The 2026

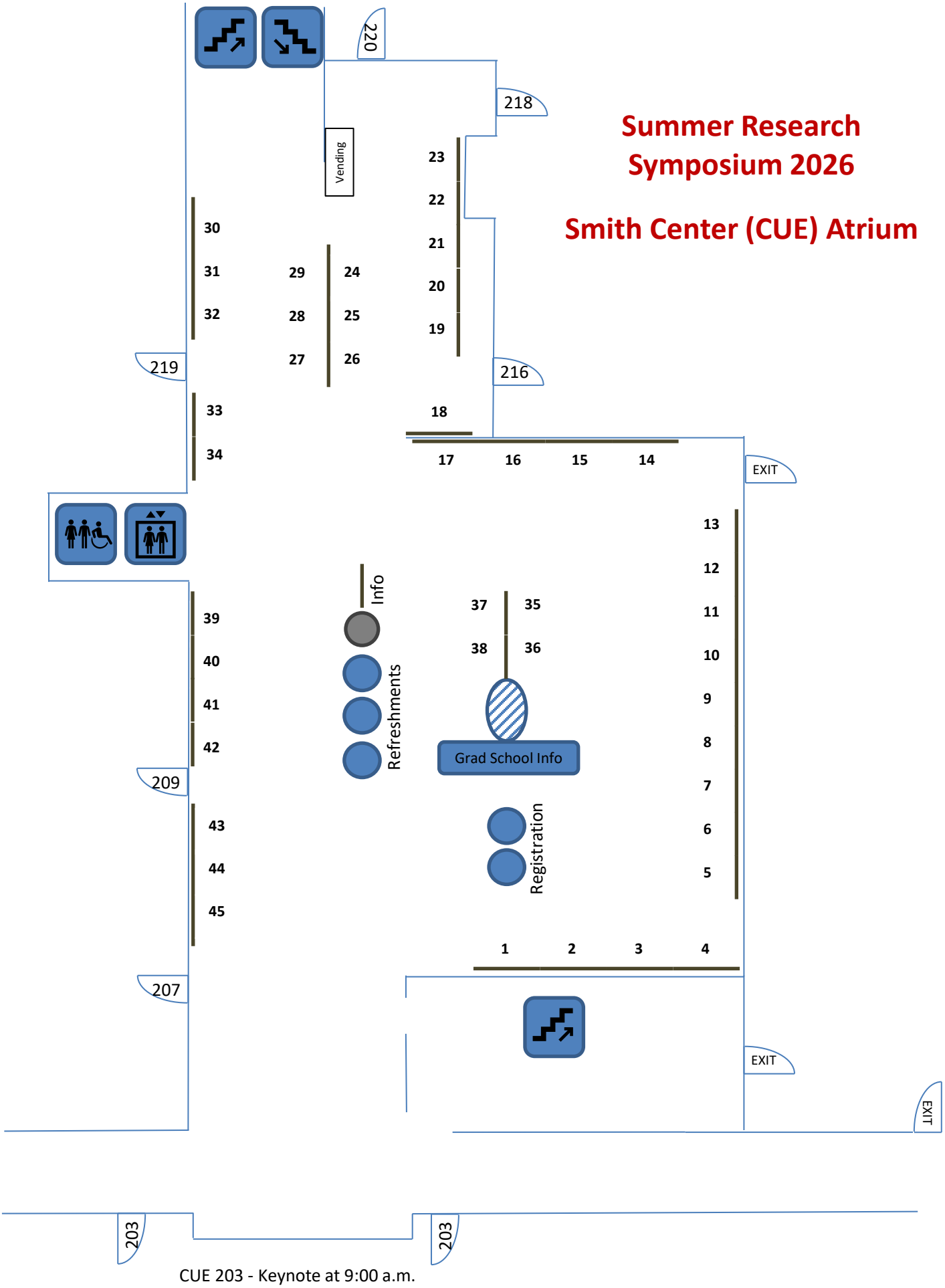
SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

at Washington State University

SUMMERRESEARCH.WSU.EDU

Summer Research Symposium 2026

Smith Center (CUE) Atrium



CUE 203 - Keynote at 9:00 a.m.

Summer Undergraduate Research Symposium 2026

Friday, July 31, 2026
8:00 a.m. – 1:00 p.m.
CUE Atrium and CUE 203

Symposium Schedule

8:00 a.m. – 9:00 a.m. CUE Atrium
Check-in and poster set-up

9:00 a.m. – 10:00 a.m. CUE 203
Welcome and keynote speaker
Keynote: Sascha Duttke

10:00 a.m. – 1:00 p.m. CUE Atrium
Students are at their posters available to discuss their research and to answer questions

1:00 p.m. CUE Atrium
End of the Symposium - put posters away and say farewell

WASHINGTON STATE UNIVERSITY
Office of Undergraduate Research

Summer Research Symposium 2026

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Organized by Research Program

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Poster 1

Too Hot to Handle?
The Impact of Heat and Drought Stress on Wheat (T. aestivum) Reproduction

Undergraduate Researchers: Hannah Fabacher, *Washington State University*

Arthur Kearney, *Washington State University*

Co-Authors: Glenn W. Turner, Andrei Smertenko

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Wheat (*Triticum aestivum*) is one of the world's most important cereal crops and a major source of food for millions of people. Rising temperatures associated with climate change, coupled with increasing drought stress, threaten wheat growth, productivity, and ultimately grain yield. Heat and drought stress can be particularly harmful during reproductive development. This study investigated how heat and drought stress affect wheat yield and fertility across different reproductive stages. Wheat seeds were planted on staggered dates so that each group reached a different reproductive stage when heat and drought stress was applied, allowing the effects of stress to be compared across developmental stages. Harvested material was analyzed for yield and fertility and compared with control plants not exposed to heat and drought stress. Anthers from wheat spikes were sampled throughout the experiment, stained with the fluorescent DNA dye 4',6-diamidino-2-phenylindole (DAPI), and examined using fluorescence microscopy to determine pollen developmental stage and identify those most strongly affected by heat and drought stress. Heat- and drought-stressed plants exhibited reduced yield and fertility compared with control plants, although the magnitude of these effects varied among reproductive stages. Microscopic analysis indicated that the mononucleate and binucleate pollen developmental stages were among the most susceptible to heat and drought stress. Together, these findings demonstrate that the timing of heat and drought stress during reproductive development strongly influences wheat reproductive success and provides insight into the developmental stages most vulnerable to environmental stress.

Poster 2

Examining Strategy Use and Performance on Verbal Fluency Tasks

Undergraduate Researcher: Kai Griem, *Washington State University*

Co-Authors: Mihika Mitra, Angela Hickman, Maureen Schmitter-Edgecombe

Summer Research Program: GSUR (NIH Training in Gerontechnology)

Abstract

Principal Topic
Verbal fluency (VF) tests require participants to generate words under time constraints and specific rules. Repeated VF assessments through ecological momentary assessment (EMA) in natural environments creates a unique opportunity to examine whether participants develop and modify strategies over time and how such changes impact performance. We hypothesized that repeated VF assessments during EMA would be associated with improved VF performance and more efficient strategy use, with the greatest gains observed among participants who adopted new strategies and those who completed more EMA assessments.

Method
Ninety-four community-dwelling midlife and older adults (M_{age} = 70.22 years, SD_{age} = 9.49 years; $M_{education}$ = 16.31 years, $SD_{education}$ = 2.32 years; 72% female; 96% White; 98% Non-Hispanic or Latino) were asked to complete VF tests at two time points. During the intervening two-week period, participants completed VF assessments on a smartwatch. VF performance was indexed by the number of correct words generated and strategy use was indexed by clustering (grouping related words), including all words produced. Participants reported whether they changed their strategy between testing sessions.

Results
Paired-sample t-tests will compare performance and proportion of strategy-generated words relative to total words across time points. A mixed factorial ANOVA will compare whether those who self-reported a change in strategy improved VF performance more than those who did not change strategy or did not use a strategy. A correlational analysis will examine whether the VF difference score between time points was associated with the number of EMA prompts completed.

Discussion
Understanding whether VF performance reflects practice effects, strategic adaptation, or both is important given that VF performance tends to decline with age. These factors may also provide insight into the use of strategies for strengthening VF abilities.

Poster 3

The Topical Effects of Leptin on Wound Healing and Limb Regeneration in Xenopus Tadpoles

Undergraduate Researcher: Karime Estrada, *Washington State University*

Co-Authors: Erica Crespi

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Because 1.6 million individuals sustain limb injuries or amputations annually, there is a need to improve treatment to restore limb repair and function. Unlike humans, amphibians can regenerate lost limbs, especially during early development, and studying mechanisms that drive regeneration could be applied to limb injuries in humans. Prior experiments showed that intraperitoneal injection of leptin, a hormone that is upregulated with food intake, accelerates limb regrowth in young Xenopus laevis tadpoles (Nieuwkoop Faber stage 53) by accelerating regrowth of the wound epidermis and increasing cell proliferation. We tested whether leptin signaling promotes regeneration in tadpoles (Nieuwkoop Faber stage 56-57) when the apical epidermal cap necessary for regeneration does not naturally form. To do this, we topically applied either 2 µL saline or 800 ng of recombinant Xenopus leptin in 2 µL of saline immediately after amputating one hindlimb (n=9/group) and reapplied these treatments 1 and 2 days post-amputation (dpa). We took images using a Leica dissecting scope on 1, 2, 7 and 14 dpa, and measured total area regenerated with ImageJ. We observed that repeated tropical administration of leptin helped boost the regeneration rate at 2 dpa compared to the saline group, which is consistent with what was found with leptin injections at younger stages. However, this growth advantage was reduced at 7 and 14 dpa after administration ceased. None of the leptin-treated limbs regenerated a paddle-like limb; instead, both groups regenerated a tissue spike. These findings suggest that there was no activation of the apical epithelial cap. Further histological analysis will show whether leptin promoted greater cartilage differentiation in regenerated limbs. This is the first demonstration that topical leptin treatment improves tissue regrowth in amputated limbs, and future research could explore whether extended administration improves regeneration outcomes.

