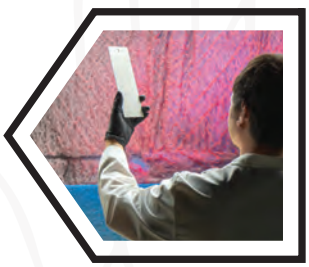
north dakota state university

ndsu

student research days

2025



welcome

MESSAGE FROM RESEARCH AND CREATIVE ACTIVITY

Welcome to the 2025 NDSU Student Research Days! We are thrilled to have you join us in celebrating the hard work, creativity, and dedication of 70 talented undergraduate researchers.

NDSU recognizes the significant impact undergraduate research has on our university, region, and nation. Student Research Days highlight the innovative ideas and projects these students have developed by following their passions and curiosity. This event provides a valuable opportunity for them to share their research findings with stakeholders, learn from their peers, and explore potential interdisciplinary collaborations.

We encourage you to engage with the students, ask questions, and delve into the fascinating topics on display. Your support and interest play a vital role in their growth as researchers.

The Office of Research and Creative Activity is proud to support undergraduate researchers through NDSU EXPLORE. Thank you for being part of this exciting event and for celebrating the spirit of discovery and the bright future of these young scholars!

Ying Huang, Ph.D.
Undergraduate Research Director
Office of Research and Creative Activity

MESSAGE FROM GAMMA SIGMA DELTA

Gamma Sigma Delta wishes to welcome everyone to the NDSU 2025 Student Research Days. Gamma Sigma Delta was founded in 1913 as an international honor society to advance agriculture. The NDSU chapter is pleased to participate in Student Research Days. We look forward to learning about the great research that our students are doing.

Sergio Cabello Leiva
Gamma Sigma Delta, NDSU Chapter President

MESSAGE FROM THE GRADUATE SCHOOL

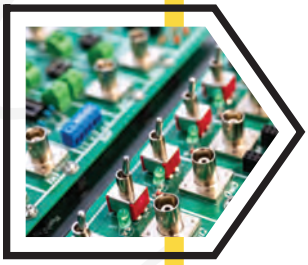
Welcome to the 9th Student Research Days at North Dakota State University. The event celebrates the achievements of graduate student researchers across disciplines. This year, 153 master's and doctoral students representing 37 programs are sharing their work: Showcasing the excellence, dedication, and innovation that are hallmarks of student success at NDSU. Graduate student researchers contribute to advancing knowledge and expanding possibilities in ways that ripple from Fargo to communities around the world.

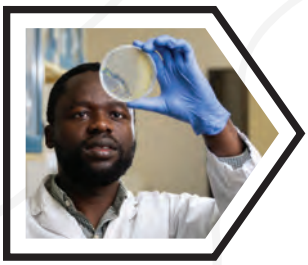
We are grateful to the faculty and staff who mentor and support graduate student researchers as they pursue excellence and push innovation. We are also grateful for the evaluators who have taken the time to engage with graduate students and learn about research at NDSU. Student Research Days reflects the best of what it means to come together as a community. We are united by curiosity, a deep appreciation for the perseverance necessary to conduct research, and a shared commitment to learning and discovery. Graduate student researchers are inspiring, and we hope you enjoy this glimpse into their research journeys.

Mark Nawrot, Ph.D.
Interim Dean, NDSU Graduate School

2025

schedule





ALL SESSIONS WILL BE HELD IN THE MEMORIAL UNION

WEDNESDAY, APRIL 9

EXPLORE (UNDERGRADUATE) SCHEDULE

10 a.m. – noon
Poster Session
Ballroom B

Noon – 1:30 p.m.
Break

1:30 – 3 p.m.

Oral Presentation Sessions
Hidatsa and Sahnish Rooms

3:30 – 4 p.m.

Awards Ceremony
Ballroom A

THURSDAY, APRIL 10

GRADUATE STUDENT SCHEDULE

10 a.m. – noon
Poster Session
Oceti Sakowin Ballroom

Noon – 1 p.m.
Break and Refreshments
Oceti Sakowin Ballroom

1 – 3 p.m.
Oral Presentations
Various Rooms

3:30 – 4:30 p.m.
Awards Ceremony
Ballroom A

undergrad participants

EXPLORE ORAL PRESENTATIONS:

Ayanle Aideed
Computer Science

Andrea Clarisse Corrales
Biochemistry and Molecular Biology

Mackenzie Hendrickson
Agricultural Education

Madison Lien
Agriculture Education

Isaac Mauch
Biotechnology

Koby Pearson-Bortle
NDSU CHANGE Program

Ella Syring
Animal Science

Kaylin Trosen
Biological Sciences

Zachary Whaley
NDSU CHANGE Program

Kamryn Wiese
Sports Management

EXPLORE POSTER PRESENTATIONS:

Maryum Adnan
Pharmacy

Abuk Akech
Psychology

Spencer Alefteras
Biological Sciences

Ashlynn Badenoch
Chemistry

Adam Bendewald
Biochemistry and Molecular Biology

Julianna Berg
Anthropology

Sofia Blair
NDSU CHANGE Program

Corrin Bottom
NDSU CHANGE Program

Alyssa Boyko
Biological Sciences

Emma Buysse
Interior Design

Savannah Christenson
Biological Sciences

Megan Clark-Lowell
NDSU CHANGE Program

Joshua Eberts
Microbiology

Lora Ensign
Pharmaceutical Sciences

Hyla Erickson
Natural Resource Management

Morgan Finneseth
Biological Sciences

Jada Ford
Statistics

Louis Gaytan
Mechanical Engineering

Kalen Gordon
Mechanical Engineering

Zoe Grossnickle
Biological Sciences

Joelle Hannam
Psychology

Hunter Hanson
Chemistry

Katelyn Hanson
Psychology

Braden Herman
Mechanical Engineering

Garrett Honzay
Biochemistry and Molecular Biology

Kelsey Hooker
Animal Science

Alex Humpherys
NDSU CHANGE Program

Faith Isaac
Pharmaceutical Sciences

Gavin Kahn
Mechanical Engineering

Sara Laliberte
Interior Design

Hieu Le
Psychology

Lauren Lowe
Anthropology

Connor Lukkari
Pharmaceutical Sciences

Abrielle Mann
Biological Sciences

Brayden McLean
Biological Sciences

Kole Menz
Pharmaceutical Sciences

Alexis Meredith
Pharmaceutical Sciences

Kaitlyn Miller
Biological Sciences

Isaac Mills
Biological Sciences

Mallory Misialek
Microbiology

Owen Nelson
Biological Sciences

Matthew Nepsund
Agricultural and Biosystems Engineering

Casey Nichols
NDSU CHANGE Program

Kendra Ovsak
Interior Design

Grant Parker
Biology

Ellee Pastwa
Biological Sciences

Olivia Peterson
Interior Design

Sierra Preabt
Biological Sciences

Kaley Quam
Pharmacy

Rubayed Razib
Mechanical Engineering

Mikayla Richmond
Mechanical Engineering

Anna Robinette
Interior Design

Gwen Sailer
Biological Sciences

Taylor Severance
Anthropology

Kimaria Stevenson
Biological Sciences

Zachary Sweep
NDSU CHANGE Program

Cheyenne Tandberg
Biological Sciences

Marissa Tiegen
Biological Sciences

Erin Tschetter
Interior Design

Gavin Vagts
Mechanical Engineering

Amy Volk
Animal Science

Isaac Wanner
Pharmaceutical Sciences

Aaron Watland
Biological Sciences

Karliegh Wattier
NDSU CHANGE Program

Kayden Werlinger
Food Science

Kiergon Wilkins
Psychology

Alyssa Willis
Psychology

undergrad advisors + mentors

COLLEGE OF AGRICULTURE, FOOD SYSTEMS, AND NATURAL RESOURCES

Brooke Thiel, Ph.D.
Agricultural and Family Education

Kasey Carlin, Ph.D.
Animal Sciences

Pawel Borowicz, Ph.D.
Animal Sciences

Barney Geddes, Ph.D.
Microbiological Sciences

Glenn Dorsam, Ph.D.
Microbiological Sciences

Thomas Baldwin, Ph.D.
Plant Pathology

Frank Manthey, Ph.D.
Plant Sciences

Juan Osorno, Ph.D.
Plant Sciences

Deirdre Prischmann-Voldseth, Ph.D.
School of Natural Resource Sciences

Travis Seaborn, Ph.D.
School of Natural Resource Sciences

COLLEGE OF ARTS AND SCIENCES

Angela Hodgson, Ph.D.
Biological Sciences

Britt Heidinger, Ph.D.
Biological Sciences

Craig Stockwell, Ph.D.
Biological Sciences

Jennifer Momsen, Ph.D.
Biological Sciences

Joshua Rinehart
Biological Sciences

Julia Bowsher, Ph.D.
Biological Sciences

Katie Reindl, Ph.D.
Biological Sciences

Kendra Greenlee, Ph.D.
Biological Sciences

Madison Floden
Biological Sciences

Matthew Smith, Ph.D.
Biological Sciences

Ned Dochtermann, Ph.D.
Biological Sciences

Steven Travers, Ph.D.
Biological Sciences

Timothy Grieves, Ph.D.
Biological Sciences

Eugene Caldona, Ph.D.
Coatings and Polymeric Materials

Xiaoning Qi, Ph.D.
Coatings and Polymeric Materials

Gudrun Lukat-Rodgers, Ph.D.
Chemistry and Biochemistry

Kenton Rodgers, Ph.D.
Chemistry and Biochemistry

Seth Rasmussen, Ph.D.
Chemistry and Biochemistry

Stuart Haring, Ph.D.
Chemistry and Biochemistry

Susan Ray-Degges, Ph.D.
School of Design, Architecture, and Art

Yongki Choi, Ph.D.
Physics

Benjamin Balas, Ph.D.
Psychology

Katherine Duggan, Ph.D.
Psychology

Christina Weber, Ph.D.
Sociology and Anthropology

Christopher Whitzel, Ph.D.
Sociology and Anthropology

Kristen Fellows, Ph.D.
Sociology and Anthropology

COLLEGE OF ENGINEERING

Jen Li, Ph.D.
Computer Science

Chad Ulven, Ph.D.
Mechanical Engineering

Long Jiang, Ph.D.
Mechanical Engineering

Yan Zhang, Ph.D.
Mechanical Engineering

COLLEGE OF HEALTH AND HUMAN SCIENCES

Seungmin Kang, Ph.D.
Health, Nutrition and Exercise Sciences

Heather Fuller, Ph.D.
Human Development and Family Science

Emma Dupont, Ph.D.
Pharmacy Practice

Heidi Eukel, PharmD
Pharmacy Practice

Elisabetta Liverani, Ph.D.
Pharmaceutical Sciences

Estelle Leclerc, Ph.D.
Pharmaceutical Sciences

Natasha Fillmore, Ph.D.
Pharmaceutical Sciences

Roberto Gomes, Ph.D.
Pharmaceutical Sciences

Sathish Venkatachalem, Ph.D.
Pharmaceutical Sciences

Sijo Mathew, Ph.D.
Pharmaceutical Sciences

Stefan Vetter, Ph.D.
Pharmaceutical Sciences

Yagna Jarajapu, Ph.D.
Pharmaceutical Sciences

EXTERNAL MENTORS

Kyle McLean, Ph.D.
U.S. Geological Survey,
Northern Prairie Wildlife Research Center

Jeremy Guinn, Ph.D.
United Tribes Technical College

Mandy Guinn, M.S.
United Tribes Technical College

Page Klug, Ph.D.
USDA-APHIS Wildlife Services,
National Wildlife Research Center

Focus on the immune response to sepsis by analyzing spleen pathology in a mouse model

MARYUM ADNAN
Pharmacy
Project Mentor: Elisabetta Liverani, Ph.D., Pharmaceutical Sciences

Sepsis is a life-threatening condition caused by an extreme immune response to infection, leading to widespread inflammation and organ damage. My research focuses on the immune response to sepsis by analyzing spleen pathology in a mouse model. I specifically studied the spleen in my research because it plays a crucial role in filtering blood and mounting an immune response, allowing me to study how sepsis affects immune cell activity and tissue structure.

Sepsis is induced in healthy laboratory [EL1] mice through injection, followed by organ harvesting after 24 hours. Using microscopy, I examine structural damage and differences between septic and healthy mice, as well as male and female variations.

Spleen cells were isolated, centrifuged, and resuspended in HBSS to maintain viability before undergoing antibody staining for analysis. I performed the same technique under a hood when sterility was needed. Sample 6 was specifically treated with CD25 and FoxP3 antibodies, followed by fixation, permeabilization, and staining to assess cellular interactions and immune response.

