporin use increased (slope ± SE: 0.8% ± 0.2%, p = 0.007) and nitroimidazole use rose modestly (slope ± SE: 0.2% ± 0.1% p = 0.025). No significant changes in the utilization of these antibiotic classes were observed in the post-COVID period.

Conclusion: Overall antibiotic use during pregnancy declined significantly prior to the COVID-19 pandemic and increased in the post-COVID period. Macrolide use declined while cephalosporin use increased slightly pre-and post-COVID.

Purification of Transcription Factor Sp1

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Alzheimer's Disease (AD) is the most common cause of dementia, as it accounts for about 60% to 80% of cases. Two of the most prominent forms of neurological degradation seen with AD are the accumulation of the protein fragment beta-amyloid into beta-amyloid plaques outside neurons and the accumulation of tau tangles inside neurons[1]. A steroidogenic acute regulatory-related lipid transfer (START) protein, StarD6, has been detected in specimens with neurological degradation[2]. Genetic studies have linked variations in the STARD6 gene to an increased risk of developing AD. Specifically, a single nucleotide polymorphism (SNP) called rs10164112 in the STARD6 gene has been associated with AD risk[3]. The purpose of the experiment is to determine whether the SNP rs10164112 introduces a biding site for the human transcription factor Sp1 and how this affects the expression of StarD6. To test this a binding assay will be performed to confirm that Sp1 will bind positive control DNA within the C-Kit promoter, will not bind our negative control, and it is predicted it will not bind to the T and G SNP. The first goal of this project was to obtain purified Sp1 protein. Growing conditions, like incubation length, temperature, and media were all changed to try and find the optimal growing conditions for Sp1. Future Research will include continuing to restructure our current protein purification protocol to find the ideal conditions to grow Sp1. Once Sp1 has been successfully purified then the binding assays will be performed and hopefully show Sp1's ability, or lack thereof, to bind the SNP rs10164112. Once the binding site is confirmed or denied we will be able to then test its effect on the expression of StarD6.

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