Poster 4

Attaining The High-Pressure Sound Speed for Tantalum Using The Front Surface Impact Method

Undergraduate Researcher: Johnathan Andrade Antonio, *California State University, Fresno*

Co-Authors: James Hawreliak

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Sound speed measurements of materials are typically measured by the echo-pulse method where a pulse is sent through the material and reflected back. However, a commonly used technique to attain high pressure sound speeds in shock physics is the Front Surface Impact (FSI) method. As the name suggests, a sample collides with the front surface of a stationary window which results in shock waves propagating through the material which produces an interesting velocity (V) vs. time (T) graph. We use Photonic Doppler Velocimetry (PDV) and Velocity Interferometer System for Any Reflector (ViSAR) to attain velocity measurements with nanosecond resolution. We then analyze our PDV and ViSAR data to derive the sound speed for our respective sample material through the V-T graphs. This is done by determining the measured shock wave arrival times from the slopes in our V-T graphs. These shock wave arrival times are directly utilized to calculate the longitudinal sound speeds. For our experiments, we used tantalum and lithium fluoride (LiF) window impactors. The tantalum samples were accelerated to speeds of 0.7 km/s, 1.3 km/s, and 1.5 km/s with the 30-millimeter gunpowder gun at Washington State University against these LiF windows. After analyzing the data attained from these trials, we were able to attain a high-pressure sound speed for tantalum.

Poster 5

Neural Circuit Mechanisms Underlying Stress-induced Recurrence of Colitis

Undergraduate Researcher: Karmalena Rodriguez, *Washington State University*

Co-Authors: Lauren Benjamin, Khadija Khawaja, Megan McGraw, Ai-Jun Li, Emily Qualls-Creekmore

Summer Research Program: ESTEEMED MIRA

Abstract

Inflammatory bowel disease (IBD), a chronic gastrointestinal (GI) disease, is an increasingly prevalent, idiopathic condition that affects millions of people. It negatively affects the daily livelihoods of these people, through its harmful symptoms and economic burdens. A leading cause of the relapse of IBD is stress. The mechanisms behind how this interaction works are not fully understood. Prior research has been done around the immune system and its connection to active GI diseases. Yet, little work has been done investigating how prior inflammatory experiences can alter stress circuits in the brain, resulting in a potentially increased vulnerability for relapses of IBD. The basolateral amygdala (BLA) is a key stress-responsive region that provides direct excitatory input to the posterior insular cortex (pIC), a cortical region that integrates interoceptive signals and coordinates autonomic responses influencing gastrointestinal physiology and inflammation. We hypothesized that neural activity in the BLA and pIC will be associated with relapse in a mouse model of IBD and chronic stress. To test this, we used the trinitrobenzene sulfonic acid (TNBS) model of colitis to mimic IBD in mice. After a two-week recovery period, chronic restraint stress began with one-hour daily sessions for five days. Twenty-four hours following the last stress episode, mice were perfused, and the brain and colon were removed for histological processing. Immunohistochemistry was used to detect the amount of c-fos in the BLA and the pIC as an indicator of neuronal activation. Data was analyzed with a two-way ANOVA which found significant main effects of both prior TNBS-induced colitis and chronic stress on c-fos expression in the BLA and pIC, with the greatest activation observed in mice exposed to both manipulations. These findings identify specific brain regions recruited during stress-induced colitis relapse, which is information that can aid in future therapeutic treatments of IBD.

Poster 6

A Tapered SLIM Focusing Interface as an Alternative to Conventional Ion Funnels for Mass Spectrometry

Undergraduate Researcher: Emily Edstrom, *Whitworth University*

Co-Authors: Nathaniel Morgan, Daniel Wu, Brian Clowers

Summer Research Program: Clowers Research Group

Abstract

Ion funnels are commonly used to focus ions for introduction into a mass spectrometer. Consisting of sets of stacked electrode rings with decreasing diameter, superimposed radiofrequency (RF) and DC potentials are applied to propel ions toward the entrance of a mass spectrometer; however, the rings can create non-ideal conditions that may activate or trap ions, ultimately resulting in ion loss. Structures for lossless ion manipulation (SLIM) were developed as a means to separate and confine ions using lower-cost materials. Conventionally, SLIM devices are assembled from two parallel mirrored PCB boards, each with RF electrodes and DC guard electrodes used to confine ions as they travel through the system. In this work, a tapered SLIM is described, consisting of patterned PCB boards assembled at an angle to capture a diverging ion beam and refocus the ions into an Orbitrap mass spectrometer, eliminating the need for an ion funnel. Traveling wave (TW) voltages are applied to separate and drive the ions forward. The Taper SLIM successfully transmitted ions across a range of masses and charge states without an ion funnel. Manipulating the voltage of RF floats enabled m/z selectivity, while altering the voltage applied to perpendicular shields inserted into the SLIM broadened the range of compounds detected. This new electrode geometry promises to mechanically simplify the apparatus, add selectivity, and minimize the drawbacks presented by traditional ion funnels.

Poster 7

Bridging Instrument Dependency in Soil Spectroscopy: CNN Transfer Learning for Cross-MIR Calibration

Undergraduate Researcher: Masaaki Ikeda, *Soka University of America*

Co-Authors: Haly L. Neely, David Sande

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Soil properties such as organic carbon, pH, and clay content are key indicators of soil condition. Predicting these properties from Infrared (IR) Spectra has been studied as an alternative method of conventional lab techniques, which are expensive and time-consuming, making it impractical to run at the sampling frequency of modern soil monitoring techniques. However, IR predictions of soil properties need robust libraries of spectra with associated soil property data. United States Department of Agriculture (USDA)'s Kellogg Soil Survey Laboratory (KSSL) database, an open-access library of over 80,000 soil samples collected across the United States, has enabled a calibration transfer method that adapts its statistical models to local data sets. However, these methods depend on an expensive mid-Infrared (MIR) spectrometer called VERTEX 70 (Bruker), which many laboratories lack.

This study proposes a method to overcome this instrument dependency gap by developing a Convolutional Neural Network (CNN)-based transfer learning model, pretrained on KSSL (n = 51,970) and then adapted to a local Washington State soil dataset (n = 708) scanned on a different MIR spectrometer (Thermo Fisher FTIR). Our CNN-based transfer learning model performed R^2 values of total carbon (0.78), pH (0.59), clay content (0.39), sand content (0.42), cation exchange capacity (0.55), and exchangeable calcium (0.76).

These results suggest that non-linear transfer learning approaches have the potential to overcome the inter-instrument differences that conventional linear models cannot. This offers a practical path for laboratories to utilize large spectral libraries such as KSSL, without demanding access to the original reference instrument.

Poster 8

Implementation of Electromagnetically Induced Transparency in a Cold Rb-85 Atomic Ensemble Toward Biphoton Generation

Undergraduate Researcher: Adhyantha Chandrasekaran, *Texas A&M University*

Co-Authors: Scott Hillen, Yefeng Mei

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Enabling efficient light-matter interactions is a formidable challenge in the development of quantum information technologies. Electromagnetically induced transparency (EIT) is a promising technique to enhance light-matter interactions through long coherence of atomic ground states. In a cold atom ensemble, EIT helps manipulate photon speeds within the medium and provides a strong foundation for future biphoton generation. This work focuses on implementing and characterizing an EIT system in a cold Rb neutral atomic ensemble to build the platform for biphoton generation using the process of four-wave mixing. The EIT system is established through a weak probe beam and a stronger coupling beam using Acousto-optical modulation (AOM), which provides precise frequency control needed to tune the lasers into resonance and forms the three-level Λ configuration on the D1 line transition of Rb-85. A double-pass AOM-based probe beam is designed to scan frequencies and reach the desired F'=3 excited state in the hyperfine structure. A single-pass AOM coupling beam optical path is designed to be in resonance with the F'=3 excited state. Essential experimental skills such as beam alignment, AOM optimization, and fiber coupling were developed during the program to enable accurate EIT measurements.

Numerical and computational simulations, including a real-time slider-based GUI platform, were developed to model expected transparency windows, optical depth (OD) of the medium, and group velocity to provide a basis for comparison with measured results, and act as an important educational tool for future students. The experiment is focused on realizing the high-OD 2D MOT and measuring the EIT transparency windows to establish the experimental groundwork for future biphoton generation using four-wave mixing, which has applications in quantum networking and quantum information science.

Poster 9

Acute CO_2 Exposure and Metabolic Response in Rainbow Trout (*Oncorhynchus mykiss*) During Early Development

Undergraduate Researcher: Sophia Leblang, *North Seattle College*

Co-Authors: Ryan Shartau, Magaleate Kostelnik, Roy Holmes

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Hypercapnia, elevated CO_2 levels in an organism's bloodstream, is a critical and escalating concern for aquatic organisms as atmospheric CO_2 levels, and subsequently the uptake of CO_2 by bodies of water, continue to increase. Understanding how organisms are impacted by elevated CO_2 levels is essential. *Oncorhynchus mykiss* (rainbow trout), a vital species for global aquaculture, has been shown to be negatively impacted by high levels of CO_2, yet the impact of CO_2 specifically on the early stages in their life cycle, which can be more vulnerable, has not been extensively researched. This study examines the effect of high CO_2 levels on metabolic rate, heart rate, mortality and embryonic development, at three critical stages of life: eyed, pre-hatch, and immediately post-hatch. At each stage, *O. mykiss* was placed in flowing water containing 22±6 mg/L of dissolved CO_2 for 4 hours. Heart rate and metabolic rate were measured immediately after exposure and after 24 hours of recovery. Mortality, hatching timing, and yolk sac absorption were monitored. Preliminary results suggest a higher variation in oxygen consumption, a proxy for metabolic rate, among CO_2-exposed trout compared to controls, though minimal correlation was observed between heart rate and CO_2 exposure. Additionally, evidence suggests delayed hatch timing for eggs exposed to CO_2 at eyed and pre-hatch stages, yet there are no significant differences in mortality rates. These findings suggest that elevated CO_2 during early development may delay hatching and alter metabolic stability in rainbow trout, with potential consequences for hatchery timing and aquaculture productivity as atmospheric CO_2 continues to rise.