Tissue is chopped on a glass platform, and the cell suspension is transferred into labeled tubes with HBSS to maintain cell integrity. The labeled tubes (1-6) are placed into a centrifuge to ensure proper identification and preparation for separation. Centrifugation separates cellular components based on density, enabling the isolation of different fractions for analysis. The Ultrasonicator uses ultrasonic waves to break apart cells or particles, while the centrifuge applies high-speed spinning to separate cellular components based on density.

Conclusion: Overall, this experiment reinforced my understanding of cell isolation, labeling, and staining techniques, which are essential for immunological analysis and flow cytometry applications.

An Agentic AI System for Personalized Support in Alzheimer's Disease and Related Dementias

AYANLE AIDEED
Computer Science
Project Mentor: Jen Li, Ph.D., Computer Science

Alzheimer's Disease and Related Dementias (ADRD) affect millions worldwide, leading to progressive cognitive decline that impairs daily functioning and autonomy. Individuals with ADRD often struggle with tasks such as remembering appointments, managing medications, and maintaining social connections, significantly impacting their quality of life and placing substantial burdens on caregivers. Traditional interventions have provided limited support in mitigating these challenges.

Recent advancements in artificial intelligence (AI) have introduced innovative solutions to support ADRD patients. Notably, AI-driven chatbots have been developed to assist with daily tasks and provide companionship. However, existing chatbot systems often lack the necessary personalization and contextual awareness required to effectively address the complex needs of ADRD individuals. They typically operate as monolithic entities, which limits their ability to handle multifaceted tasks such as scheduling, reasoning, and proactive reminders.

To address these limitations, this research proposes a multi-agent system architecture designed to provide personalized, context-aware support for ADRD patients. By dividing complex tasks among specialized agents, the system effectively manages various responsibilities such as appointment scheduling, resolving scheduling conflicts, retrieving necessary information, sending medication reminders, and encouraging social engagement. Each agent functions independently but collaborates seamlessly, enhancing system modularity and adaptability.

The primary objective of this study is to create an intelligent, AI-powered system that assists ADRD patients in managing daily tasks through personalized, context-sensitive interactions. This multi-agent architecture facilitates coordinated efforts among specialized agents.

Key contributions include: Modular Multi-Agent Workflows Tailored to ADRD Care: Using specialized agents to independently manage specific tasks, providing flexibility and ease in patient care. Integrated Reasoning, Conflict Resolution, and Personalized

Reminders: Equipping agents with capabilities to assess patient needs, handle scheduling conflicts smoothly, and deliver personalized, timely reminders to support daily living.

User-Friendly Design to Enhance Autonomy and Social Interaction: Creating an easy-to-use interface that empowers ADRD patients, promoting their independence and enhancing social participation. This research addresses unique ADRD care challenges, contributing significantly to AI-based healthcare and paving the way for further advances in personalized assistive technology.

Simulating the Effects of Visual Cataract on Facial Recognition

ABUK AKECH
Psychology
Project Mentor: Benjamin Balas, Ph.D., Psychology

Cataracts impairs facial recognition by reducing contrast sensitivity and spatial resolution. Studies have shown that short-term visual deprivation, such as that caused by cataracts, can lead to temporary changes in early visual processing (Jamal and Dilks, 2020). Furthermore, individuals who underwent cataract vision-restoring surgeries struggled with facial recognition, suggesting that cataract related visual deficits may have lasting effects (Kalia et al, 2013). This poses a vital question of if individuals were to learn faces under simulated cataracts, how might their visual perception be affected,

and for what duration. To explore this, our study investigates how learning to recognize new faces with impaired visual acuity affects later recognition once vision improves. By utilizing cataract-simulation goggles during both training and testing of new faces, we examined whether temporary visual disruptions during identity learning lead to lasting deficits in facial recognition. Participants, recruited from the NDSU Undergraduate Psychology Study Pool, were randomly assigned to one of four groups experiencing different visual impairment conditions. The experiment consists of two phases; a training phase where participants learn to distinguish images of two faces, and a testing phase, which measures their ability to distinguish between two unfamiliar faces from one another relative to their discrimination abilities for a second set of novel faces. The stimulus set consisted of 80 color images of 4 female celebrity faces (20 images per celebrity) displaying a range of facial expressions, poses, and other types of ambient variability. Results show that training with cataract simulation goggles had a significant effect on recognition accuracy ($F(1,26) = 10.86$, $p = 0.003$, $\eta^2 = 0.104$) while testing with goggles had an even larger significant effect ($F(1,26) = 62.77$, $p < 0.001$, $\eta^2 = 0.602$). Notably, participants training with goggles while testing with normal vision (M=0.819) led to better accuracy than the reverse (M=0.709). These findings suggest that unexpected visual impairment during testing disrupts recognition more than learning under impaired conditions. This highlights the importance of visual stability for facial recognition performance.

Minimizing Bee Bycatch in Japanese Beetle Traps

SPENCER ALEFTERAS
Biological Sciences
Project Mentor: Deirdre Prischmann-Voldseth, Ph.D.,
School of Natural Resource Sciences

Pest trapping is a common practice when monitoring and managing harmful insect pests, but these traps can also attract non-target insects, or bycatch, such as bees (Hymenoptera: Apoidea). Bee bycatch has been noted in traps for pest Japanese beetles (JB, Coleoptera: *Popillia japonica*), which could harm important insect pollinators. We identified and quantified bee bycatch within the standard yellow-green JB traps throughout different regions of North Dakota. We also tested two trap alternatives at a site with high JB densities, *i.e.* an all-green trap and the standard yellow-green trap covered with metal mesh, with the goal being to maintain the number of JB trapped while decreasing the incidence of bee bycatch. We expected that: 1) geographic region will impact the identity of bees in JB traps, 2) bycatch will increase along with the size of the urban area being surveyed, 3) large bees will make up a greater proportion of bycatch than small bees, 4) trap alternatives will catch equivalent densities of JB and lower densities of bees compared to the standard trap. Results from the state survey are forthcoming. With the alternative trap testing. The standard control traps (Green & Yellow) caught significantly more JB than the two alternative traps. In addition, control traps also caught more bees than the two alternative traps and were the only traps that caught bumble bees. However, the overall level of bee bycatch was low, possibly because of the extremely high densities of JB. Bee bycatch may be more of an issue in rural areas with higher densities of nesting bees. Understanding how insect pest traps affect non-target insects can help people adjust their practices to achieve both IPM and conservation goals.

Other Contributors: Deirdre Prischmann-Voldseth, Charles Elhard, Scott Opatril

Enhanced mechanical and adhesion properties of biodegradable Zein-based coatings plasticized with vegetable oils

ASHLYNN BADENOCH
Chemistry
Project Mentor: Xiaoning Qi, Ph.D., Coatings and Polymeric Materials

Non-biodegradable materials are a major contributor to environmental pollution, ecosystem degradation, and climate change, underscoring the need for sustainable alternatives. Zein protein (ZP), derived from renewable feedstocks such as corn, presents a promising biodegradable option for coating applications. However, pure zein films are prone to brittleness, cracking during curing, and poor adhesion to metal substrates, limiting their practical use. Defatting zein (ZPD) reduces intramolecular and intermolecular interactions, thereby increasing the availability of bonding sites for plasticizers and improving flexibility and adhesion. In this study, castor oil (CO) and cottonseed oil (CSO), both biodegradables, non-toxic, and commercially available, were evaluated as plasticizers to enhance the mechanical and adhesion properties of zein-based coatings. The coatings were prepared using CO and CSO at concentrations of 5%, 10%, and 15% by weight. Mechanical tests, including tensile strength, elongation at break, and hardness, were conducted along with adhesion tests using a pull-off method. The results revealed that the 10% CO formulation exhibited the highest surface adhesion strength of 280 psi and enhanced flexibility without compromising mechanical integrity. Both plasticizers demonstrated excellent solvent resistance, confirmed by the MEK double rub test. However, the 15% CSO formulation resulted in reduced mechanical performance, indicating plasticizer oversaturation. These findings suggest that CO at 10% concentration is an optimal plasticizer for improving the performance and durability of biodegradable zein-based coatings, offering a sustainable alternative for protective and functional coatings.

Other Contributors: Iram Riaz, Ravi Arukula, Andriy Voronov, Xiaoning Qi

Coproheme III Channeling from Coproporphyrin Ferrochelatase to Coproheme Decarboxylase

ADAM BENDEWALD
Biochemistry and Molecular Biology
Project Mentor: Kenton Rodgers, Ph.D., Chemistry and Biochemistry

The coproporphyrin-dependent (CPD) heme *b* biosynthesis pathway is unique to Gram-positive bacteria making it a promising antimicrobial target. Its last three enzyme-catalyzed steps diverge from the canonical protoporphyrin-dependent pathway present in eukaryotes and Gram-negative bacteria. In the penultimate step of the CPD pathway, coproporphyrin ferrochelatase (CpfC) catalyzes the insertion of Fe^{2+} into coproporphyrin III to yield coproheme III (CH3). CH3 is then transferred to the final enzyme in the pathway, coproheme decarboxylase (ChdC), which catalyzes the sequential H_2O_2-dependent oxidative decarboxylation of propionate groups at β-pyrrole positions two and four to yield heme b. However, the mechanism in which CH3 is transferred from CpfC to ChdC remains unresolved. There are two mechanistic hypotheses for this transfer. In the first, dissociation of CH3 from CpfC is followed by its more strongly driven association with ChdC (hereinafter, passive transfer mechanism). Alternatively, an active transfer mechanism would

proceed via a ternary precursor complex between CH3:CpfC and ChdC to facilitate the direct, intracomplex handoff of CH3 to ChdC. To address these two mechanisms, initial reaction rates for CH3 transfer from CH3:CpfC to ChdC were measured by stopped-flow ultraviolet-visible spectrophotometry. Specifically, CH3:CpfC was rapidly mixed with ChdC at a series of concentrations allowing for initial rates to be plotted as a function of [ChdC]. These measured initial rates were compared with initial rates calculated from an initial rate expression derived from the passive transfer mechanism. Conversely, experimental initial rates were fitted using an initial rate expression whose derivation is based on the active transfer mechanism. The results of the fitted and calculated initial rates and the insight they provide into the mechanism by which CH3 is transferred will be discussed.

Other Contributors: Olivia Stiller, Gudrun Lukat-Rodgers

Successes and Challenges of Implementing Tobacco/ Nicotine Dependence Treatment Services in North Dakota Pharmacies

JULIANNA BERG
Anthropology
Project Mentors: Kristen Fellows, Ph.D., Sociology and Anthropology, and Emma DuPont, Ph.D., Pharmacy Practice

Community pharmacies tend to rely on dispensing medications as their primary business model, but decreasing reimbursement rates are prompting pharmacists to investigate other avenues of revenue. In 2021, North Dakota Senate Bill 2221 expanded pharmacies' clinical service capabilities, including authorization to provide tobacco
and nicotine dependence treatment. Defining success with the implementation of a new service varies depending on the pharmacy setting and the population it serves. Based on ongoing ethnographic research in six North Dakota community pharmacies, we highlight a range of emic perspectives on the successes and challenges of implementing tobacco and nicotine dependence clinical services.

The Biotic Homogenization of Prairie Pothole Upland Plant Communities

SOFIA BLAIR
NDSU CHANGE Program: Research and Mentoring for Postbaccalaureates in Biological Sciences
Project Mentor: Kyle McLean, Ph.D., U.S. Geological Survey

Across the Great Plains of North America, grasslands have declined, with an estimated 62% loss overall. In the Prairie Pothole Region, remaining grasslands are highly invaded by cool season invasives, including smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*), which outcompete native plant species and reduce ecosystem diversity. The expansion of these species in North Dakota is likely promoted by a recent climatic shift to wetter and warmer conditions. To document changes in plant communities across two distinct climate periods, we collected plant species data to compare against records from a 1989 survey at the Cottonwood Lake Study Area in North Dakota. We replicated the previous survey design as closely as possible by using transects on North, East, South, and West aspect sites, as well as mesic and xeric sites, to record data on plant species presence and canopy cover via the Daubenmire method. We observed that diversity between sites in 2024 was much less than that in 1989, with specific invasive species such as smooth brome greatly increasing in occurrence. The data demonstrate a biotic homogenization over time, which coincides with a climatic shift to wetter conditions. This study illustrates the importance of recording changes in plant communities to gain a better understanding of the ecological processes influenced by climatic shifts.

Elucidating Phenotype Genes of Wild *S. meliloti* pSymA Mega Plasmid.