Poster 10

Sustainable Wheat Production: Isolation of Free-Living Nitrogen Fixers from Wheat Rhizosphere

Undergraduate Researcher: Malak Bensaud, *Washington State University*

Co-Authors: Vincent James, Maren Friesen

Summer Research Program: Molecular Plant Sciences

Abstract

Nitrogen is an essential nutrient for plant growth. 78% of the atmosphere is made of nitrogen (N2) gas; however, plants can't directly use it. Instead, atmospheric nitrogen must be converted into biologically available forms through nitrogen fixation. The most common way nitrogen is supplemented is through synthetic fertilizers. However, they are energy-intensive to produce, contribute to soil acidification, and >50% of the applied nitrogen fertilizer runs off into waterways before plants can absorb it. Biofertilizers are more sustainable and efficient, relying on microorganisms that colonize the rhizosphere to improve plant growth and soil health. Previous nitrogen-fixing biofertilizers have performed inconsistently because laboratory strains of bacteria compete with native microbiomes and pose a risk of microbial invasion. This project aims to isolate native nitrogen-fixing bacteria to use as a biofertilizer that are already suitable for the climate and soil type they are deployed in. Soil samples were collected from three Eastern WA wheat fields. Bacteria were cultivated using sprinkle and dilution plating. Colonies were grown and purified through three rounds of isolation streaking to obtain fast-growing and pure cultures. Genomic DNA was extracted from each isolate, followed by 16S and nifH PCR to determine taxonomic identity and confirm the presence of nitrogenase. Sanger Sequencing will be used for isolate identification. This project is expected to yield a collection of nitrogen-fixing bacteria specific to Palouse wheat fields. In previous studies using Palouse Prairie soils, we identified six nitrogen-fixing genera. Once identified, nitrogen-fixing bacteria will be used in a greenhouse experiment to determine their effectiveness as biofertilizers for wheat. This project validates and expands a reproducible method for isolating and identifying native nitrogen-fixing soil bacteria. If successful, locally sourced biofertilizers could reduce the use and reliance on synthetic fertilizers while providing a more environmentally friendly and cost-effective approach to improving plant growth.

Poster 11

Validating Biomarkers for Switchgrass Defense Signaling Pathways in Symbiotic and Pathogenic Fungal Interactions

Undergraduate Researcher: Seokyun Hong, *Cornell University*

Co-Authors: Taylor Stevens, Jeremy Jewell, Laura Bartley

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Switchgrass (*Panicum virgatum*) is a promising bioenergy crop with strong potential as an alternative to fossil fuels and non-renewable energy sources. Integrating endophytic fungal interactions with switchgrass offers a sustainable method of promoting its resiliency in place of herbicides and fertilizer, which are known to exacerbate environmental pollution and greenhouse gas emissions. In addition, endophytic fungal interactions can promote switchgrass' resiliency against fungal pathogens that threaten its performance and yield.

Trichoderma spp. is a well known biological control agent that exhibits a significant inhibitory effect on *Fusarium oxysporum,* and preliminary results have also confirmed that it increases biomass and root volume of switchgrass. While the benefits of *Trichoderma spp.* have been well documented, how other fungal isolates would impact productivity warrants further investigation. An additional fungal strain that also serves as a promising candidate is *Linnemannia elongata* for its ability to enhance defense signaling pathways and growth-promoting phytohormone production in plants. These benefits were well documented for *Arabidopsis,* but its direct effects on switchgrass have not been fully studied.

The long-term objective is to understand how biocontrol fungi influence the molecular mechanisms underlying switchgrass resilience against *Fusarium oxysporum*. Investigating the impact of the fungal screening system will provide valuable insight to both the individual and combined effects that each fungal strain has in influencing switchgrass productivity, and how this can be further harnessed in sustainable biofuel production. Primer design and validation for candidate genes involved in the Systemic Acquired Resistance (SAR) and Jasmonic Acid (JA) signaling pathways have been completed and optimized for RT-qPCR analysis. These primers will be used to quantify the expression of these candidate genes in *Trichoderma spp.*, *L. elongata*, and *F. oxysporum*-inoculated treatment groups. Gene expression will be compared to assess how SAR and JA signaling pathways are differentially regulated in pathogenic and symbiotic contexts.

Poster 12

Associations Between Gait and Cognitive and Mental Health Outcomes in Older Adults

Undergraduate Researcher: Joshua Vinson, *Washington State University*

Co-Authors: Shenghai Dai, Mac Murphy, Destinee Winston, Angela Hickman, Diane Cook, Brian Minor, Maureen Schmitter-Edgecombe

Summer Research Program: GSUR (NIH Training in Gerontechnology)

Abstract

Objectives: Changes in gait have emerged as potential early markers of cognitive decline in older adults. Wearable devices enable continuous real-world gait measurement and may provide ecologically valid indicators of cognitive and mental health. However, the smartwatch-derived gait features associated with cognition and mental health remain unclear. This study aimed to identify smartwatch-derived gait characteristics most strongly associated with cognitive and mental health outcomes in older adults.

Methods: The sample comprised 182 older adults (71.1% female, mean age 69.3 years, mean education 16.8 years): 104 healthy older adults (HOA), 38 with subjective cognitive decline (SCD), and 40 with mild cognitive impairment (MCI). Gait metrics (turning speed, cadence, stride time variability, root mean square (RMS) acceleration, and Lyapunov exponent) were examined in relation to ecological momentary assessment (EMA) and clinical measures. EMA measures included *n*-back performance, self-reported mental sharpness, and fatigue. Clinical measures included global and domain-specific cognition, self-reported mental health, and everyday functioning. Linear regressions were performed in SPSS.

Results: Higher RMS acceleration was associated with better *n*-back performance ($\beta = 0.188$, $p = .005$), greater mental sharpness ($\beta = 0.187$, $p = .025$), and better mental health ($\beta = 0.430$, $p < .001$). Faster turning speed was associated with higher mental sharpness ($\beta = 0.183$, $p = .020$) and better mental health ($\beta = 0.405$, $p < .001$), whereas slower turning speed and lower RMS acceleration were associated with greater depressive symptoms. These relationships were strongest among MCI participants, whereas mental health associations were observed across all diagnostic groups. No strong associations were observed with clinical cognitive measures.

Conclusion: RMS acceleration and turning speed demonstrated the strongest associations with EMA cognitive performance particularly among participants with MCI, and self-reported mental health. These findings support smartwatch-derived gait metrics as potentially valid indicators of cognitive and affective functioning in older adults.

Poster 13

Effects of Dietary Butyrate Supplementation on Individual- and Population-Level Disease Severity in the Ranavirus-Wood Frog System

Undergraduate Researcher: Brady Williams, *Cornell University*

Co-Authors: Nick Kessler, Jesse Brunner, Erica Crespi

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Disease outcomes at the individual level do not always translate directly to population-level epidemics; while some environmental conditions may alter disease outcomes for individuals, infection dynamics in populations are much more complex. We investigated how dietary butyrate supplementation influences ranavirus dynamics in wood frogs across both individual and population levels. Because butyrate, a short chain fatty acid produced by gut microbes, has been shown to enhance host immunity in mammals, we predicted that supplementing butyrate in the diet of tadpoles would reduce ranavirus infection severity at the individual level and possibly delay or reduce the severity of epidemics at the population level. In individual trials, tadpoles received either a control diet (boiled alfalfa) or 1% butyrate supplementation beginning either seven days before or three days after viral exposure to 10^3 pfu ranavirus. Relative to the control diet, both pre- and post-exposure butyrate supplementation reduced median viral loads but did not improve survival. Particularly in the post-exposure treatment, individuals died at lower viral titers, suggesting reduced tolerance. To assess how these individual-level effects of butyrate supplementation were related to population-level effects, we set up 20 mesocosms containing 20-24 tadpoles, half receiving 1% butyrate-supplemented diet, and half receiving a control diet. Epidemics were seeded by adding to each mesocosm two tadpoles that were exposed to ranavirus for 24 hr. Mortality and viral environmental DNA (eDNA) were monitored for 18 days, during which epidemics occurred in all but one mesocosm. We found modest evidence of delayed and less severe epidemics in the butyrate diet mesocosms. These dynamics are consistent with reduced transmission resulting from lower viral shedding by infected individuals given dietary butyrate supplementation. These findings highlight the importance of integrating individual and population level studies when evaluating disease interventions and lay a foundation for future research of butyrate as an antiviral treatment.

Poster 14

Computational Optimization of Point-Charge Locations for Maximizing the First Hyperpolarizability β

Undergraduate Researcher: Henry Harding, *University of Denver*

Co-Authors: Mark Kuzyk, Garret Compton, Elliot Steissberg

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

The β term in nonlinear susceptibility applies to many nonlinear systems, including nonlinear optical devices and medical imaging. However, any molecules tested have been found to have a maximum β that falls a factor of 30 lower than the quantum limit. Here, we develop a program to computationally find optimal point-charge positions in an ideal system to maximize the β term. We create a 3D time-independent Schrödinger equation solver to find the eigenstates of a system with any defined potential, including an easy way to input point charges. This is done by creating a 3D grid and using imaginary time evolution with the split operator method to find the ground state. We then incorporate the Gram-Schmidt method to force orthogonality to the previous ones, resulting in the next excited states. From this, we can create dipole matrices to calculate the β term using sum-over-states. We then use Bayesian optimization to systematically search for positions that maximize β. The program can then be used as a base for trying to create real systems with a large β term.

Poster 15

Analysis of the Variability of Arabinoxylan Content in Hard Red Winter Wheat

Undergraduate Researcher: Eleanor Row, *Oregon State University*

Co-Authors: Elizabeth Khinotskaya, Aichatou Djibo Waziri, Kimberly Garland-Campbell

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Fiber is an essential macronutrient with various benefits for human health. Unfortunately, only 5% of Americans are meeting the daily recommendation of 25-30g of daily intake. Since the United States is the third-largest consumer of wheat flour products worldwide, a possible solution to closing the fiber gap is by developing higher-fiber flour for consumers. The goal of this study was to assess the variability in fiber content in a large collection of 396 individual genotypes of hard red winter wheat. The set of genotypes was planted at the Spillman Agricultural Research farm in Pullman, WA for two years (2024-2025) using a partially replicated block design. The Arabinoxylan content ($mg.g^{-1}$) of wholemeal was quantified using a spectrophotometer after acid digestion and colorimetric reaction with phloroglucinol. Plant height (cm), yield ($kg.ha^{-1}$), and grain protein content (%) were also measured. The arabinoxylan content across the two years was compared and checked for correlations between plant height, yield weight, and protein content to identify a high-fiber variety with an overall strong output profile. In 2024, Arabinoxylan content ranged from 46.95-83.27 $mg.g^{-1}$ and averaged to 64.44 $mg.g^{-1}$. In 2025, it ranged from 51.14-86.28 $mg.g^{-1}$ and averaged 66.78 $mg.g^{-1}$ in 2025, roughly a 2-3 $mg.g^{-1}$ increase overall. Plant height averaged to 89.96 cm, yield weight to 105.19 $kg.ha^{-1}$, and protein content to 12.57%. Overall, there was a weak positive correlation between fiber and plant height (0.155), a moderate positive correlation between fiber and protein (0.292) and a moderate negative correlation between fiber and yield weight (-0.289). Given those factors, genotypes U6714-F and U6711-C were identified as the most consistent producers of high-fiber flour across both years. These genotypes will be further validated for trait stability to determine their potential for crossbreeding in pursuit of a higher fiber flour.

Poster 16

Impacts of Acute Microcystin Exposure on the Metabolism of Juvenile Rainbow Trout (Oncorhynchus mykiss)

Undergraduate Researcher: Nathaniel Franklin, *Oregon State University*

Co-Authors: Roy Holmes, Ryan Shartau

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Cyanobacterial harmful algal blooms (cHABs) are spikes of blue-green algae (cyanobacteria) growth driven by environmental eutrophication. As metabolites, blue-green algae produces cyanotoxins such as microcystin leucine-arginine (MC-LR), a well-studied compound that has extreme negative effects on animal welfare including liver disease, decreased cardiovascular function, and, in some species, fatality. Salmonids (salmonidae) are a particularly vulnerable clade, and subyearlings require pristine and highly specific water parameters to survive. This study examines the effects of aqueous exposure to MC-LR on the standard metabolic rate (SMR) of 8-month old rainbow trout smolts. Eight fish per treatment were exposed to tanks of 0 µg/L, 10 µg/L, and 50 µg/L of MC-LR for 24 hours, and their SMR was recorded overnight using intermittent respirometry. As cHABs increase in prevalence due to climate change and human development, studying how cyanotoxins impact the physiology of salmonids at different life stages is imperative to protection and recovery plans for both wild and cultured populations.

Poster 17

Beam Axis Stabilization System

Undergraduate Researcher: Brooke Padgett, *Oberlin College*

Co-Authors: Nandika Damarla, Peter Engels

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Modern optical setups often consist of an extensive array of beam paths that need to remain precisely aligned for long times. In particular, the Bose-Einstein condensation (BEC) experiment at Washington State University consists of a multitude of laser paths for optical lattices, Raman beams, laser cooling, etc., spanning multiple optical tables. The optical components are subject to drift, altering the alignment and requiring regular corrections.

In this project, I have developed, constructed and characterized an automated beam axis stabilization system based on a quadrant photodiode and piezobender to automatically realign laser beam paths. The quadrant photodiode detects the exact position of a portion of the light split off from the main beam, while the piezobender moves a mirror upstream to physically realign the beam. The interaction between the photodiode and piezobender is mediated by custom circuitry to calculate the deviation of the beam. A PID controller can then be used to control how much the piezobender needs to move.

Solidworks was used to design mounts for the photodiode and piezobender. The electronic circuitry, designed using Diptrace, calculates the x and y differences and to sum the total light onto the photodiode. My preliminary testing found a response time of approximately 5 ms of the photodiode, and a resonance of the piezobender of 270 Hz with a mirror attached. The next step will be to complete the electronics, construct a PID controller and implement this stabilization system to align lattice beams for the overall BECs experiment.

The developed beam stabilization can easily be adapted to other large optical systems where high alignment precision is needed yet there is a large quantity of optical components subject to drift. I anticipate that this system, or variations thereof, will be highly useful for any advanced optical setup requiring long-time alignment of beam paths.

Poster 18

Associations Between GPS-Derived Location Mobility, Momentary Experiences, and Cognitive Functioning Among Older Adults

Undergraduate Researcher: Destinee Winston Childers, *Norfolk State University*

Co-Authors: Shenghai Dai, Maureen Schmitter-Edgecombe, Brian Minor, Diane Cook, Mac Murphy, Joshua Vinson, Angela Hickman

Summer Research Program: GSUR (NIH Training in Gerontechnology)

Abstract

PURPOSE: Objective mobility measures collected through smartwatch-based GPS technology offer a novel approach to characterizing behavioral differences across cognitive aging. Evaluating these measures alongside ecological momentary assessment (EMA) and clinical measures may improve understanding of behavioral patterns associated with cognitive status among older adults. This study aims to examine the associations between GPS-derived mobility measures, EMA outcomes, and clinical measures across healthy older adults (HOA), individuals with subjective cognitive decline (SCD), and mild cognitive impairment (MCI).

The sample included 182 community-dwelling older adults (71.1% female, mean age 69.3, mean education 16.8 years), comprising 104 HOA, 38 with SCD, and 40 with MCI. Smartwatch data included location mobility (distance and time) and EMA measures (*n*-back shape test scores, mental sharpness, fatigue, and stress). Clinical measures included global cognition, everyday functioning, mental health, and social activities. Correlations were used.

In the full sample, more time at home was associated with better mental sharpness ($r = 0.20$, $p = .011$) and global cognition ($r = 0.16$, $p = .047$), whereas more time away from home was associated with higher shape test scores ($r = 0.18$, $p = .024$), lower depression ($r = -0.17$, $p = .033$), and more frequent family activities ($r = 0.18$, $p = .030$).For SCD participants, only time at home correlated with global cognition ($r = 0.40$, $p = .025$). For HOA, both time at and away from home were associated with shape scores, mental sharpness, executive functioning, and internal distractions. For MCI participants, greater time spent and greater distances from home were associated with better cognitive measures, lower fatigue, and better brain and mental health.

CONCLUSION: Smartwatch-based mobility measures were associated with various cognitive outcomes among older adults across cognitive aging, especially for MCI participants. Study findings highlight the value of digital mobility markers for research and practice.

Poster 19

Digital Phenotyping as a Non-Destructive Method to Characterize Imazamox Resistance in Bromus tectorum L.

Undergraduate Researcher: Rae Marie Najera, *Gonzaga*

Co-Authors: Olivia Landau, Franco Sanchez-Izurieta

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Agricultural weeds are increasingly evolving herbicide resistance, reducing the efficacy of chemical control. Traditionally, scientists characterize herbicide-resistant plants by performing dose-response assays, which require treating plants with increasing herbicide doses, then harvesting aboveground tissue for fresh weight (FW) and dry weight (DW). These experiments provide growth reduction 50 (Gr_{50}) estimates, to compare resistance levels among sensitive and resistant populations. Digital phenotyping provides a non-destructive alternative to reduce time and labor required for biomass harvest. However, because digital metrics measure plant volume rather than biomass, they require validation across species and herbicide treatments to ensure they produce results comparable to biomass data. In this study, we conducted an imazamox dose-response assay on sensitive (S) and resistant (R) populations of Downy brome, (*Bromus tectorum L.),* a grass weed in winter wheat fields prone to evolving acetolactate synthase (ALS) inhibitor resistance. We compared digital metrics collected by the Phenospex TraitFinder with manually harvested biomass. Sequencing confirmed the Pro197Leu target site-mutation in the resistant population. Within both populations, the Gr_{50} estimates for FW and DW were not significantly different, ranging from 3.10-3.62 and 15.00-17.67 g ai/ha, respectively, and the R/S ratios ranged from 4.85 to 4.88 for each metric. Several digital metrics, 3D Leaf Area, Convex Hull Area, Digital Biomass, Projected Leaf Area, and Voxel Volume Total, produced statistically similar Gr_{50} estimates, ranging from 3.10 to 4.05 and statistically similar Gr_{50} estimates and R/S ratios. This work validates digitally collected data yields similar results to destructive harvesting. Utilizing this non-destructive imaging approach allows researchers to drastically reduce manual labor, preserve surviving plants for downstream phenotyping or seed increase, and enables more efficient monitoring of herbicide resistance dynamics over time.

Poster 20

Stress on the Menu: Dietary Lipids and Copepod Physiology

Undergraduate Researcher: Mateo Monteiro, *University of California, Santa Cruz*

Co-Authors: Murad Jah, Wes Dowd

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Environmental change is altering the strength of individual stressors and the ways multiple stressors interact in coastal ecosystems. For example, temperature and salinity can affect organisms independently, additively, or through more complex interactions. Moreover, physiological responses to environmental stress are not determined solely by direct exposure. Interactions between organisms, including the transfer of nutrients and other macromolecules from primary producers to consumers, may also affect core physiological processes and responses to stressful conditions.

Fatty acids are essential components of cellular membranes and help maintain physiological function under varying temperatures and salinities. Environmental stress can change the fatty-acid composition of primary producers, altering the dietary fatty acids available to consumers, which are incorporated into their tissues. This may link stress experienced by primary producers to the physiology and stress tolerance of their consumers. Temperature and salinity may therefore affect consumer physiology both directly and indirectly through changes in food quality.

This study examined these relationships using the marine diatom *Phaeodactylum tricornutum* and the supratidal copepod *Tigriopus californicus*. Diatoms were grown at 17 or 27 °C and salinities of 10, 35, or 65 parts per thousand. Copepods were maintained under corresponding temperature and salinity treatments and fed diatoms grown at the same salinity under both temperatures. Fatty-acid composition was measured in both organisms using gas chromatography with flame-ionization detection to determine whether environmentally induced changes in diatom fatty acids were incorporated by copepods. Copepod thermal and salinity tolerance were also measured to evaluate whether dietary fatty-acid composition was associated with resistance to environmental stress.