CORRIN BOTTOM
NDSU CHANGE Program: Research and Mentoring for Postbaccalaureates in Biological Sciences
Project Mentor: Barney Geddes, Ph.D., Microbiological Sciences

The symbiosis between rhizobia and legumes is widely studied because of its ability to fix atmospheric nitrogen. The efficiency of this symbiosis is measured by its ability to fix nitrogen in root nodules (effectiveness) and the ability of rhizobia to form nodules (competitiveness). Bacteriophages are viruses that infect bacterial hosts for reproduction. It has been suggested that strain susceptibility or resistance to bacteriophages has a significant impact on the population diversity of rhizobia in the fields, potentially impacting this symbiotic interaction (phage resistance). Rhizobia have multi-partite genomes, and the *nod*, *nif*, and *fix* genes that are essential for symbiosis are typically located together on mobile plasmids, however, less is understood about the organization of genes that contribute to symbiotic effectiveness, competitiveness, or phage resistance. The genome of *Sinorhizobium meliloti* is majorly comprised of a chromosome, a symbiotic mega plasmid (pSymA), a chromid (pSymB), and occasionally accessory plasmids. In *S. meliloti*, the pSymA mega plasmid is known to have a diverse pangenome relating to intraspecific genetic differentiation, possibly contributing to a strain's evolutionary persistence in the field. In this study, we investigate the genomic context genes encoding symbiotic effectiveness, competiveness and phage resistance phenotypes in the model rhizobium *S. meliloti*, a symbiont of the crop alfalfa (*Medicago sativa*) and model legume *Medicago truncatula*. We hypothesized that the gene contents of pSymA is responsible for genetic variation in each of these phenotypes in a subset of 13 highly competitive strains with varying levels of effectiveness and phage resistance were selected from a collection of 200 strains that had been evaluated previously. To test this hypothesis, we transferred pSymA from each strain to a naïve wildtype background and evaluated the "hybrids" for transfer phenotypes from the pSymA parent strains. Characterization of effectiveness phenotypes was performed by single-strain inoculation in plant assays, while phage resistance was confirmed by plaque assay using three phages, i.e., phiM12, 115, and 116. These strains were also evaluated to verify their competitiveness using CFP and YFP fluorescent markers. Identifying the location of phenotype genes will help provide a better understanding of Rhizobia's symbiotic relationship with Legumes.

Other Contributors: Tania Gupta, Barney Geddes

Investigation of PDAC cell death mechanism by COPZ1 inhibition

ALYSSA BOYKO
Biological Sciences
Project Mentor: Roberto Gomes, Ph.D., Pharmaceutical Sciences

The objective of this project is to investigate and identify the mechanism of death of pancreatic ductal adenocarcinoma cells by selective inhibition of COPZ1. We believe that a synergistic effect of Golgi Complex disruption and Ferroptosis induced by NCOA4 mediated autophagy. We have developed a set of compounds that were able to inhibit and kill PDAC cells. We plan to use those drugs in our knockdown normal pancreatic cell and HPNE as control while using MiaPaCa-2, PANC-1 and ASPC1 pancreatic tumor cell. After cell culture is done, cells will be collected and lysed with RIPA lysis buffer (Thermo Fisher Scientific) supplemented with the proteinase inhibitor PMSF (Solarbio, Beijing, China) at a ratio of 100:1 (v/v). Protein concentration will be determined with the BCA Protein Assay Kit (Beyotime). Equal quantities (20 ug) of protein extracts will be separated with 10% SDS-PAGE and transferred to PVDF membranes (Merck Millipore; Billerica, MA, USA). The membrane will be blocked with skimmed milk for 1 h and incubated with primary antibodies overnight at 4 °C. For detection, membranes will be incubated with horseradish peroxidase-conjugated secondary antibodies (ZSGB-BIO) dissolved in antibody dilution buffer (Beyotime) for 1 h at room temperature. The membranes will be visualized with chemiluminescence (Bio-Rad; Hercules, CA, USA) according to the manufacturer's protocol. For immunofluorescence assay for Golgi studies, cells will be cultured on glass coverslips (Bellco Glass) were fixed with 3.7% paraformaldehyde in PBS for 20 min at room temperature and permeabilized with 0.5% Triton X-100 in PBS for 3 min. The coverslips will be incubated with mouse anti-GM130 antibodies (BD Bioscience PharMingen) and DAPI (Invitrogen). The secondary antibody will be Alexa Fluor 594- conjugated goat anti-mouse IgG (Invitrogen). Fluorescence images will be acquired using a Leica DM IRE2 microscope equipped with a Leica cooled CCD camera, Leica FW4000 software, and an HCX PL Apo 63/1.4 NA objective. Brightness, contrast, color balance, and final size of the images will be adjusted using Adobe Photoshop CS software. Both experiments will be confronted so we can study and learn what is the mechanism of death used for our drug prototypes.

Other Contributors: Allana C. F. Martins, Roberto Gomes

Community on College Campuses: Student Preferences Within Student Housing

EMMA BUYSSE
Interior Design

ANNA ROBINETTE
Interior Design

ERIN TSCHETTER
Interior Design
Project Mentor: Susan Ray-Degges, Ph.D., Interior Design

This study aims to understand how the interior environment of student housing supports the well-being and success of college students. When transitioning to higher education it can be particularly stressful, and "properties of students' physical environment can have a critical impact on their psychological experience" (Meagher, 2020, p. 30). Modern student housing is seen as indispensable to students' needs (Najib et al., 2011, p. 52). A purposive study was conducted among current and former college students who had lived in student housing.

To gain insights into student housing preferences and community experiences from current and former students, an online survey was conducted. The survey was sent out to students at multiple universities and contained multiple choice, fill-in-the-blank, and open-ended questions, some of which used the Likert scale.

The study revealed key insights based on the 274 responses to the survey. Private and group study rooms were viewed as highly valued amenities, with many students (80%) preferring to study alone. This highlights the need for a balance between group and individual areas, to cater to as many students as possible. When asked about specific study preferences, the results were mixed. This suggests that it would be beneficial to offer a variety of study environments for students to choose from. Additionally, the survey asked about the desirability of other amenities, as well as habits regarding student socialization. Many students stated they preferred to socialize in a home-like environment, which could be satisfied by including informal lounge areas.

The last section of the survey was limited to those who have a pet, emotional support animal, or service animals. While amenities such as walking paths (85%), pet parks (53%), and relief areas (64%) were considered desirable, the limited number of pet owners in our sample meant we had less data to analyze in this section.

This survey included limitations in addition to the limited number of responses from pet owners. Terms like "socialization" were not defined, which might have caused participants to interpret them differently. Lastly, there were a few unfinished surveys, reducing the amount of usable data in certain areas.

Investigating Genetic Origin and Bottleneck of a Co-Managed Elk Herd in North Dakota

MEGAN CLARK-LOWELL
NDSU CHANGE Program: Research and Mentoring for Postbaccalaureates in Biological Sciences
Project Mentor: Jeremy Guinn, Ph.D., United Tribes Technical College Intertribal Research & Resource Center

Although once widespread, Elk (*Cervus canadensis*) were extirpated from North Dakota and occur today only in several populations as a result of natural immigration, escapes, and intentional translocations. Although there are earlier accounts of elk in the area, 47 elk were sent to the Standing Rock Sioux Tribe (SRST) in 1993 and the population maintained at around a dozen animals for decades before aerial surveys estimated 97 elk in 2017, over 250 in 2019, and over 300 in 2023. There is a portion of the population with malformed antlers. SRST Game & Fish Department and the ND Game & Fish Department (NDGF) are co-managing the herd. The purpose of this project was to better understand the relationships among elk populations in North Dakota and gain insights into the origins and possible genetic bottleneck of the population at SRST. We extracted DNA (Qiagen DNEasy Blood and Tissue Kit) from the oral mucosa attached to hunter-provided samples of harvested elk teeth. Samples were submitted to the U. Minnesota Genomics Lab for sequencing and bioinformatics (Genome By Sequencing (GBS) methods). While the number of samples collected from the SRST herd this year were insufficient to make definitive statements about antler growth, we will continue to add samples to the pool of data in future years. The project

adds several layers of knowledge about elk in the state and their place in the broader region. The partnership represents the first time the state and tribal G&F departments have collaborated to co-manage a population.

Temperature-Dependent Corrosion Inhibition of Soybean Extract on Carbon Steel in Acidic Medium

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Biochemistry and Molecular Biology
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Corrosion poses a pervasive challenge across various industries, causing substantial economic losses and compromising the integrity of critical infrastructure. Although corrosion-inhibiting agents emerge as a promising solution to control these detrimental effects, traditional corrosion inhibitors often entail the utility of complex and costly synthetic chemicals, which come with environmental and health risks. Consequently, there is a growing interest in exploring sustainable and cost-effective alternatives sourced from plants, aiming to address both the efficacy and environmental impact of corrosion control methods. Soybean extract (SE) emerges as an attractive candidate, offering a renewable and environmentally friendly solution to corrosion inhibition. Its appeal lies in sustainability with a steadily growing global demand, ensuring viability in the long term. In addition, its comparatively lower cost compared to conventional inhibitors enhances its economic appeal as a corrosion mitigation solution. SE demonstrates the ability to form thin protective films on metal surfaces owing to its abundance in isoflavones containing pi-electrons, which facilitate bonding with metal substrates, effectively slowing down the corrosion process. This study investigates SE's efficacy as a corrosion inhibitor by conducting various experimental analyses on carbon steel substrates immersed in an acidic solution at different temperatures. Characterization techniques, including open circuit potential, electrochemical impedance spectroscopy, potentiodynamic polarization, and atomic force microscopy, are employed to elucidate SE's inhibitive mechanisms and evaluate its performance. Overall, our results highlight SE's potential as a viable and environmentally benign corrosion inhibitor, providing a sustainable solution to address corrosion across a wide range of industrial applications.

Other Contributors: Marcel Roy B. Domalanta, Mark Rigel R. Ali, Eugene B. Caldona

Characterization of a gut epithelial-specific VPAC1 Knockout mouse model

JOSHUA EBERTS
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Vasoactive Intestinal Peptide (VIP) is a neuropeptide expressed throughout the mammalian central and peripheral nervous systems. VIP receptors, termed VPAC1 and VPAC2, are widely expressed and transmit intracellular signals regulating VIP's diverse biological processes, including circadian rhythms, fatty-acid metabolism, and immune homeostasis. VPAC1, but not VPAC2, is exclusively expressed on intestinal epithelial cells (IEL), which function as a barrier between the host and luminal content. There are at least 7 different IEC lineages derived from intestinal stem cells (ICL) located within the crypts of Lieberkühn. VPAC1 expression is well-documented in IELs, but its contribution to stem cell differentiation, migration, and survival of IELs is not well characterized. Therefore, we have established a tissue-specific VPAC1 knock out exclusively in ICLs and IELs, with a green fluorescent protein cassette inverted and expressed upon VPAC1 recombination. At present, we have successfully bred VPAC1 floxed mice harboring either a constitutive or an inducible CRE recombinase gene under the control of the intestinal cell promoter, villin, as assessed by polymerase chain reaction (PCR). Quantitative PCR , Immunofluorescence, immunoblots, and flow cytometry end-point analyses have been initiated. Results from this project are expected to be used to determine which lineages of IECs are dependent on VPAC1 expression, and to demonstrate how a disruption of the epithelial barrier in the gut may lead to impaired mucosal immunity and nutrient absorption.

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Binding of Calmodulin to CAMKV: A Crystallographic Approach

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The calcium-binding protein Calmodulin (CaM) is an important regulator of many cellular processes. Calcium binding to calmodulin in response to an intracellular calcium increase, enables Ca-CaM binding to specific regions of CaM-regulated proteins. Several calmodulin regulated proteins are important drug targets. It is therefore important to understand how calmodulin interacts with each of its target proteins. The pseudo kinase CAMKV contains a putative calmodulin binding domain, which has not been characterized so far. We have previously demonstrated that Ca-CaM does bind to the predicted CaM-binding region of CAMKV and have further refined these studies recently.
To gain further insights in the interaction between the proteins on the molecular level, we attempt to crystallize the complex of Ca-CaM and a synthetic CAMKV peptide. We have not yet obtained crystals of the protein complex. The poster will explain the steps necessary to co-crystallize CaM with its target and present our preliminary results.

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The Influence of Pollination Mutualism on Floral Morphology in Platanthera Orchids

HYLA ERICKSON
Natural Resource Management
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Pollination mutualisms have long been thought to play a role in the evolution of floral morphology. Flowers often reflect the type of pollinator that visits and pollinates them. If this statement holds true, we expect closely related plant species to have divergent floral morphologies if they have different pollinators, and the morphologies should reflect those pollinators. This study investigates this phenomenon in four Platanthera orchid species. Two species are

nocturnally pollinated, sharing the same pollinator, the Hawk Moth, while the other two are diurnally pollinated, sharing the Swallowtail Butterfly as a pollinator. We expect the nocturnally pollinated plants to be more similar than diurnally pollinated plants because they share the same pollinator and vice versa. Additionally, due to a process called character displacement, plant species that share the same pollinator should have more distinct characteristics with less variability within a species to reduce hybridization between species. I expect the nectar spur length of the species pollinated by the Hawk Moth will be longer than those pollinated by the Swallowtail because the Hawk Moth's proboscis is longer. Similarly, plants pollinated by Swallowtail Butterflies are expected to have smaller sepals compared to those pollinated by Hawk Moths, as larger pollinators tend to be attracted to larger flowers. To test this, I looked at five morphological features of the praeclara and leucophaea, our two nocturnally pollinated Platanthera plants, and the grandiflora and psycodes, our two diurnally pollinated Platanthera plants. I also mapped where each plant was found to see whether character displacement took place. I used images on SEINet, provided by many institutions, of these four species to measure the morphological features- nectar spur length, ovary length, side sepal area, inflorescence length, and basal leaf area. Based on this data, I performed a T-test and a PCA, which revealed that the flowers pollinated nocturnally exhibit greater differences from one another compared to those pollinated diurnally, while plant size changed very little between all four species. These results could indicate that pollination mutualism has a greater influence on the Swallowtail Butterfly orchids, and character displacement is shown more in those pollinated by Hawk Moths.

Quantification and Molecular Characterization of Extracellular Vesicles

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Biological Sciences
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Extracellular vehicles (EVs) are lipid-bound particles secreted by all cells that help intercellular communication through the transfer of macromolecules such as proteins, lipids, and nucleic acids. EVs have been implicated in various physiological and pathological processes, including cancer progression, making them promising candidates for liquid biopsy applications. However, the isolation and characterization of EVs present technical challenges due to the lack of standardized methods, low yield, and preparation variability. This current project aims to characterize EVs derived from diverse cell sources to improve their detection and analysis for biomedical applications. EVs isolated using multiple established methods, including ultracentrifugation, the total exosome isolation reagent kit, and size exclusion chromatography. Their quantification conducted using nanoparticle tracking analysis and a colorimetric enzyme activity assay to assess size distribution and concentration. By employing these approaches, we aim to categorize EVs based on their size and molecular composition, providing valuable insights into their heterogeneity. This research contributes to the development of more reliable EV-based diagnostic tools by improving our understanding of EV molecular profiles and refining isolation techniques for clinical and research applications.

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Expanding Access & Reducing Stigma: The Impact of ONEBox on North Dakota's Opioid Crisis

JADA FORD
Statitics

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Anthropology
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The rate of drug overdose deaths in North Dakota has increased from 3.1 deaths per 100,000 in 2012 to 17.2 per 100,000 in 2021. In 2022, North Dakota reported 148 overdose-related deaths, and in 2023, 116 overdose-related deaths were reported. This project aims to understand the impact of ONEBoxes that have been placed in communities across the state through a qualitative approach. The ONEBox is a tool to reverse emergency opioid overdoses by offering two doses of Narcan, a personal protective equipment (PPE) kit, and an educational video. Interviews were conducted with public health professionals employed at local public health units (LPHUs), further exploring topics such as the introduction of ONEBoxes to the community, box placement locations and usage, perceptions of opioid use and harm reduction tools, and future needs related to opioid use prevention. Our findings indicate that the core challenges stem from persistent systemic barriers, including those of stigma and resistance, community pushback, denial of local opioid problems, and constraints related to staffing and funding. However, the introduction of the ONEBox has increased awareness and education within communities, thus contributing to a larger impact of reducing the overarching stigma around opioid use.

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Effects of Gravity on Immiscible Drop Transport in Collapsible Thin-Walled Vessel: An Experimental Study

LOUIS GAYTAN
Mechanical Engineering
Project Mentor: Yan Zhang, Ph.D., Mechanical Engineering

The formation and transport of immiscible liquid drops in large, thin-walled vessels are crucial for cardiovascular flow phenomena, such as thrombus transport, and endovascular treatments like portal vein embolization. Physiologically, thin-walled vessels are highly flexible and can buckle or collapse when subjected to imbalances in transmural pressures, such as muscle and hydrostatic pressure changes. Despite extensive research on microfluidic droplet formation, the dynamics of large drops in collapsible vessels under naturally constricted or collapsed conditions remain underexplored. This study experimentally investigates the formation and transport dynamics of immiscible liquid drops in deformable thin-walled tubes. A co-flow liquid-in-liquid injection system generated immiscible silicone oil drops within a continuous phase of glycerin and water mixtures, ensuring neutral buoyancy as drops flowed through distended and constricted tube cross-sections. Additionally, high- and low-density ratios have been examined to compare the gravity effects on the drop transport dynamics. High-speed camera footage captured drop motion, while pressure and flow rates were monitored. Results indicate that drop size, spacing, and the transition from dripping to jetting regimes depend on both the external Capillary number (ratio of

viscous force to surface tension) and the internal Weber number (ratio of inertial force to surface tension). Vessel deformation and collapse further constrict drop transport, altering drop geometry, average diameter, and transport efficiency.

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Impact Characterization of 3D Printed Continuous Carbon Fiber Reinforced Thermoset Composites

KALEN GORDON
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Continuous carbon fiber reinforced (CCFR) thermoset composites exhibit excellent mechanical and thermal properties. However, conventional manufacturing of CCFR thermoset composites is expensive and labor intensive. In contrast, 3D printing offers design flexibility in manufacturing these composites. This study 3D printed CCFR thermoset composites using an ultraviolet light- assisted printing process. The primary objective of this study is to characterize the impact behavior of 3D printed CCFR thermoset composites. Impact characterization of the 3D printed fiber reinforced composites was performed using a drop-weight impact test. A 4 × 4 in panel was fabricated using 3D printing. The panel was subjected to a specific impact energy. The load-history curve was recorded during the test. The load history curve was divided into two distinct regions – a region of fracture initiation and a region of fracture propagation. The ratio of propagation energy to initiation energy is known as ductility index (DI). A low value of DI is an indication of the brittleness of the material, while a higher value indicates ductility. The DI was calculated for the 3D printed specimen to determine the nature of failure. Additionally, the perforated specimen after the impact test was qualitatively analyzed using an optical microscope.

Sea Otter (*Enhydra lutris*) & Human Interactions in the Homer Harbor

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Alaska has a stereotype of large expanses of wildlife with wild land. Located on the southern exterior of the state is the quaint town of Homer. The Homer Harbor is home to water vessels and many marine organisms. Two of the prominent marine mammals are the sea otter (*Enhydra lutris*) and the harbor seal (*Phoca vitulina*). Both species have achieved refuge and food in this area, making it an exciting site for tourists to visit. It was unknown how the increased human presence affects the sea otters' behaviors and natural activities. The reason for this study was to determine if our activity would affect the SEOTs (sea otters). This would hopefully result in a practical solution for SEOT conservation and protection. The observed behaviors of sea otters include foraging, diving, grooming, resting, alert, and vigilant. The group conducted a methodical procedure utilizing wildlife cameras to capture SEOT and boat activity influencing one another. Over the course of six weeks 28 videos fit the criteria and were analyzed with excel and R-studio. Both programs resulted in a supported hypothesis that sea otters do change their behavior in response to boat activity. As the study was concluded, the data was given to graduate students furthering the research, and it was given to the Coast Guard. We hope the research will be valuable to a proposed expansion of the harbor that would increase boat capacity from 40 to 200, including a dock for cruise ships. The purpose of this study was to see if the presence of people, and their activities, results in sea otters shifting their displayed behaviors.

Sociodemographic factors and sleep: A multi-wave longitudinal approach

JOELLE HANNAM
Psychology
Project Mentor: Katherine Duggan, Ph.D., Psychology

Disparities in sleep associated with socioeconomic status (SES) have been well documented. Generally, lower SES relates to worse sleep cross-sectionally and worsening sleep longitudinally. Fewer studies have tested whether sleep can predict decreases in SES longitudinally. This limitation in the literature has occurred in part because most studies do not have repeated assessment of SES. Here, we will evaluate how SES and sleep are related to each other across multiple waves of data collection. The study uses data from the NDSU National COVID study which has followed 300 American adults since April 2020. The analysis will include data from all waves in participants with data on demographics and sleep. Here, we present descriptive findings of correlations between sleep and SES within and across all waves of data collection. The study results have implications for understanding the dynamics of SES and sleep across time, which can inform public health efforts to improve sleep and reduce health disparities.

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Reducing Synthetic Complexity for Acceptor Units in Conjugated Polymers

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With the growth of organic semi-conducting materials in the market, such as OLED displays, a variety of optimizations are under review to bolster possible applications. Importantly, the complexity of related chemistry is a major perspective that limits industrial motivation. As such, the chemical foundation of organic semi-conductors, specifically conjugated polymers, needs to be addressed. Due to the structural nature of conjugated polymers, a multitude of avenues can be pursued to reduce synthesis related complexity. Notably, the influence of acceptor units within industrial conjugated polymers displays a greater role than other structural counterparts. Thus, attempts to combat the growth of synthetic complexity in modern conjugated polymers, the synthesis of various acceptor units is under investigation. These include compounds such as 3,6-dibromo-1,2-diaminobenzene (DBDAB) which is of interest due to relevant and numerous acceptor derivatives: 2,1,3-benzothiadiazole (BTD), 2H-benzotriazole (BTA), and quinoxaline (Qx). Utilizing an established formula to quantify synthetic complexity, efforts have been made to reduce required synthetic steps, procedural operations, and the number of hazardous reagents present in synthesis while increasing overall yields. The optimization of traditional synthetic pathways and various novel routes for DBDAB were addressed. The synthetic complexity index for the above-mentioned synthetic pathways will be discussed.

Can films be used to experimentally induce stress in a home environment? Results of a manipulation check from a pilot study

KATELYN HANSON
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Project Mentor: Katherin Duggan, Ph.D., Psychology

Emotional reactions to stress are a crucial part of psychological functioning, processing, and overall well-being. Experimental inductions of stress can be used to identify factors causally involved in these processes. For example, some studies experimentally induce stress by requiring people to make speeches or do challenging arithmetic tasks while being evaluated by others. However, it can be challenging to standardize these experiences across participants, and these tasks require visits to the research lab, limiting the ability to generalize to real-life scenarios.

Our lab has been developing an experimental stress induction paradigm using popular films which can be watched in participants' own homes, and which contain inductions of emotions and experiences (e.g., stress). However, the effectiveness, reliability, and validity of specific films in inducing stress and affect (i.e., the manipulation check) needs to be confirmed before looking at potential causal effects of the stimuli. This pilot study serves as a manipulation check to assess the efficacy of three different films in changing self-reported stress and mood. By confirming these films function as intended, we hope to establish a foundation for future research examining how emotional experiences such as stress impact psychological and physiological outcomes, including sleep.

In this study, participants completed one week of at home monitoring of mood, stress, and sleep before they watched one of three films. Two films were hypothesized to be emotionally neutral, and one was hypothesized to elicit stress. Immediately before and after watching the film, participants completed self-report measures of mood and stress, for a pre/post film comparison using repeated measures. These analyses will help us see whether each film elicited the hypothesized emotional responses.

By validating these films as effective for emotional stimuli, the study establishes a foundation for future research investigating the effects of stress on outcomes such as sleep. Specifically, our future research in this project will look at how stress influences sleep while also identifying protective factors. We aim to contribute to the broader understanding of the stress-sleep relationship by exploring how emotional experiences shape mental and physical health, with potential implications for interventions addressing stress- and sleep-related disorders.

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Societal Implications of Clean Energy Tractors for Farming

MACKENZIE HENDRICKSON
Agricultural Education

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Agriculture Education
Project Mentor: Brooke Thiel, Ph.D., Agricultural and Family Education; Christopher Whitzel, Ph.D., Sociology and Anthropology

Our research project seeks to collect feedback by interviewing farmers, industry experts including engineers and business professionals, and consumers about clean-energy-powered tractors. The results of this study will assist in understanding the long and short-term effects of clean-energy tractors on society, culture, the environment, and the economy. Our motivation for this problem is to understand what equipment farmers and ranchers are most likely to use on their operations and what factors influence their choices. We feel this research study is filling the practical gap of what clean-energy farming looks like or can look like in the industry. This study utilizes a qualitative approach by interviewing farmers and ranchers. Recruitment of participants involved sharing a google form for interested participants to sign up for an interview. After that, we contacted the participants to arrange a Zoom or phone call. Once we connected with our interviewees that agreed to join in on our study, we had a list of 11 questions to ask about their current tractors and potential future tractors, as well as what factors influence their perceptions of tractor features. After completing and transcribing several interviews with a range of individuals from all over Minnesota and North Dakota, we analyzed the data for codes and themes. Our findings highlight farmers who are of the older generations are less likely to change their ways to newer equipment mostly because of the cost and they are used to what they have if it works. Some younger generations have told us that they would be open to the idea of choosing clean-energy tractors if there were incentives to do so or if electric diesel engines were available. The goal is to interview 30 individuals with hopes of seeing responses reach saturation, though we do expect the occasional outlier response. The results of our findings show that younger individuals are willing to jump in and take the risk to better their operations so we would recommend the industry to prioritize younger individuals within agriculture.