By connecting interactions among environmental stressors with nutritional interactions between species, this research addresses an important source of complexity in organismal physiology. Understanding these combined effects will improve predictions of how coastal organisms and food webs respond to increasingly variable environmental conditions.

Poster 21

Examining Stable Phenomena in Turbulent Quantum Fluids: Solitons and Vortices in Bose-Einstein Condensates

Undergraduate Researcher: Taddeo Mathews, *Reed College*

Co-Authors: Michael Forbes, Edward Eskew

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Turbulent systems can be found throughout nature, from the largest scales to the smallest scales. We studied the stability and behavior of stable phenomena like solitons and vortices in Bose-Einstein Condensates (BEC's), where superfluidity has a significant impact. To study these structures we first simulated turbulent systems by solving the Gross-Pitaevskii Equation (GPE). We used different methods depending on the dimension of the simulation, with a time varying potential for 1D, and a random phase imprint relaxed to the ground state for 2D. By counting these solitons and vortices, and examining their behaviour and characteristics as we varied different quantities, we are working on constraining the soliton size, and have begun studying the counterflow turbulence that can occur between different species of BEC's within the Coupled GPE, and vortex soliton interactions in this system. Through better understanding the stability of certain phenomena in superfluid BEC's at ultracold temperatures, we can improve our predictions about the behavior of neutron star cores and superconductivity.

Poster 22

A Plant's Got to Drink: Addressing Climate Change Through Drought Resistance

Undergraduate Researcher: Taylore Wolfe, *University of Idaho*

Co-Authors: Se Eun Jung

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Drought stress is known to negatively affect plants. Some natural plants have a thin pit membrane, which allows an embolism in the stem to spread through the plant, ultimately preventing the plant from receiving water to grow. Our project is designed with the intention of reducing the effects of drought stress, by increasing the thickness of the pit membrane. CRISPR Cas-9 was used to create a mutation in a brome plant (*Brachypodium distachyon*), which caused the pit membrane to thicken. This gene was altered in specific plants in hopes of creating a drought resistant line. This gene also has the potential to present other visible characteristics such as altered height and weight of the plants. I recorded these metrics and ran statistical tests to determine if the gene has a significant impact on the plant aside from the thickness of the pit membrane. Results show few statistical differences between the wild type plants and the genetically altered plants in terms of physical features.

Poster 23

Simulating How a Black Hole Warps an Image Behind It

Undergraduate Researcher: Elizabeth Walsh, *Grangeville High School*

Co-Authors: Matthew Duez

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Black holes are some of the least understood objects in the known universe. Because black holes do not emit light and heavily warp light from nearby sources, they can be difficult to visualize. Using ray tracing and assuming the light rays follow Newtonian orbital trajectories, we created a code that warps an image in a way that mimics a black hole. This allows us to recreate how a black hole affects what an observer sees as it bends light from an object behind it.

Poster 24

Cross-Cultural Comparison of Compensatory Strategy Use and Prospective Memory Performance in Older Adults

Undergraduate Researcher: Maria Ruelas, *Washington State University*

Co-Authors: Regan Jenkins, Maureen Schmitter-Edgecombe, Diane J. Cook, Shenghai Dai

Summer Research Program: GSUR (NIH Training in Gerontechnology)

Abstract

Introduction: Prospective memory (PM) is the ability to carry out intended actions in the future, such as remembering appointments or taking medicine. Compensatory strategies (CS) include external (e.g., technology, paper) and internal (e.g., elaboration) approaches that help complete everyday tasks.

Objective: This study examined whether older adults from the U.S. and Chile differed in PM performance and CS used to support performance.

Methods: Participants were 107 Chilean (68.97% female, M age = 80.17, M MoCA = 23.60) and 220 American (65.80% female, M age = 76.56, M MoCA = 25.88) adults. They completed two real-world PM tasks, a time-based call (TBT), and an event-based task (EBT) performed after a cue during testing. Differences in task accuracy and CS were analyzed using *t*-tests and chi-square tests of independence.

Results: The groups were well-matched in age (70+), cognition (MoCA), and sex. Both reported similar CS count across tasks and performed better (TBT, EBT) ($p > .10$). No significant differences were observed on the TBT PM performance (t (325) = -1.90, $p = .06$). U.S. participants scored higher on the EBT (t (323) = -2.73, $p = .010$). They also reported greater use of technology-based CS for the TBT (χ^2 (1) = 50.59, $p < .001$) and EBT (χ^2 (1) = 5.62, $p = .002$). No significant differences were found in the use of paper-based strategies. Chilean participants reported greater use of help on the TBT (χ^2 (1) = 50.59, $p = .02$). There were significant differences ($p < .05$) in the other four CS groups (internal cognitive boost, external task management, environmental cue, and routine).

Conclusions: These findings suggest culture may influence types of CS used to support PM performance. Future research should examine factors (e.g., technology access, CS familiarity, and social support) that may influence strategy selection and PM performance.

Poster 25

Expression Optimization and Biochemical Characterization of (-)-trans-isopiperitenol Dehydrogenase (ISPD)

Undergraduate Researcher: Pablo Gonzalez Jr, *Whitman college*

Co-Authors: Jannelle Andrews, Bernard Markus Lange

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Monoterpenoid pathways produce natural products such as menthol and other components of peppermint essential oil, which are widely used in pharmaceuticals, oral care, and flavoring applications. The biosynthesis of these products requires specialized enzymes that control and modify monoterpene intermediates. This project focused on the enzyme isopiperitenol dehydrogenase (ISPD), a short-chain dehydrogenase/reductase enzyme that catalyzes the oxidation of (-)-trans-isopiperitenol to (-)-isopiperitenone using NADH as the cofactor. The primary objective was to optimize ISPD expression and purification, evaluate enzyme activity, and characterize its kinetic behavior with a variety of monoterpenoid substrates.

The ISPD gene was amplified through polymerase chain reaction and inserted into the pET-28b vector, which contains a polyhistidine tag, for recombinant protein production in E. coli. Expression conditions were optimized after initial expression failed to produce sufficient protein yields concluded by Bradford assay. Based on SDS-PAGE analysis, we optimized culture volume, expression temperature, IPTG induction concentration, elution volume, imidazole concentration, and the purification apparatus. The optimal conditions consisted of nine 145 mL cultures grown at 28°C with induction using 0.3 mM IPTG. Following expression, cells were harvested, lysed, and ISPD was purified using nickel-affinity chromatography with a centrifugation-based protocol. The protein was eluted in three fractions using 200 mM imidazole, and the second elution produced the highest protein concentration for kinetic assays.

The optimized procedure produced sufficient protein for enzyme reactions, and protein concentration was quantified using a Bradford assay. Reaction mixtures contained MOPSO buffer (pH 7.5), purified ISPD, NADH, and individual monoterpenoid substrates. Samples were analyzed by GC-FID for kinetic measurements and by GC-MS for monoterpene identification.

These optimized expression and purification conditions produced sufficient quantities of purified ISPD for further biochemical characterization. Ongoing GC-FID, GC-MS, and kinetic analyses will determine substrate conversion, product identity, and catalytic behavior, helping to clarify the role of ISPD in monoterpenoid biosynthesis.

Poster 26

Prefrontal Cortex Neuronal Activity and Excessive Exercise During Food Restriction

Undergraduate Researcher: Isabella Flores, *Washington State University*

Co-Authors: Shane Hentges, Pratyush Suryavanshi, Amit Thakar

Summer Research Program: ESTEEMED MIRA

Abstract

Anorexia nervosa (AN) has one of the highest mortality rates of any mental health disorder and is characterized by severe food restriction, excessive exercise, and body image distortion. Despite the high prevalence of AN the neural mechanisms leading to it remain poorly understood. To better understand the neuronal drive underlying aberrant exercise during restricted food intake, we used the activity-based anorexia (ABA) model in mice. ABA combines timed food presentation and running-wheel availability to recapitulate the food restriction and excessive exercise seen in AN. Using the ABA paradigm, we asked whether neurons in the medial prefrontal cortex (mPFC), a brain region involved in executive function, decision-making, and cognitive control might drive the hyperactivity observed with food restriction.

Specifically, we hypothesized that there would be increased activity in parvalbumin (PV)-positive interneurons within mPFC coinciding with excessive exercise during ABA in mice. We used transgenic mice expressing a red fluorescent protein (tdTomato) in PV-positive interneurons. Brain sections containing the mPFC were prepared from mice undergoing ABA or exercise only and labeled for the immediate early gene protein c-Fos which is a robust marker of active neurons. Co-localization between tdTomato and the green fluorophore detecting c-Fos protein was used to quantify the relative activity of PV cells during food-restriction-evoked exercise and general voluntary exercise in free-feeding animals. Increased activity in PV-positive inhibitory interneurons would lead to reduced excitatory output from the mPFC which could underlie the maladaptive behavior seen in ABA and AN.

This work will be followed up with patch-clamp electrophysiology to examine dynamic cellular activity in neurons identified as activated in the paradigm. Together, the work will help determine whether altered balance between excitatory and inhibitory signaling contributes to aberrant PFC activity during the excessive exercise and may provide greater insights into the elusive biology of anorexia nervosa

Poster 27

Examining the Effect of Flow Regime Variation on the Feeding Performance of Juvenile Rainbow Trout

Undergraduate Researcher: Eleanor Janish, *Emory University*

Co-Authors: Roy Holmes, Katherine Corn

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Salmonids are some of the most important fish species in their ecosystems and the economy, and they are constantly facing changing environments, such as dynamic flow regimes. Despite the major implications of flow regime shifts, little is known about how the rate of flow affects the feeding ability of salmonids. We studied the effects of flow rate on the feeding performance and swimming kinematics of juvenile rainbow trout (*Oncorhynchus mykiss*). We videoed juvenile rainbow trout feeding on California blackworms in swim tunnels at three different rates of flow – no flow, moderate flow, and high flow. The videos were analyzed to record the time, number of strikes, and number of failed strikes before the first successful strike it took the fish to eat. We used LoliTrack v5 to analyze the swimming kinematics, including speed, acceleration, and bend of the fish. We analyzed both the feeding and kinematics data using linear regression in R, including fish ID as a random effect to account for individual variation. We found that the fish took significantly less time to eat the worms in moderate flow than in no flow, and that the fish performed fewer dynamic movements such as bends and bursts in the moderate flow compared to the no flow. The results of the study provide insight into the decisions salmonids face in their environments as the rate of flow varies. While in little to no flow, they can decide when to swim and burst at prey, in moderate to high flow, they must continuously swim and grab prey before it flows past them. These insights can be applied to conservation and aquaculture by providing greater knowledge of how changes in flow impact the ability of salmonids to obtain food.

Poster 28

Probing the Structure of Active Galactic Nuclei in Dwarf Galaxies with Multiband Variability Correlation

Undergraduate Researcher: Jonathan Berkson, *Elon University*

Co-Authors: Vivienne Baldassare, Erin Kimbro

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Intermediate-mass black holes (IMBHs), with masses between roughly 100 and 1,000,000 times that of the Sun, are thought to bridge the gap between stellar-mass and supermassive black holes. The population of accreting IMBHs, or black holes that are actively siphoning matter, in dwarf galaxies (dwarf AGN) are of utmost importance in studying how black holes both form and grow. One promising method of detecting and analyzing dwarf AGN is through examining the variability of emitted light at different wavelengths. The higher-energy optical continuum radiated by the hot inner accretion disk can be absorbed and reprocessed by the outer dusty torus which, after a characteristic time lag, is reemitted as mid-infrared light. This study investigated a sample of 25 dwarf galaxies known to exhibit variability in the mid-IR as measured by WISE W1 and W2 bands. We examine their optical variability as measured by the Zwicky Transient Facility (ZTF) G- and R- bands. Quality reduction was applied to all data before using the Gaussian processing framework EzTaoX (Yu et al. 2025) to model the four bands' light curves and compute multiband correlation parameters, such as damping timescale, variability amplitude, and band-lag. Through this we found that 24% of galaxies demonstrate both optical and mid-IR variability, for which we find significant, well-converged lags across optical-IR band pairs. These sources show an average lag of 17.16 ± 1.14 days, corresponding to an average accretion disk-torus distance of 0.014 pc. Additionally, IMBH masses were calculated from the damping timescales and compared to broad-line virial mass estimates. Joint multiband fits agreed with estimates within ~1 dex for the majority of galaxies, consistent with multiband correlations reflecting a shared physical origin for variability, while single-band estimates showed substantially larger discrepancies.

Poster 29

Transient Expression of *Pfe* TAGL1 Brassicaceae Homologs in *Nicotiana benthamiana* Indicates Potential Lipase Fatty Acid Substrate Selectivity

Undergraduate Researcher: Josephine Cort, *University of Puget Sound*

Co-Authors: Nicholas Neumann, Philip D. Bates

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Products from oilseed crops are widely used for human consumption, livestock feed, and industrial applications. Understanding the metabolic pathways for the synthesis of triacylglycerols (TAGs), the major lipid in seed oils, is an important area of research for the engineering of oilseed crops to make healthier and designer oils for various products. *Physaria fendleri*, a member of the Brassicaceae family, uses a specialized TAG remodeling pathway, through the enzyme *TAG LIPASE-LIKE 1 (Pfe*TAGL1*)*, to remove a common fatty acid (FA) at the *sn-1* position, creating an *sn-2,3*-DAG with a lesquerolic acid (20:1-OH) at the *sn-3* position. A diacylglycerol acyltransferase enzyme can then add a second 20:1-OH at the free *sn-1* position to generate the final 2-hydroxylated FA TAG. Homologs of the *Pfe*TAGL1 gene were identified in other species within the Brassicaceae family: *Brassica carinata*, *Brassica napus*, *Camelina sativa*, *Crambe abyssinica*, and *Thlaspi arvense*. The function of TAGL1 homologs in these species has not been determined biochemically.

In this study, the effect of *B. napus* and *T. arvense* TAGL1 homologs expressed in *Nicotiana benthamiana* leaves on FA levels and content were evaluated using gas chromatography flame ionization detection (GC-FID). Both TAGL1 constructs showed altered FA levels with lower 16:0 and higher 18:3 levels as compared to the empty vector (EV) control. While *Ta*TAGL1 had slightly lower levels of 16:0, 18:2, and 18:3 as compared to *Bn*TAGL1. In addition, total FA content levels were lower for both TAGL1 constructs when compared to the EV. These findings indicate that *B. napus* and *T. arvense* TAGL1 act as lipases and cleave FAs from TAG or other lipids. These results support the claim that the TAGL1 homologs affect total fatty acid composition and suggest potential fatty acid substrate selectivity.

Poster 30

Advancing Structural Analysis of Stimuli-Responsive Micelles Using WSU's New X-ray Infrastructure

Undergraduate Researcher: Alivia Thomas, *Washington State University*

Co-Authors: Devin Scott Grabner, Tanner M Melody, Brian Collins

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Targeted drug delivery systems often use block copolymer micelles to transport medicine, but it is difficult to predict how these micelles behave when they are crowded together in high concentrations. Most current models struggle to account for how micelle shells interact and overlap in these dense environments, which limits our ability to design reliable delivery vehicles. To address this, I developed Small-Angle X-ray Scattering (SAXS) protocols on the new WSU X-ray beamline to analyze micellar structure, extending the study to vary pH, a typical strategy to trigger the release of molecular drug cargo in the body. This work provides a robust method and initial model for predicting how nanocarriers change shape under physiological conditions, making it easier to develop more effective and stable drug delivery platforms.

Poster 31

The Effect of the Intramandibular Joint on the Feeding Kinematics and Performance of the Southern Platyfish

Undergraduate Researcher: Maya Malev, *Scripps College*

Co-Authors: Summer Duba, Roy Holmes, Katherine Corn

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Fishes are adaptable predators, capable of modifying their feeding across various environments. Some lineages of fishes have an additional jaw joint, the intramandibular joint (IMJ), that further their ability to eat prey with diverse functional properties, particularly expanding their capacities to partake in herbivory from diverse substrates and structures. This project investigates the feeding performance and kinematics of southern platyfish (*Xiphophorus maculatus*), a small, freshwater species that utilizes an IMJ–for attached prey from four substrates with different shapes. Performance was measured by weighing the feeding structures before and after 20 minute feeding periods in addition to the calculation of the fish bite rates for each replicate and structure; kinematics were measured using two-camera, 3D high speed videography and landmark morphometrics. Data obtained from performance and kinematic trials were analyzed using two tailed ANOVA. We find these fish perform best when picking from a structure composed of thin tubes that test the fish's ability to access restricted spaces, closely followed by the feedings from relatively flat surfaces, which is supported by the full expansion of the IMJ. Results from this research may provide insight into why species in the *Xiphophorusgenus* are so adaptable and potentially invasive to vulnerable habitats. Taken together, it is clear that the evolution of a novel jaw joint equips *Xiphophorus maculatus* for feeding success on a wide range of prey.

Poster 32

Grain Quality Degradation due to Preharvest Sprouting: examining effects of cold stratification on germination, dormancy, and alpha-amylase production in wheat.

Undergraduate Researcher: Jazelle Samp Curry, *Oregon State University*

Co-Authors: Mazon Langford, Corbin Chapman, Scott Carle, Rehana Parveen, Camille Steber

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

This study examined the effects of cool temperature treatment on the induction of alpha-amylase during preharvest sprouting. Preharvest sprouting (PHS) is the induction of mature germination on the mother plant when rain occurs before harvest. PHS events are more severe when rain is associated with cooler temperatures. Germinating seeds require the enzyme alpha-amylase to fuel seedling growth by cleaving starch bonds to release sugars as an energy source. However, farmers are penalized severely for excessive grain alpha-amylase levels because starch degradation causes lower gelling capacity leading to quality problems such as collapsed cakes and sticky bread. Breeders need to select for resistance to PHS without undermining seed germination, emergence, and yield. Thus, the goal is to improve understanding of PHS and alpha-amylase regulation. Grain dormancy can prevent PHS and the subsequent induction of alpha-amylase. Dormant seeds cannot germinate, even under favorable environmental conditions. Dormancy can be broken by after-ripening during a period of dry storage (0.5-6 months in wheat), or by cold stratification which is exposure to cool, wet conditions. The effects of varietal differences and of different cold stratification times and temperatures on the timing of alpha-amylase induction during germination were examined. Germination efficiency and alpha-amylase levels were examined during germination time courses conducted at 22°C following cold stratification treatments of varying temperature and duration. The varieties Cayuga and Xerpha showed more initial seed dormancy than Crescent, Bruneau, and Pritchett. Cold stratification strongly stimulated germination with more dormant varieties showing less response to cold. Interestingly, cold stratification at warmer temperatures of 10°C and 15°C appeared to break dormancy more efficiently than the colder 4°C temperature. However, germination was able to begin during cold stratification at the warmer temperatures. Longer periods of cold stratification also resulted in faster germination, proving cold exposure is a strong dormancy-breaking treatment in wheat.

Poster 33

Effects of Taurine Supplementation and Thermal History on Acute Heat Stress Tolerance in Mytilus californianus

Undergraduate Researcher: Elizabeth Spence, *Reed College*

Co-Authors: Talia B. Head, Wes Dowd

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Rising global temperatures lead to unprecedented thermal extremes and dynamic environmental conditions that may compound thermal stress in intertidal organisms. Mussels are an ideal model for this issue because of their sessile lifestyle and extreme daily thermal fluctuations. Prior studies have established that mussels' resilience to heat stress is partly dependent on thermal history. This resilience is associated with elevated tissue taurine, an osmolyte involved in osmoregulation, oxidative stress mitigation, and potentially thermoprotection. This study investigates the effect of recent thermal history and taurine supplementation on the acute heat stress response in *Mytilus californianus*, specifically by monitoring effects of taurine on heat tolerance, gill ciliary activity, and expression of taurine-related genes. Mussels were acclimated to 20ºC or 30ºC mid-day low-tide temperatures for 14 days and then subjected to a single low-tide acute heat stress ramping to a peak of 36ºC. A subset of animals from each group were supplemented with 5 mM taurine in 32 ppt saltwater for 6 hours prior to the acute heat stress. No mortality was observed among the four groups, and results from a post-stress ciliary function assay approximating physiological performance have yet to be quantified. Notably, qPCR analysis of gill tissue RNA showed significantly higher expression of taurine-transport gene TauT1 in all three experimental groups when referenced to the 20ºC control. A second isoform of the taurine transporter, TauT2, had significantly higher expression in 20ºC taurine-supplemented mussel gills as compared to control. The taurine-degradation gene TauD did not differ in expression among treatments. Although taurine supplementation showed no direct thermoprotective effect, our results support a relationship between thermal history and taurine transport into gill tissue. These findings provide a foundation for future studies of osmolyte-mediated thermal resilience in marine organisms.