Investigation of corrosion inhibition of steel using a microbial approach

BRADEN HERMAN
Mechanical Engineering
Project Mentor: Xiaoning Qi, Ph.D., Coatings and Polymeric Materials

Metal corrosion is a common issue that can weaken structures and lead to significant maintenance and repair costs. Protective coatings are commonly used to prevent corrosion by forming a barrier against harmful environmental factors. This study explores the potential of alkali-halophilic bacteria to enhance mineral deposition through microbial-induced calcium carbonate precipitation (MICP) for corrosion protection of steel in aggressive environments. Steel samples were exposed to a simulated corrosive environment with or without a calcium ion source. After two weeks, the samples with calcium ions exhibited reduced surface corrosion, whereas the other samples showed signs of both uniform and pitting corrosion. These preliminary results suggest that a microbial approach could provide effective corrosion inhibition and offer a promising alternative for improving corrosion resistance in marine and other challenging environments.

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The Mechanistic Role of Active-Site Residue K149 in Coproheme Decarboxylase

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Coproheme decarboxylase (ChdC) is the ultimate enzyme of the coproporphyrin-dependent heme b biosynthesis pathway (CPD). The CPD pathway is present in Gram-positive bacteria, diverging from the canonical pathway in eukaryotes and Gram-negative bacteria for the last three steps of the heme *b* biosynthesis. Divergent or alternate biosynthesis pathways are a common target for antimicrobial research. Thus, our goal is to characterize the mechanistic details of the enzymes in the CPD pathway. ChdC sequentially catalyzes the oxidative decarboxylation of propionate groups at β-pyrrole positions 2 and 4 (P2, P4) on coproheme III (CH3) to yield vinyl groups. To further understand the catalytic mechanism of ChdC, several surface and active site residues have been mutated and show in vivo disruptions of the heme *b* biosynthesis pathway. In vitro research has demonstrated ChdC(K149A) only catalyzes the decarboxylation of P2, stopping at the half-product harderoheme III. The presented substrate- and product-binding thermodynamic equilibrium constants provide several hypotheses for the role of Lys149 in the catalyzed transition to the P4 decarboxylation. Kinetic results will be presented as further evidence for these hypotheses.

The Effect of One-Carbon Metabolite Supplementation on Oxidative Stress in Pregnant Beef Heifers, Histology Approach

KELSEY HOOKER
Animal Science
Project Mentor: Pawel Borowicz, Ph.D., Animal Sciences

Maternal nutrition plays a vital role in fetal development, influencing key cellular pathways that regulate stress responses, metabolism, and tissue growth. One-carbon metabolites (OCM)– including methionine, choline, folate, and vitamin B12–are essential for proper cellular function and may impact these pathways in both maternal and fetal tissues. This study investigated how maternal diet, combined with OCM supplementation, affects liver health, a key organ involved in metabolism and inflammation, while using pregnant beef heifers as an animal model.

Thirty-two Angus beef heifers were bred using the same sire and assigned to four dietary treatments (n = 8 ± 1 per group); adequate nutrition (CON) or restricted nutrition (RES), with or without OCM supplementation (+/- OCM). Nutritional treatments were provided for the first 63 days of pregnancy, after which all heifers received the same diet. Liver samples were collected at day 260 of gestation and examined under a microscope using fluorescent markers to measure the abundance of phosphorylated p38 MAPK (p-p38), a protein involved in cellular signaling related to inflammation, metabolism, and tissue remodeling.

While overall diet did not significantly alter p-p38 levels, heifers that received OCM supplementation showed a 54.75% increase in these proteins' levels compared to those without supplementation. This suggests that OCM may enhance liver function and help the body to adapt to the demands of pregnancy. By understanding how maternal nutrition influences stress responses in pregnancy, we can develop better feeding strategies to support both maternal health and fetal growth. Further research is needed to determine how these liver changes impact pregnancy outcomes and offspring development.

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Tissue Renewal Through Metamorphosis and its Impact on Cellular Aging

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Project Mentor: Kendra Greenlee, Ph.D., Biological Sciences

Telomeres are protective caps at the ends of chromosomes that protect from degradation during DNA replication. Telomere length gradually decreases after successive replication cycles; thus, telomere length can be used as a common predictor of biological age in many organisms. In contrast, the alfalfa leafcutting bee, *Megachile rotundata*, and the orchard mason bee, *Osmia lignaria*, have increased telomere length in later stages of development. Holometabolous insects, such as *M. rotundata* and *O. lignaria*, undergo metamorphosis, which is a transformative process that uses stem cell-like imaginal cells to replace larval tissues with new, adult tissues. Disposable tissues undergo complete morphological remodeling, while non-disposable tissues remain unaffected by the process. To determine the impact this physiological remodeling process has on biological aging, we will explore telomere length in larval and adult tissues in the model organism, *Manduca sexta*, the tobacco hornworm. We will measure telomere length in disposable and non-disposable tissues in fourth and fifth instar larvae as well as in adult *M. sexta* following metamorphosis. We predict that non-disposable tissues such as neural tissue and testes/ovaries will have shorter telomeres, but that disposable tissue types integument and muscle will have increased telomeres following metamorphosis because the adult tissues are made from imaginal cells. We predict that constantly regenerated cells such as hemocytes will experience no significant change in telomere length. *M. sexta* is a common pest for several major crops such as tomatoes and potatoes. Understanding its physiology and aging mechanics can provide a better understanding of how to deter these pests from crucial crops. Moreover, this work could provide a better comprehension of age-related physiological dysfunction and provide an impetus for other researchers interested in cellular aging.

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3D Printing of Continuous Hemp Fiber Reinforced Thermoset Composites

GAVIN KAHN
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Project Mentor: Chad Ulven, Ph.D., Mechanical Engineering

The fabrication and use of natural fiber-reinforced composites enhance environmental friendliness and sustainability. As awareness of environmental impact grows, the application of these materials is increasing. Some Natural fiber sources are essentially an inexhaustive

resource when derived from agricultural and forestry by-products. They offer several advantages, including diverse sources, large reserves, low cost, and high bio-degradability. When used as reinforcement, natural fibers enable polymeric composites to achieve promising mechanical properties while reducing environmental impact.

This research aims to investigate the 3D printing of continuous hemp fiber-reinforced thermoset composites and evaluate their mechanical behavior. Hemp fibers are specifically known for toughness. This study 3D printed continuous hemp fiber reinforced composites using a liquid photocurable thermoset resin. An in-nozzle impregnation process was used to infuse the liquid thermoset resin into the hemp fiber. Ultraviolet (UV) light was used to solidify the resin on the print bed. A rectangular specimen was 3D-printed using a back-and-forth motion of the print nozzle to characterize its mechanical properties. The fiber volume fraction of the printed specimen was measured using an analytical approach and was found to be 15%.

The quality of the printed composite lay-up was analyzed using a Keyence surface profilometer. The printed composite exhibited regular loops in one side and overlapping loops on the other. Tensile and Flexural testing were performed on two-layer 3D printed unidirectional specimens. The average tensile strength and modulus were 21 MPa and 4.3 GPa, respectively. Scanning electron microscopy (SEM) was conducted on the fracture surface of the failed specimen under tensile loading. SEM images showed evidence of good impregnation of the thermoset resin within the fiber tow. Flexural 3D printed unidirectional specimens with a span-to-thickness ratio of 32:1. The average flexural strength and modulus were found to be 68.3 MPa and 3.15 GPa, respectively. The strain before failure was 3.3%, indicating the high flexibility of the printed specimens.

Thus, this study highlights the potential for fabricating and utilizing natural fiber-reinforced thermoset composites with improved biodegradability and renewability.

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Bloom Core, by Laliberte Interiors, is a wellness space within a senior living facility

SARA LALIBERTE
Interior Design
Project Mentor: Susan Ray-Degges, Ph.D., Interior Design

Over the past decade, there has been exponential growth in the elderly population, and it is expected to quadruple over the next thirty years. Senior citizens are also choosing to live at senior living facilities earlier than has been seen in the past. These factors, paired with how aging brings on physical and mental aliments that affect day-to-day living, show that the focus on interior design in senior living needs more focus now than ever. Bloom Core, lounge and gym, strengthens community by encouraging stimulating socialization, and creates an inviting environment for daily wellness by introducing nontraditional forms of exercises. To successfully create Bloom Core, I completed several research methods. I analyzed and reviewed a range of articles, studies, and websites, compiling research focused on how aging affects what is needed in day-to-day life, the effects of socialization and exercise on the elderly population, and how the interior living environment affects elders. I completed site visits to a range of senior living facilities, all with different services, styles, and locations. I interviewed several interior designers with a focus on senior living, as well as completing observations at a local senior living facility to see how the residents interact with the environment around them. A Qualtrics survey was also sent out to staff at a local senior living facility to better understand how the residents use the space. Through my research I found the importance of designing a living space for elders that promotes daily socialization and exercise. By creating a welcoming environment with design aspects that resonate with the residents, comradery and pride will spread throughout the community. The focus and care of designing senior living facilities needs to increase alongside the rise in the elderly population. As elders have a wide range of physical and mental aliments, designing their home to match their needs and functions is pertinent.

An inductive thematic approach to uncovering personality processes linking neuroticism to sleep: early results from a systematic review

HIEU LE
Psychology
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Personality, or the thoughts, behaviors, and feelings that make us uniquely ourselves, is related to many dimensions of sleep (Duggan & Križan, 2019). Neuroticism (negative mood and emotional lability) specifically is strongly related to perceptions of poor sleep quality and insomnia. Personality processes (series of actions that unfold over time to link personality to important outcomes) remain understudied, including in the context of person-situation transactions as well as sleep. Qualitative research methods are well-suited to identify complex health-relevant pathways, like personality processes, because they prompt participants to provide rich, detailed narrative data (Chamberlian et al., 1997). In this study, we are using qualitative research methods to verify whether existing personality processes in the literature are reflected in people's narratives of their sleep routines (i.e., in a specific person-situation transaction). In the NDSU National COVID Study, participants (N=300; mean age = 45, 50% women, 73% White) described salient nights from and general patterns in their sleep during the early stages of the pandemic (April 2021). The narrative prompt is broad enough so participants can describe a variety of behaviors and experiences, but specific enough so that it is a contextualized narrative that will capture processes which are salient and meaningful to sleep. The development of the codes for the theoretically-generated processes, which will be applied to the narratives, is also pre-registered. Here, we describe initial findings from our interdisciplinary, systematic literature review of book chapters, meta-analyses, systematic reviews, and empirical papers on personality- and health-related processes. Overall, our findings thus far support the relevance of a *priori* processes linking neuroticism and health, such as rumination, perseveration, and hyperarousal; stressful experiences and stress reactivity; poorer social relationships and support; and negative attentional biases. However, we also found evidence for novel processes from related literatures, including neuroticism influencing health through generalized increased variability and sensitivity to the environment. We will apply these codes to our narratives in order to test their relevance for linking neuroticism with poor sleep.

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Impact of renal aging on cubilin functions

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Project Mentor: Sijo Mathew, Ph.D., Pharmaceutical Sciences

Cubilin, a multiligand endocytic receptor, is expressed on the apical surface of renal and intestinal epithelial cells. It plays a critical role in the intestinal absorption of vitamin B12 and the tubular reabsorption of filtered ligands such as albumin and hormones in the kidneys. Additionally, cubilin is involved in the hydroxylation and activation of vitamin D. Notably, the renal absorption of nephrotoxic drugs, including aminoglycosides, occurs primarily through cubilin in proximal tubule cells. Our preliminary findings indicate that cubilin expression is higher in two-month-old female mice than in male mice, indicating sexual dimorphism in cubilin-mediated functions. Age-related analysis revealed that cubilin expression increases with age. Previous studies did not show any phenotypical features in cubilin knockout mice. However, our findings suggest that increased cubilin may influence kidney function in the elderly. Given its key role in reabsorption, elevated cubilin levels may enhance nephrotoxin uptake, potentially exacerbating pharmaceutical drug-induced acute kidney injury (AKI) in the elderly. Ongoing studies are investigating the impact of obesity on cubilin functions.

Just in case: How students use a case study to prepare for exams in introductory biology

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Context. Systems are a core, cross-cutting concept in biology education, as identified by the Next Generation Science Standards (NGSS Lead States, 2013). The Biology Systems Thinking (BST) framework (Momsen et al., 2022) supports instructors in developing courses that center systems and assessments that evaluate systems thinking skills. Case-based assessments enable students to reason about complex living systems; however, we find that students' content literacy skills - the ability to read and understand information - can be cognitively taxing, potentially leading to poor exam performance. In response, we implemented a light-touch intervention - releasing the full text of the case study ahead of the exam. Here, we report whether and how students used the case study to prepare for the exam.