Poster 34

Optical Characterization of Silicon by FTIR and of ITO by UV-Vis and Hall Effect Measurements

Undergraduate Researcher: Joshua Elbertson, *High Point University*

Co-Authors: Matthew D. McCluskey

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Silicon and indium tin oxide (ITO) are important materials used for diverse applications. The former is a dominant semiconductor in integrated circuits and shows significant promise for solar cells and future battery technologies. On the other hand, ITO, due to its high optical transparency and electrical conductivity, is used as a material for displays in OLEDs or touch panels and is seeing uses in photovoltaics and biosensing technologies. Motivated by these crucial materials, we performed optical transmission spectroscopy -- specifically, Fourier transform infrared (FTIR) spectroscopy on silicon and Ultraviolet-Visible (UV-Vis) spectroscopy on ITO. Both methods revealed interference fringes as a core focus of study: determining the index of refraction for silicon and measuring the band gap with respect to wavelength. Optical measurements in the infrared range (1800-5500 cm^-1) were performed on the silicon sample for a range of temperatures, from 10 K to 278 K. From the fringe spacing, and using the relation $2nd = m\lambda$, we determined that the refractive index increased from 3.42 to 3.46. In the UV-Vis range, the ITO sample was first measured in its as-is state, then annealed in a furnace to crystallize the material, since it was initially amorphous. Performing the same UV-Vis scan revealed a shift in band gap towards shorter wavelength. Furthermore, the carrier type was characterized by a Hall effect measurement, which identified the carriers as electrons and quantified their concentration before and after annealing. In summary, optical analysis combined with Hall measurements provides a fast, non-destructive way to track how altering the material, whether through temperature or annealing, can change a material's optical constants and carrier concentrations.

Poster 35

Cetacean Morbillivirus Infection in a Stranded Fin Whale (Balaenoptera physalus) in Washington state

Undergraduate Researcher: Sarah Ramirez, *Washington State University*

Co-Authors: Thomas Waltzek, Allan Pessier, Jessie Huggins, Dyanna Lambourn, Amany Hassan

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

Cetacean morbilliviruses (CeMV) are highly infectious single-stranded RNA viruses that have caused mass mortality events in cetaceans worldwide. This study describes a stranding of a juvenile female fin whale that was first observed alive in the surf before being found dead at Copalis Beach, Grays Harbor County, WA on November 11, 2023. Fin whale strandings are rare in WA, with only 13 documented since 2000, and are typically caused by ship strikes making this case unusual. Sections of lung, liver, stomach, skin, and blubber were fixed in formalin for histopathological evalutation. Syncytial lesions were found, and a semi-nested PCR (RT-PCR) assay targeting morbillivirus was positive in the liver and lung tissue. Sanger sequencing of the partial L gene sequence followed by BLASTN analysis revealed 99.2% sequence identity to a morbillivirus recovered from a Longman's beaked whale that stranded in Maui, Hawai'I in 2010. To our knowledge, CeMV has never been detected in Washington State, and the only cases of CeMV in fin whales have been Dolphin Morbillivirus in the Atlantic Ocean; therefore, keeping surveillance on this novel strain is imperative to lessen the risk of a mass mortality event on the West Coast and in endangered species.

Poster 36

Quantum Sensing Modeling Accounting for Doppler Broadening

Undergraduate Researcher: Dyson Whitney, *Washington State University*

Co-Authors: Mei Yefeng

Summer Research Program: Summer Undergraduate Research Experience (SURE) (Brian Jensen)

Abstract

Quantum sensing is an emerging technology that measures the amplitude of microwaves similar to a dipole antenna. This sensor would have practical applications in precise communications, metrology, and quantum technologies. It has notable advantages over the traditional antenna as it doesn't rely on calibration; it is more accurate and most importantly is highly sensitive. A problem with quantum sensing is that it requires strict parameters for the Rabi frequency of the lasers/MW as well as the atomic density of the cell being used. At higher temperatures however, doppler broadening makes these operating parameters more difficult to identify. I have been working on a quantum sensing model that accounts for the doppler broadening caused by temperature and predicts the temperature dependent sensor response. This model would provide guidance when determining operating parameters for the sensor for clear results especially for temperatures well above absolute zero; ultimately it lays the groundwork for future experimental implementation

Poster 37

Preharvest sprouting in wheat: examining the effects of after-ripening and germination temperatures.

Undergraduate Researcher: Mazon Langford, *Whitman College*

Co-Authors: Jazelle Samp-Curry, Corbin Chapman, Scott Carle, Rehana Parveen, Camille Steber

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Preharvest sprouting (PHS) is when mature wheat (*Triticum* aestivum L.) grain germinates on the mother plant before harvest in rainy conditions. While in extreme cases visibly germinated wheat must be sold either as feed or abandoned, in mild cases the excessive accumulation of the enzyme alpha-amylase can lead to starch digestion and baked products leading to fallen cakes and sticky bread crumb. While farmers receive serious discounts for elevated grain alpha-amylase, the enzyme is needed during late germination to mobilize starch to fuel seedling growth. Grain dormancy can prevent PHS and the associated alpha-amylase induction; however, excessive dormancy can result in uneven/slow germination, leading to poor plant establishment and lower yields Dormant grain cannot germinate under favorable conditions until dormancy is lost either through dry after-ripening during a period of dry storage or through cold stratification when grains take up water under cold, nonfreezing conditions. Previous work showed that cold stratification could strongly stimulate alpha-amylase induction in germination wheat grain. This study examined whether after-ripening has a similar effect. During germination time course experiments, after-ripening did result in earlier germination and alpha-amylase induction. However, the effect of cold stratification was stronger. Next, the effect of varying germination temperatures was examined. Both high temperature (37C) and low temperature (10C) resulted in slower germination than the normal germination temperature (22C). This result points to the importance of sowing wheat at the correct time in the spring after temperatures become warm enough to stimulate germination, but before they become too warm. Interestingly, cold stratification at 4C prevents the inhibition of germination at 37C. This suggests that exposure to wintry conditions is needed before grain will germinate at high temperature. These results can inform crop management decisions and help develop breeding selection strategies.

Poster 38

Energy Barriers to Charge Generation in Organic Photovoltaics

Undergraduate Researcher: Khusanjon Bobokhojaev, *California Lutheran University*

Co-Authors: Brian Collins, Acacia M. Patterson, Sushil Adhikari

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Solar energy is one of the most promising paths toward sustainable, scalable power generation, and Organic Photovoltaics (OPVs) push that promise further: as carbon-based, solution-processable devices, they are more robust, cheaper, and easier to manufacture than conventional cells, and their mechanical flexibility opens applications (wearable and building-integrated power, lightweight sensitive devices) that rigid silicon simply cannot reach. Yet this potential is currently limited on two fronts. Silicon, which still dominates the industry, is difficult and costly to manufacture at scale, while OPVs, though far easier to produce, have not yet reached competitive power conversion efficiencies. A major bottleneck to closing that efficiency gap lies in the active layer, where charge generation occurs and where a significant fraction of photogenerated excitons fail to separate into free charge. This project investigates the quantum barrier to that exciton separation, the charge generation activation energy, in bulk heterojunction (BHJ) cells made from a PM6:Y6 blend. To probe this behavior, the activation energy barrier to charge separation was measured using Time-Delayed Collection Field (TDCF), a pump-probe technique in which a laser pulse generates excitons and a delayed extraction field collects the resulting charge, allowing photogenerated charge to be measured before bimolecular recombination can diminish it. This was paired with J-V characterization, with both techniques carried out across a temperature range down to -196°C (77 K) at fixed prebias, so that charge generation could be tracked as a function of temperature. Understanding this barrier ultimately gives device engineers a target to design around, moving OPV technology one step closer to matching silicon's efficiency without sacrificing its manufacturing advantages.

Poster 39

Testing the Assumption that Infection Outcomes are Determined by First Exposure

Undergraduate Researcher: Yehonatan Tammam, *Midland University*

Co-Authors: Robert Pearhill, Jesse Brunner

Summer Research Program: Robustness and Resilience of Aquatic Biosystems (Erica Crespi)

Abstract

A key assumption about how infectious disease works in vertebrate hosts is that after an infection is established, subsequent exposures to the same pathogen do not change the outcome. Pathogens replicate rapidly such that later exposures contribute insubstantial numbers to the growing pathogen population. At the same time, cross-reactive immune responses to the initial exposure can protect against later exposures, even before immune memory is established. However, re-exposures may be important in some systems. For instance, if pathogen replication is slow, later-arriving pathogens might add substantially to the pathogen population and even push it beyond a threshold associated with more severe disease. Alternatively, pathogen-induced immunosuppression could place the host in a more susceptible state, increasing the effect of re-exposure to the pathogen. Indeed, this alternative hypothesis seems plausible in the case of ranavirus infections of larval amphibians. These viruses grow to peak viral titers over days or even weeks and actively suppress aspects of the host immune response. Larval amphibians do sometimes recover from ranavirus infections, but do not become immune. We therefore tested the hypothesis that re-exposures to ranavirus could alter the outcome of ranavirus infections. We exposed Columbia spotted frog (Rana luteiventris) tadpoles to ranavirus and then enforced one of three treatments: no re-exposure (complete flow-through of water), repeated re-exposures (flow-through with virus added twice more), or self re-exposure (tadpoles held in static water).

We found that the mortality was similarly high (~93% mortality) and similarly rapid (median time to death of 10-11 days) in all treatments. While data on the intensity of infection are not yet complete, it seems that even in this system, the outcome of infection is largely determined at its outset.

Poster 40

A Bayesian Inference of Neutron Star Mass Hyperparameters from Multiple GW Detections

Undergraduate Researcher: Justin Kenneally, *University of Rochester*

Co-Authors: Amlan Nanda, Sukanta Bose

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

We have observed that the more massive neutron star (NS) in a NS-NS coalescence has a greater spin magnitude than the less massive NS. This suggests that the two NSs have different mechanisms of origin, and therefore populate different mass distributions; the more massive NSs are spread according to a two-peaked Gaussian distribution, while the less massive NSs are distributed uniformly. By simulating the gravitational waves produced by NS-NS mergers on the LIGO Hanford Interferometer and assuming flat Hubble cosmology with H_0 = 70 km/s/Mpc and Ω_m = 0.3, we conduct Bayesian inference to see how tightly we can constrain the NS mass hyperparameters of the two-peaked Gaussian distribution. We can expand this analysis to estimate the hyperparameters of the hybrid + piecewise polytrope equation of state of NSs.

Poster 41

Evaluating Mucor Molleri as a Biological Control Agent in Switchgrass (Panicum Virgatum L.)

Undergraduate Researcher: Luke Falter, *Washington State University*

Co-Authors: Taylor Stevens, Laura Bartley

Summer Research Program: Molecular Plant Sciences

Abstract

Switchgrass (*Panicum virgatum L.*) is a perennial C4 crop that is typically used as animal feed and is an emerging candidate for biofuel production. Biological control agents (BCAs) such as *Trichoderma* have sometimes been used to enhance crop yield and mitigate the effects of other pathogenic fungi such as *Fusarium*. The fungi *Mucor molleri* is a fast-growing fungus that has shown promise as a possible BCA and plant growth promoter in other crops. The purpose of this study is to evaluate whether *M. molleri* can act as a BCA for switchgrass, stimulating growth and protecting against a presumed pathogen, *Fusarium oxysporum*. This will be done by using 4 treatments with 6 plants for each treatment. The treatments are as follows: an uninoculated control group, a group inoculated with *M. molleri*, a group inoculated with *F. oxysporum*, and a group double inoculated with both *M. molleri* and *F. oxysporum*. The growth rates of each treatment will then be recorded daily for 4 weeks and analyzed to investigate the effects of the fungal inoculants. To further investigate the mechanisms of any potential plant outcomes, in-vitro dual culture assays will be used to analyze the growth rates of the fungi when interacting with each other. These findings can be used to determine whether *M. molleri* should be studied further for use as a BCA in switchgrass. By enhancing crop resistance against pathogens and stimulating growth, effective BCA use could help make switchgrass an economically feasible biofuel crop.

Poster 42

The Photometric Effect of Starspotting in RS Canum Venaticorum Variable Stars

Undergraduate Researcher: Emma Biskie, *Augustana College*

Co-Authors: Guy Worthey

Summer Research Program: Waves in the Universe and Technology (Brian Collins and Anya Guy)

Abstract

Stars that deviate from their positions in the color-magnitude diagram relative to single star evolution models raise questions about the mechanisms that drive these inconsistencies. We aim to enumerate and physically explain such "impossible stars" with data from Gaia DR3 on Milky Way star clusters. Using the sky positions, proper motions, and parallaxes of 17 distinct star clusters, we create clean color-magnitude diagrams. By overlaying isochrones and computing approximate probabilities of membership for each star within its cluster, we identify outliers. Our analysis reveals numerous categories of "impossible stars." As expected, we find blue straggler stars which are rejuvenated by gas accretion and bright sequences parallel to the main sequence containing binary and multiple systems. Visual doubles where the star of interest is not properly resolved result in large photometric errors. Photometric noise for faint stars is also apparent. Post-Asymptotic Giant Branch stars, a rare late phase of stellar evolution in which hot stars are on their way to becoming white dwarfs, explain stars that are too blue and bright. We detect a possible Blue Horizontal Branch or Extreme Horizontal Branch star, which is a helium fusing star with a thin hydrogen envelope. The most peculiar category is a subset of RS Canum Venaticorum variable stars: close binary systems with heavy starspot coverage and orbital periods of less than a day. We model the starspots to infer that the primary star of the binary is a subgiant, and the induced starspotting is consistent with the significant redward drift in the color-magnitude diagram. This result suggests a potential new method for identifying additional members of this rare class of variable stars.

Poster 43

Genome-based and Functional Screening of Dryland Rhizosphere Actinobacteria for Plant Growth-Promoting Traits

Undergraduate Researcher: Ismael Tamba, *Washington State University*

Co-Authors: Oleksandra Shabliy, Olga Mavrodi, Dmitri Mavrodi

Summer Research Program: Improving Crop Resiliency: Agriculture in Changing Climate (Matthew Peck and Andrei Smertenko)

Abstract

Plant growth-promoting rhizobacteria (PGPR) are microorganisms that mitigate environmental stresses and inhibit harmful microorganisms. Many known PGPR are Actinobacteria that benefit plants by bolstering nutrient uptake, root elongation, and suppressing pathogens. Previous research revealed an abundance of endophytic Actinobacteria associated with the roots of dryland wheat grown in low-precipitation regions of Washington State. We hypothesized that this enrichment reflects a functional role for these microorganisms in promoting plant growth and enhancing tolerance to abiotic and biotic stress. To test this hypothesis, we focused on 45 Actinobacterial strains belonging to 6 genera and at least 26 species. The genomes of these strains were analyzed using KEGG mapper and other bioinformatics tools to identify genes and pathways associated with putative PGPR traits, including ACC deaminase, IAA biosynthesis, siderophore production, phytate mineralization, and osmotic stress adaptation through ectoine and glycine betaine pathways. Beyond genome screening, we conducted in vitro culture-based assays to validate selected phenotypes suggested by the observed pathways. The in vitro assays confirmed several of the predicted phenotypes, although agreement between genomic screening and observed phenotypes varied across isolates. A key ACC deaminase pathway gene, acdS, was present in 44 of the 45 screened genomes, yet only 17 strains exhibited the predicted phenotype in vitro. Similar discrepancies between genotype-phenotype discrepancies were also observed for IAA biosynthesis and siderophore production. Additionally, four representative strains were evaluated for their effects on Arabidopsis root development and showed differences in root length relative to the control, indicating PGPR activity. These results indicate that endophytic Actinobacteria associated with dryland wheat possess diverse plant-growth-promotion pathways. However, the expression of these traits appears to be strain- and condition-dependent, underscoring the need to complement genome mining with functional assays to identify organisms that express PGPR activities under biologically relevant conditions

Poster 44

The mechanism of bacterial lactate oxidase inhibition of cancer cell growth

Undergraduate Researcher: Oliver Ling, *Baylor University*

Co-Authors: Tom Li, Michael Quigley, Weimin Li

Summer Research Program: Li Research Group, College of Medicine

Abstract

Lactate is a significant carbon source for the TCA cycle and an essential energy source for cancer cells, also acting as a signaling agent within the tumor microenvironment (TME), making lactate metabolism a target for anticancer strategies. Bacterial lactate oxidase (LOX), which catalyzes the breakdown of lactate and oxygen into pyruvate and hydrogen peroxide (H2O2), selectively kills breast cancer (BCa) cells of all molecular subtypes in vitro without affecting normal cell survival. This effect has traditionally been attributed to LOX depleting cellular lactate and producing the oxidative stressor H2O2. However, systemic LOX administration in mice was recently found to inhibit breast tumor growth without decreasing TME lactate levels, and LOX was discovered to enter cancer cells and bind peroxiredoxin 1 (PRDX1), an enzyme responsible for removing excess cellular H2O2. This suggests the mechanism of LOX-induced cancer cell death extends beyond its oxidase activity. Hydrogen peroxide and pyruvate react to produce acetate and carbon dioxide, which could be cytotoxic by decreasing culture medium pH; this lab's preliminary studies have also shown that LOX associates with PRDX1 and PAFAH1B2, both overexpressed in cancer cells. This preliminary study investigates the contributions of acetate, pyruvate, H2O2, and PRDX1/PAFAH1B2 association to LOX-mediated cancer cell death.

Preliminary results indicate at extremely high concentrations, acetate induces cell death, while lower concentrations do not appear to affect proliferation. Hydrogen peroxide combined with pyruvate trended toward encouraging rather than inhibiting proliferation. LOX qualitatively associates with PRDX1 and PAFAH1B2 in staining images.

While high concentrations of acetate induce cell death, this effect is not replicated by simulating the pyruvate and hydrogen peroxide reaction downstream of the LOX reaction; the staining images support earlier data. These results suggest acetate production alone does not account for LOX-induced cancer cell death, but LOX's associations with PRDX1 and PAFAH1B2 may play a role.

Poster 45

Nodule Fluorescence as a Biosensor for Nitrogenase Activity in Response to Insect Attack

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Abstract

Rhizobia are a group of bacteria which form symbiotic relationships with legume hosts. Host plants create root nodules to house the rhizobia from which nitrogen fixation occurs, a process driven by the enzyme nitrogenase. Biotic stress, like insect herbivory, can negatively impact nitrogenase activity. The development of a specialized rhizobia plasmid system may allow for the detection of nitrogenase activity via fluorescent analysis. This system can be used to measure the effect of insect herbivory on nitrogen fixation efficiency.

Peas (*P. sativum*) were inoculated with rhizobia (*R. leguminosarum*) and exposed to pea aphids (*A. pisum*) for 10 days before being removed. Every 5 days for 15 days samples were collected and recorded beginning 5 days after aphids were added. The rate of nodules formed per day on aphid infested plants was found to be 1/3 that of control plants while average nodule size was significantly reduced in aphid infested plants compared to control plants. Nodule fluorescence was found to be consistent between both treatments for up to 10 days, but after 15 days, nodules from plants exposed to aphid herbivory displayed significantly reduced fluorescence compared to nodules from control plants.

Developing methods to better quantify nitrogenase activity will aid in understanding legume-rhizobia interactions and how biotic stressors affect these interactions. This technique could offer a superior method of quantifying nitrogenase activity over existing assays.

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