Methods. This research was conducted in three sections of a General Biology course (n=349) focused on the storage and flow of biological information; data come from Exams 3 and 4. Students could access the exam case study roughly 48 hours ahead of the closed-book, in-class exam with no guidance from the instructor on how to use it. Following the exam, we asked students whether they accessed the case study and how they used it to prepare for the exam. We used deductive coding to identify themes in responses; the authors independently coded responses and discussed all disagreements.

Results. Roughly 80% of students responded to our prompt. Most respondents used the case study to prepare for each exam (77% on exam 3; 70% on exam 4), become familiar with the system (33% on exam 3; 27% on exam 4), and to create and answer potential exam questions (82% on exam 3; 59% on exam 4).

Contributions. We found that a light-touch intervention prompted many students to engage in active, evidence-based learning strategies, particularly creating potential exam questions. Future research will explore (1) how student use of the case study changes over the course of a semester, and (2) how exam performance of students who use evidence-based learning strategies compares to those using passive strategies. Our preliminary findings provide evidence to instructors wishing to adopt similar interventions which can help create equitable classrooms.

Studying the effects of temperature on the differential expression of the RNA sequences in in *Phaseolus vulgaris L.* flavonoid production

ISAAC MAUCH
Biotechnology
Project Mentor: Juan Osorno, Ph.D., Plant Sciences

Seed colors and their patterns have been fascinating humans since they were first grown for consumption. Today, seed patterns are pivotal in the common bean market and certain varieties of color have been shown to have differing nutritional value. Flavonoid compounds, specifically those found in *Phaseolus vulgaris L.*, are quite arcane in the genetic and environmental control of them. Previous research has suggested that temperature had played a crucial role in the adaptation of certain genes to favor more flavonoid production. This study aimed to confirm that temperature affects the expression pattern in flavonoid production within the seed coat layer. Orca beans are a variety of common beans that are mottled black and white, which provides an easy template for flavonoid research. Three seed pattern loci have already been genetically mapped by Travis Parker from University of California, Davis. The loci *T*, *Bip*, and p^{hbw}, co-segregated completely with PvTTG1, PvMYC1, and PvTT8, respectively. Proteins encoded by these genes are predicted to work together in MYB-bHLH-WD40 (MBW) complexes, propagating flavonoid biosynthesis. Using growth chambers set to a temperature difference of 10°C; pigmentation contrast was shown between the different growth conditions. In order to narrow down the nature in which the temperature affects these seed patterns encoding proteins, seed coats will undergo RNA expression analysis to gain insight into their genetic differences. Understanding the differential expression of the proteins involved in seed coat color narrows down the loci involved in expression. Once the seed coat proteins responsible are determined for flavonoid production in Orca beans, the same principle may be applied to many other varieties. This will give far more insight into the world of flavonoids and possibly discovering their purpose in *Phaseolus vulgaris L.* as well.

Patient-Derived 3D Tumor Models: A Custom ECM Approach for In Vitro PDAC Research

BRAYDEN MCLEAN
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Project Mentor: Katie Reindl, Ph.D., Biological Sciences

Matrigel® is the most widely used hydrogel for developing and testing 3D in vitro pancreatic ductal adenocarcinoma (PDAC) models; however, its extracellular matrix (ECM) composition does not accurately reflect that of most PDAC tumors found in human patients. To address this problem, we created an approach for generating patient-derived 3D tumor organoids embedded in customized hydrogels that reflect the tumor microenvironment in patients.

Using surgically resected patient tissues, we quantified the relative abundance of key ECM components—collagens I, III, IV, and laminin—via immunohistochemistry (IHC). Cells from patient-derived tumors (PDX) were then cultured in hydrogels formulated to match the ECM composition determined from the relative abundance calculations. Organoid growth and proliferation were assessed using MTT assays, while integrin expression (α1, α2, α6), indicative of interactions with the hydrogel, are obtained via IHC.
As a result, we anticipate that organoids cultured in these patient-specific hydrogels will exhibit higher growth rates and improved model fidelity compared to those grown in Matrigel®. Additionally, we expect increased expression of integrins α1, α2, and α6, suggesting enhanced ECM interactions. These findings provide preliminary evidence that hydrogel composition influences the phenotypic behavior of 3D in vitro tumor models. Further development of this approach could enhance the physiological relevance and accuracy of preclinical PDAC models, ultimately improving therapeutic testing and translational research.

Other Contributor: Jade Vipond

Western Blot Analysis of Pancreatic Tumors Treated with Gemcitabine and RAGE Inhibitors

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Project Mentor: Estelle Leclerc, Ph.D., Pharmaceutical Sciences

At a five-year survival rate of just 13%, pancreatic cancer is one of the most lethal types of cancer. The location of the pancreas within the human body poses significant challenges in detecting pancreatic tumors. As the pancreas sits deep within the abdomen, pancreatic tumors are difficult to detect and are oftentimes painless at the early stages. This makes it difficult for physicians to detect pancreatic tumors until metastasis has already occurred. Pancreatic tumors are difficult to surgically remove due to nearby critical blood supplies. Currently, the chemotherapeutic agent gemcitabine is a standard of care for pancreatic cancer. However, the overall median survival is only 2 years for patients treated with gemcitabine and improved treatment options are thus urgently needed.

Previous studies have shown that the Receptor for Advanced Glycation End products (RAGE) plays a major role in facilitating the growth of tumors. To further investigate, a previous student from our lab conducted an animal study in which she injected mice with pancreatic tumor cells, treated them with different treatment groups, and recorded the weight of the tumor growths. She found that when the mice were treated with a combination of gemcitabine and a RAGE inhibitor, the weight of the tumor was significantly reduced compared to gemcitabine alone. This led to our investigation into what specific molecular signaling markers are causing this difference. We are using Western blotting techniques to measure the differences in levels of these markers between four treatment groups: a control vehicle, gemcitabine only, RAGE inhibitor only, and a combination of gemcitabine and RAGE inhibitor. Western blot methodology is an appropriate method for exploring the differences in molecular signaling markers in tumors. Significant findings would lead us one step further into understanding how to effectively target and kill pancreatic cancer cells.

Other Contributors: Priyanka Swami, Yousuf Alam, Mathilde Vetter, Estelle Leclerc

Determining The Host Range of *Trichoderma spp*. on Cultivated Fungi and Fungal Pathogens

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Trichoderma species pose an interesting parallel in fungal research as they are both formidable pests in mushroom cultivation and widely employed as biocontrol agents against plant pathogens. Their ability to aggressively colonize and parasitize a wide range of fungal species makes them valuable in agriculture but challenging for commercial mushroom growers. In this study, we examined the growth dynamics of edible and medicinal fungi (golden oyster '*Pleurotus citrinopileatus*', turkey tail '*Trametes versicolor*', chestnut '*Pholiota adiposa*', wine cap '*Stropharia rugosoannulata*', lion's mane '*Hericium erinaceus*', and pink oyster '*Pleurotus djamor*'), alongside common fungal pathogens (*Fusarium graminearum, Bipolaris sorokiniana*, and *Pyrenophora teres*) and 11 *Trichoderma spp*. found in agricultural soils and in mushroom cultivation contaminants. We compared their growth across multiple culture media (V8, PDA, Mungbean, and Malt Extract). These initial growth assessments guided our inoculation strategy for Trichoderma challenge assays, where we co-cultivated *Trichoderma* isolates. With both cultivated and pathogenic fungi to observe their interactions. Our findings contribute to understanding Trichoderma host range dynamics and provide insight into potential molecular and ecological factors influencing its dual role in fungal cultivation systems. This research has implications for both mushroom growers seeking mitigation strategies and agricultural biocontrol applications leveraging *Trichoderma*.

The influence of heat exposure during development on heat shock proteins

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Rising temperatures due to climate change are increasing the risk of mortality and morbidity in humans (Bouchama et al. 2017) and other organisms (Woodruff et al. 2022). However, we currently have little understanding of the mechanisms that contribute to variation in thermotolerance and resilience to heat stress. One mechanism that may be important in this context are heat shock proteins (HSP), an evolutionarily conserved group of proteins that stabilize, ensure proper folding, and remove proteins damaged by stressors including elevated heat exposure (Kourtis et al.2012). However, much of what we know about HSP comes from model organisms under laboratory conditions. This project will examine variation in HSP in developing house sparrows (Passer domesticus) from 2 different populations at the ends of a latitudinal gradient that varies greatly in heat exposure. HSP gene expression will also be measured using transcriptomics. We predict that HSP expression will be higher in nestlings from the more southern populations that potentially experience higher levels heat during development.

Bouchama, A., Aziz, M. A., Mahri, S. A., Gabere, M. N., Dlamy, M. A., Mohammad, S., ... & Hussein, M. (2017). A model of exposure to extreme environmental heat uncovers the human transcriptome to heat stress. *Scientific reports*, 7(1), 9429.

Woodruff, M. J., Zimmer, C., Ardia, D. R., Vitousek, M. N., & Rosvall, K. A. (2022). Heat shock protein gene expression varies

among tissues and populations in free-living birds. *Ornithology*, 139(3), ukac018.

Kourtis, N., Nikoletopoulou, V., & Tavernarakis, N. (2012). Small heat-shock proteins protect from heat-stroke-associated neurodegeneration. Nature, 490(7419), 213-218.

Relation to biomedical research: Growing evidence suggest that heat waves induced by climate change pose a major health risk for humans, however our understanding about which individuals are likely to be more vulnerable remains limited (Arasad et al. 2022). This research will provide new insight into the role of heat shock proteins in mediating the effects of heat exposure during development, which is expected to have implications for human health.

Arsad, F. S., Hod, R., Ahmad, N., Ismail, R., Mohamed, N., Baharom, M., ... & Tangang, F. (2022). The impact of heatwaves on mortality and morbidity and the associated vulnerability factors: a systematic review. *International Journal of Environmental Research and Public Health*, 19(23), 16356.

Maggots are like snowflakes

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Introduction: The Sugar Beet Root Maggot (SBRM), *Tetanops myopaeformis*, a severe pest to the sugar beet in much of the high plains area, is a freeze-tolerant species. Freeze-tolerant insects can withstand internal freezing by accumulating ice-nucleating particles, heat shock proteins, and cryoprotectants. Freeze-tolerant insects have been a driving force in the scientific world of cryobiology, and the SBRM is one of few species native to North America that have this capability. If maggots are gradually cooled to -20°C, the location where freezing occurs first can be observed, potentially revealing a consistent pattern. This pattern may indicate the specific locations of freeze-tolerant components within their bodies, as the site of freezing could correspond to the presence of these components. The supercooling point, which is the point at which freezing begins, was used to pinpoint the location of the maggots freezing initiation location. I expected to observe a common location in the SBRM's 11 segments where the supercooling begins. This can determine the location of the freeze-tolerant components, which can help us better understand the freeze-tolerance of the SBRM.

Methods: SBRM were collected from sugar beet fields in St. Thomas, ND (2022) and Thompson, ND (2023) and stored at 15°C as a field treatment or 4°C as an overwintering treatment. The mass of each maggot was determined prior to sampling. SBRM were placed on a chill plate and viewed through a FLIR infrared camera to observe the exothermic patterns of freezing, and duration of the event. The maggots were exposed to a temperature ramp of -1°C/min to -20°C. The recording was sustained for a maximum length of 40 min. After the recording was concluded, samples were warmed to 4°C at 1°C/min. The maggot was then placed in a petri dish and stored at 4°C to check for survival daily for three days. Data was processed using FLIR studio software, and statistical analysis was done using JMP.

Results: The freezing location within the maggots was variable, because we found no common pattern among the ones that froze. The Thompson, ND maggots in field treatment were unable to freeze in this experiment, which could be attributed to the plasticity of the maggots supercooling point. 100% survival was achieved showing exposure to -20°C was not lethal at a maximum of 1 hour of exposure.

Generalized vs Specialized Colonizers: Comparing Host Specific Microbiome Recruitment

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Plant microbiomes confer a variety of benefits to their host, including nutrient acquisition and disease suppression. It has been long thought that plant microbiomes assemble through host-specific mechanisms, but there is a lack of empirical evidence to support this assumption, and the extent to which this relationship exists is unknown. Understanding how plants interact with microbes in the soil is important to improving agricultural productivity, as optimized microbiome management can enhance crop resilience and yield. In this study, we used 94 taxonomically similar microbes previously cultured from either corn or pea rhizosphere samples. This mixed community was applied to both corn and pea plants to study the ability of the microbes to preferentially colonize their original host. Microbial abundance in the rhizosphere was assessed to evaluate colonization patterns.

The results of this study indicate that there is a range in colonization pattern between the tested microbes. Some microbes acted as generalists, successfully colonizing both corn and pea rhizospheres; whereas, other microbes, called specialists, exhibited a host preference, showing a significantly higher abundance in the rhizosphere of their native host. These findings support the hypothesis that both generalist and specialist colonization strategies contribute to plant microbiome assembly.

Future research will focus on identifying the molecular and genetic mechanisms that drive host-specific colonization. By understanding these mechanisms, we can develop targeted strategies for enhancing beneficial plant-microbe interactions, improving crop resilience and agricultural sustainability.

The magnitude of observer error in animal behavior research, a meta-analysis

OWEN NELSON
Biological Sciences
Project Mentor: Ned Dochtermann, Ph.D., Biological Sciences

Observer error is commonly recognized as being particularly important in animal behavior studies but has not been quantitatively analyzed. Measurements of animal behavior can be influenced by several sources of error, including sampling or confirmation biases, intra- and inter-observer variability/error, environmental influences, and elements of study designs. Here, using meta-analysis we estimated the magnitude of observer error in animal behavior research and its potential impact on study validity and reliability. We examined articles from a top behavioral journal, Animal Behavior, published between January 2001 and December 2024. Our analysis of articles from Animal Behavior revealed substantial observational error as well as a large over representation of mammalian taxa. Technological advancements, such as automated tracking and coding have the potential to reduce measurement error. Understanding changing trends in observer error will also be crucial for improving research methodologies. Implementing robust methodologies and establishing standardized rules for quantifying behavioral studies will enhance the replicability of research findings.

Talin-1 regulates the Ang II signaling in renal epithelial cells

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G protein-coupled receptors are critical in human physiology and pathology. In blood pressure regulation, Angiotensin II (Ang II) signals through G protein-coupled receptors, AGTR1 and AGTR2. Studies investigating Ang II signaling reported that AGTR1 and AGTR2 have opposing roles in cellular physiology. The AGTR1 signaling encourages vasoconstriction, inflammation, and proliferation; on the contrary, AGTR2 signals are vasodilatory and antifibrotic in nature. The association of talin-1 (a cytoskeleton-modifying protein) and Ang II signaling is unknown. Talin-1 shRNA-treated renal epithelial cells had diminished matrix signaling and increased AGTR2 expression in the cells. Ongoing studies are investigating the impact of renal aging on talin-1 and AGTR2 signaling.

Other Contributors: Sreyasi Pal, Sijo Mathew

Investigating the Genotype-by-Genotype (GxG) Interactions between Rhizobia and Dry Bean Cultivars

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Legume-rhizobia symbioses are essential for symbiotic nitrogen fixation (SNF), promoting sustainable farming practices by reducing our dependence on synthetic N fertilizers. Dry beans (*Phaseolus vulgaris L.*) are a staple crop, contributing to global food security while also generating economic value through their role in sustainable agriculture, crop rotation systems, and international trade. When compared to other legume crops, dry beans exhibit relatively lower SNF rates, partly due to rhizobia effectiveness and plant host compatibility. Investigating the genotype-by-genotype (GxG) interactions between dry bean cultivars and rhizobia is crucial for optimizing symbiotic efficiency and for integrating microbial partnerships into dry bean breeding programs. A collection of 500 rhizobia strains was extracted from the nodules of pinto, black, and kidney beans grown on farms across North Dakota and Minnesota. These strains were purified, stocked, and are now being included in a plasmid-based ID barcode library designed to track the competitiveness of rhizobia nodule occupancy using Next-Generation Sequencing (NGS). Following the identification of competitive rhizobia, we aim to assess their nitrogen fixation efficiency through the development of a high-throughput phenotyping (HTP) greenhouse platform. This platform will evaluate leaf greenness as a proxy for plant nitrogen uptake, a correlation established in multiple studies linking chlorophyll content to nitrogen availability. Identifying strains that are both competitive and effective at fixing nitrogen will help determine whether dry bean cultivars exhibit preferences for specific rhizobia genotypes, providing a framework for studying their genotype-by-genotype (GxG) interactions. These findings could contribute to breeding strategies that enhance host-microbe symbioses, ultimately improving dry bean productivity and symbiotic nitrogen fixation in agricultural systems.

Other Contributors: Mia Haugen, Mohamed Salem, Juan M. Osorno, Barney A. Geddes, Ahmed H. Rabia

Third Place - Intergenerational Community Engagement in an Open Market and Wellness Center

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Interior Design

OLIVIA PETERSON
Interior Design
Project Mentor: Susan Ray-Degges, Ph.D., Interior Design

The purpose of the research conducted is to better understand how interior design can affect the setting of a Third Place, support stress reduction, sensory sensitivity, and intergenerational community engagements to promote health and well-being. Community is an important aspect to the health and wellbeing of all types of individuals, and to promote the idea of intergenerational connectivity as well as personal betterment, our goal was to explore the impact of designing an effective third place (Wu et.al., 2023). We hypothesize that creating a dedicated space that encourages social interaction, caters to individual preferences, and enhances the health and wellbeing of the community will lead to greater community involvement.

After reviewing previous studies related to the third place and community involvement, we conducted a two-part research project involving an online survey and observations that focused on what individuals prefer in a community environment and how they interact with design features within those spaces. 227 participants took part in the questionnaire, which ranged from students, faculty, and community members that frequently visit Twenty Below in Moorhead, Minnesota, Brewhalla in Fargo, North Dakota, and the Jasper Hotel in Fargo, North Dakota. To gain a deeper understanding of how individuals interact within these spaces, we observed the natural tendencies to better comprehend how people navigate and engage with community environments.

Throughout the course of research as well as conducting a study pertaining to the hypothesis, we found that spaces such as lounge areas, restaurants, and coffee shops can enhance the functionality of the third place and support intergenerational socialization and community. We also found that the third place allows users to find a space away from home and work that provides them the same amount of comfort and satisfaction while also being able to explore other things that are not normally within a personal dwelling. The conducted survey results are the basis of our Interior Design Senior thesis and provide ample information for spaces designed specifically to support stress reduction, sensory sensitivity, and intergenerational community engagements to promote health and well-being.

Evaluating the Ability of AI to Generate Lower and Higher Order Biology Assessment Items

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The Assessment *for* Learning approach to instruction requires students to actively engage with course material by answering formative assessment items throughout the learning process—as pre-class assignments, in-class activities, and as post-instruction homework. Using this approach for learning, however, requires a large number of high-quality questions on each topic across various levels of Bloom's Taxonomy. The process of producing this large set of questions can be very time consuming. The purpose of this study is to assess the ability of an AI-powered large language model (ChatGPT 4.0) to consistently generate both lower and higher order multiple choice questions (MCQs) that will effectively assess the knowledge of introductory biology students. To conduct this study, we developed a prompt template that included a biology topic, a link to a textbook chapter, and text describing each level of Bloom's taxonomy. The prompt was entered into ChatGPT 4.0, and used to generate multiple choice questions. We evaluated four different topics seen in college introductory biology courses. The AI generated questions were combined with previously written Advanced Placement introductory biology MCQs and the order of the questions was randomized. The questions were evaluated by experts in the field who assigned each question a Bloom's Taxonomy level. Our results will show whether ChatGPT 4.0 is able to generate multiple-choice questions at the correct level of Bloom's taxonomy for the four different introductory biology topics.

Frightening blackbirds foraging in sunflower: Testing natural and artificial sounds broadcast from a drone

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Blackbirds (*Icteridae*) cause significant sunflower damage each year in North Dakota. Currently, multiple lethal and nonlethal methods are used to reduce blackbird damage to crops (e.g., propane cannons, pyrotechnics, and drone hazing). Due to continental declines of red-winged blackbirds (*Agelaius phoeniceus*), we tested a nonlethal method to disperse blackbirds from sunflower fields. We used a drone equipped with a loudspeaker to test the anti-predator response of blackbird flocks to 1) artificial sounds = firecrackers and pyrotechnic screamers; 2) natural sounds: distress calls (blackbird and starling), predator calls (merlin, *Falco columbarius*), 3) non-threatening bird calls (American robin, *Turdus migratorius*), and 4) a control (drone rotor). We hovered the drone 50 m above a flock and systematically played the six sound treatments (5 s each). After which, we repeatedly lowered the drone (1 m/s) until the flock flushed or when the drone reached 15 m above ground level, while broadcasting one of the sounds on each descent. We observed flock behavior during and 1-minute after each broadcast. We measured flight initiation (Y/N), flight initiation distance with drone descent (m), percent of flock reacting, severity of reaction (cohesive-chaotic [0-5]), and percentage of the flock that reacted. Firecrackers had the greatest impact with 92% of flocks responding to a stationary broadcast (n = 61), 100% taking flight before the drone reached 15 m AGL (n = 45), an average of 65% of birds within a flock reacting, and a high probability of eliciting a chaotic reaction compared to other sounds (7% reacting with the highest scale of chaos). Distress calls were the second best sound for reactivity, whereas pyrotechnics and merlin calls were not as effective, but more effective than controls (i.e., robin and rotor). We conclude that implementing firecracker recordings with drone hazing or with other frightening methods would reduce blackbirds' presence in sunflower.

Neuroendocrine Regulation of Female Reproduction: Gene Expression in the Hypothalamic-Pituitary-Gonadal Axis of Dark-eyed Juncos

SIERRA PREABT
Biological Sciences
Project Mentor: Timothy Greives, Ph.D., Biological Sciences

Understanding the neuroendocrine regulation of reproduction in seasonally breeding birds remains a significant challenge, as the feedback loops regulating gene expression along the hypothalamic-pituitary-gonadal (HPG) axis are complex and not explicitly known in females. This study aims to better understand the relationship between reproductive timing and genetic regulation by differentiating differences in the expression patterns of key reproductive genes during two critical points in the breeding season: April (Pre-breeding) and May (Early- breeding). For this study we focused on expression levels of Gonadotropin-releasing Hormone (GnRH), estrogen receptor (ERα), and androgen receptor (AR) in the hypothalamus of female Dark-eyed Juncos. An independent t-test revealed that GnRH expression was significantly lower in May than in April ($p < 0.05$). Additionally, positive correlations were observed between GnRH and both ERα ($r = 0.82$, $p = 0.025$) and AR ($r = 0.87$, $p = 0.010$), challenging the previously held theory of negative feedback regulation observed in males. These findings may suggest the possibility of a more dynamic co-regulation between GnRH, ERα, and AR in females. This research emphasizes the importance of studying both female and male physiology. Filling this knowledge gap is essential for understanding the endocrine mechanisms that drive reproduction in seasonally breeding species, especially in the context of changing environmental conditions. As many species rely on precise timing for survival, these insights can also inform conservation efforts, allowing us to anticipate how species will respond to shifts in seasonal timing.

In vitro Characterization of Bacterial Invasion using Pancreatic Cancer Cells

KALEY QUAM
Pharmacy
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Cancer remains one of the most prevalent diseases affecting humans today, with the Center for Disease Control (CDC) reporting over 600,000 deaths in 2022. Much effort has been dedicated to improving the survival rate of these devastating diseases. Despite these efforts, the 5-year survival rate for pancreatic cancer remains low, around 12-13%, with rates ≤ 3% for metastatic pancreatic cancers. One new area of research involves the interplay between cancerous cells and the body's natural microbiota, and recent data suggests the idea that bacterial invasion of tumor cells promotes tumorigenesis. Importantly, the presence of cancer microbiota may offer new therapeutic

avenues to explore. Using *Bacteroides thetaiotaomicron* (*B. theta*), an obligate, Gram-negative anaerobe and natural resident of the human microbiota possessing 2,500-barcoded transposon-insertion mutants, we aim to determine which genes are critical for cancer cell invasion. To achieve this goal, we will monitor the growth rates of PANC-1 human pancreatic cancer cells and *B. theta* cells in the presence and absence of oxygen, respectively, using cell counting and optical density measurements. Next, we will co-incubate *B. theta* with PANC-1 cells using monolayers and spheroids in an anaerobic chamber. Intracellular invasion of PANC-1 cells by *B. theta* will be determined post-gentamycin and D-alanine incubation. The purpose of the incubation is to kill only extracellular bacteria through the action of gentamycin and mark viable up-taken bacteria through D-alanine metabolism and subsequent immunofluorescence. Monitoring the presence of *B. theta* in PANC-1 cells will also be completed through next-generation sequencing and flow cytometry. These ongoing experiments are expected to confirm the veracity of bacterial invasion into eukaryotic cancer cells, identify relevant genes important for tumor invasion, and potentially identify PANC-1 cancer cell gene expression changes associated with bacterial invasion.

Other Contributors: Razia Dawlaty, Joshua Eberts, Savanah Klegon, Teala Matiur, Scott Hoselton, Kaycie Schmidt, Karl Van Horsen, Glenn P. Dorsam

Effect of Extrusion Nozzle Tilt Angle on the Surface Quality and Density of the 3D Printed Continuous Fiber Reinforced Composites

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Mechanical Engineering
Project Mentor: Chad Ulven, Ph.D., Mechanical Engineering

The additive manufacturing process enables the fabrication of complex geometries with ease using continuous carbon fiber reinforcement. However, due to its layer-by-layer deposition nature, additive manufacturing process often results in high surface roughness. Conducting the printing process in multiple axes alongside optimized nozzle tilt angle can mitigate this issue by refining material deposition and fiber orientation during fabrication process. A 4-axis printer, compared to a traditional 3-axis printer, provides greater control over these parameters, helping to improve surface quality and material properties.

A key prerequisite for reducing void content in a printed specimen is achieving a smooth surface. As each layer is deposited, rough surfaces with ridges and valleys can trap air pockets, preventing proper adhesion between layers. These trapped voids lower material density and disrupt uniformity, negatively impacting mechanical properties. Reduced adhesion leads to weaker shear strength, while voids create stress concentration points that compromise tensile, fracture, and fatigue strength. Additionally, voids disrupt material flow, compromising the structural integrity. By ensuring smooth surfaces, the risk of void formation is minimized, resulting in a denser, stronger, and more uniform material.

The primary objective of this study is to investigate how the tilt angle of the nozzle in a 4-axis printing process affects the surface roughness and density of the printed specimens. The specimens are printed using continuous carbon fiber reinforced and liquid photocurable thermoset resin. UV light was used to cure the resin on the print bed. In this setup, the custom-built printer operates by rotating the print bed while also allowing movement along the X, Y, and Z axes, keeping the extrusion nozzle stationary. The nozzle has the capability to adjust its tilt angle relative to the horizontal print bed.

In this study, square-shaped rings were 3D printed using both axial and rotary movement of the print bed. After each linear motion, the print bed rotates by the desired angle (e.g. 90° for a square shape) to change the nozzle direction. The thickness of the ring, defined as the distance between the outer and inner edges, was 10 mm comprised with 10 lines printed on each layer. The raster gap was 1mm. The specimens were printed with a layer height of 0.9 mm and a printing speed of 690 mm/min. The tilt angle of the nozzle is the angle between the nozzle's axis and the horizontal (X-axis). The tilt angle of the nozzle varied from 20° to 50° in 5° increments. The average surface roughness (measured in micrometers) of each arm of the square specimen was used for analysis. A 3D optical profilometer (KEYENCE VR-200) was used to quantify surface roughness, while specimen density was determined using the immersion density test.

The surface roughness varies 70 mm to 39 mm while increasing the tilt angle. The results indicate that increasing the tilt angle leads to lower surface roughness. Specimens printed at higher tilt angles had smoother surfaces with fewer indents than those printed at lower angles. The reduction in surface roughness at steeper angles also contributed to minimizing voids, thereby improving the overall density of the printed specimens. At the higher tilt angle, the extrusion path becomes more refined making the fiber orient in the correct direction, resulting in smoother surface.

Development of a Manufactured Testing Box for a Synthetic Heart Valve

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Mechanical Engineering
Project Mentor: Yan Zhang, Ph.D., Mechanical Engineering

This project focused on the design, fabrication, and initial evaluation of a custom testing box for a synthetic heart valve. The primary goal was to create a cost-effective and adaptable platform for visualizing and assessing the valve's dynamic behavior under simulated physiological conditions.

The testing box was designed with transparent acrylic walls to allow for unobstructed visual observation. The core innovation lies in the utilization of additive manufacturing (3D printing) for the creation of intricate internal components that precisely secure and interface with the synthetic heart valve. This approach offered significant design flexibility and rapid prototyping capabilities compared to traditional manufacturing methods.

The project involved several key stages: conceptual design based on typical heart valve testing setups, CAD modeling of the acrylic enclosure and 3D-printed external connection structures, fabrication using fused deposition modeling (FDM) for the internal components and laser cutting for the acrylic walls, and assembly of the final testing box.

Preliminary evaluation involves fluid flow testing using a basic pump system to observe valve leaflet motion and identify potential areas of interest for future, more sophisticated hemodynamic analysis. The transparency of the acrylic walls allows for direct observation and video recording of the valve's opening and closing dynamics. This initial work demonstrates the feasibility of utilizing additive manufacturing and acrylic construction for creating customizable and visually accessible testing platforms for medical devices like synthetic heart valves. Future work will focus on integrating more precise flow control and measurement systems for quantitative performance analysis.

Future work will focus on integrating more precise flow control and measurement systems for quantitative performance analysis. Critically, the testing box will serve as a vital tool in evaluating the synthetic

heart valve's durability and long-term performance under simulated physiological stresses. The data gathered will directly inform design iterations and material choices, with the ultimate goal of creating reliable synthetic heart valves suitable for extended use and improved patient outcomes.

Artist Meets Architect: Color nesting preference of *M. rotundata*

GWEN SAILER
Biological Sciences
Project Mentors: Julia Bowsher, PhD, Biological Sciences,
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The Alfalfa Leafcutting Bee (*Megachile rotundata*), is a solitary cavity nesting bee that is commercially managed for alfalfa seed production. Farmers use commercial nesting blocks which are manufactured with patterns, shape, color, orientation, and contrast believed to help these bees locate their nest to promote bee productivity. Nesting preference has been studied with regards to cardinal direction, temperature, plant quality, and pattern, but color is underexplored. Establishing nesting preferences for color may increase bee productivity and yields. To observe how color affects the nesting preference of alfalfa leafcutting bees, we painted nest boxes with ten different colors in three different patterns and two different orientations. We found that brood cell numbers were affected by color, but not by orientation. Cavities painted pink, white, yellow and unpainted experienced higher nesting rates suggesting preference for those colors. The number of uncompleted nests and nest completion time was not affected by color or orientation. This study provides evidence that color plays an important role in nesting preference which could be used to promote solitary bee management and conservation.

Investigating Material Culture; A Look into the Work and Lives of Bonanza Farm Laborers

TAYLOR SEVERANCE
Anthropology
Project Mentor: Kristen Fellows, Ph.D., Sociology and Anthropology

The history of Bonanza farms in the Midwest is essential to understanding immigration patterns, lifestyle changes, and the demographics of rural North Dakota in the early 1900's. A thorough catalog of what kinds of objects were used and how they were utilized provides invaluable context into the everyday lives of those living and laboring on Bonanza farms. In this project, an artifact excavated from the 4e Homestead was identified and its usage discussed. Using the techniques of historical archaeology a chosen artifact, the classification of which was unknown, was researched. The techniques utilized include patent searching, finding manufacturing processes, document analysis and broader historical research. Through this method, the artifact was identified as a sleeve nut used in the manufacturing of furniture and other industrial equipment. Understanding why this particular artifact was utilized helps describe the life and work habits of North Dakota laborers in the 1900's and can provide details into ways labor changed with the arrival of more industrial equipment to compensate for the large demand of production.

Vitamin D and its roles in immune function and reproduction in the nocturnal Leopard Gecko (*Eublpharis macularius*)

KIMARIA STEVENSON
Biological Sciences
Project Mentor: Matthew Smith, Ph.D., Biological Sciences

Ultraviolet B radiation (UVB) is required for the photo-biochemical synthesis of vitamin D3 in most vertebrates. Vitamin D has been studied extensively in mammals and birds, playing critical roles in many biological functions. Our understanding of vitamin D in reptiles, however, has been mostly limited to its role in phosphorous and calcium homeostasis. Beyond its role in calcium homeostasis and its importance in preventing metabolic bone disease, we know very little about the importance of vitamin D in the biological functions in nocturnal, ectothermic organisms. This study's objectives were to evaluate the potential role of vitamin D in immune function and reproductive success in the Leopard gecko. Three treatments that varied in UVB levels and vitamin D3 supplementation, each consisting of 6 female and 3 male geckos were had their plasma levels of vitamin D, immune functions as expressed in a bacterial killing assay (BKA), and egg production and hatch rates measured over the course of five months of treatment conditions. Our results suggest vitamin D may play a role in many more biological functions in reptiles than previously thought and stressed the need for future research to look into appropriate plasma levels of vitamin D to prevent hyper or hypovitaminosis and have healthy animals.

Genetic and environmental sources of behavioral individuality: a test of our standard model

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Project Mentor: Ned Dochtermann, Ph.D., Biological Sciences

Understanding the sources of variation among individuals has been a major topic of research in animal behavior. Classically, this variation has been attributed to genetic differences and differences in the environment throughout an individual's lifespan. The classic model has been challenged by observations of high levels of among-individual variation among clones inhabiting similar environments. This surprising observation suggests that micro-environmental variation is sufficient to explain patterns of behavioral repeatability in parthenogenic species. We measured activity in crickets (*Gryllodes sigillatus*) from five inbred and one outbred line. We found that among-individual variation was substantially lower in the inbred lines versus the outbred line. Our results support the classic model and suggest that micro-environmental variation is insufficient to produce typical patterns of behavioral variation. These findings suggest that individual variation in behaviors of parthenogenic species stem from different processes than those for variation in sexually reproducing species. Finally, our results emphasize the continued need to identify the sources of behavioral variation.

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The Effect of One-Carbon Metabolite Supplementation on cell proliferation staining in Fetal Brown Fat in pregnant heifers

ELLA SYRING
Animal Science
Project Mentor: Pawel Borowicz, Ph.D., Animal Sciences

Calving season in North Dakota runs typically from late winter to early spring when the bitter cold temperatures cause a reduction in available feedstuff for gestating beef heifers. This may have a long-term impact on developing calves. Fetal brown adipose tissue (BAT), allows newborns to adapt to cold environments and increase survival rates. To help improve operation efficiency, this study took a histology approach to observe the effects of supplementing one-carbon metabolites (OCM) of methionine, choline, vitamin B12, and folate to heifers in early gestation on fetal BAT cell proliferation. Thirty-one crossbred Angus heifers were successfully bred by artificial insemination and produced offspring. Each of the cows were randomly assigned into one of four nutritional treatments: Control (CON) weight gain with OCM (+OCM), CON weight gain without OCM (-OCM), Restricted (RES) weight loss +OCM, and RES weight loss -OCM. Nutritional diets were given for 63 days. Afterwards, the heifers were fed a common diet. On day 260 of gestation, fetal BAT was harvested, stained fluorescently with Ki 67 and Proliferating Cell Nuclear Antigen (PCNA) antibodies, and analyzed to compare the number of proliferating BAT cells in each treatment. Heifers in the CON +OCM group and RES -OCM group had calves with the highest number of proliferating BAT cells ($P > 0.05$). Whereas heifers in the CON -OCM group and RES +OCM group had calves with a lower number of BAT proliferating cells ($P > 0.05$). All treatments were not statistically different from one another, therefore OCM supplementation does not have a significant effect on BAT cell proliferation. Factors that could affect BAT growth like nutrition and temperature are relatively new and unknown. Further investigation is needed.

Key words: Fetal brown adipose tissue, fetal programming, Proliferating Cell Nuclear Antigen (PCNA), Ki 67 antibody, nutrition, one-carbon metabolism

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Activation of Aryl hydrocarbon receptor inhibits mitochondrial fission in inflamed human airway smooth muscle cells

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Rationale: Asthma is an inflammatory disease associated with airway remodeling. Airway smooth muscle (ASM) is a structural cell that contributes to airway remodeling. The aryl hydrocarbon receptor (AhR) is a ligand-activated transcription factor which senses environmental pollutants, inflammation, and regulates cellular homeostasis. AhR has been proven protective against inflammation in different cell types, however, it has been less explored in ASM and asthma. Mitochondrial dynamics, known as fission/fusion, is a response of mitochondria to stress within the cell. Inflammation increases mitochondrial fission in asthma. However, how AhR regulates the fission in ASM during inflammation is unknown. In this work, I explored the role of AhR in regulating mitochondrial fission in human ASM cells during inflammation.

Methods: Primary human ASM cells isolated from surgical lung sections (Mayo IRB approved) were cultured in Labtek 8 well chamber in DMEM-F12 medium. Cells were serum deprived for 48 h, treated with AhR agonist 6-Formylindolo[3,2-b]carbazole (FICZ: 10 nM) with/or without TNFα (20 ng/mL) for 24 h, and tagged with mitotracker dye (200 nM) for 30 mins at 37°C. Mitochondrial morphology was recorded using the Lionheart FX (Biotek). Images were processed using ImageJ and Mitomorph to calculate the form factor/aspect ratio and mitochondrial volume. Expression of mitochondrial genes and proteins were determined using qPCR and Western blotting in whole ASM cell lysate. In addition, mitochondrial fraction of ASM cells was isolated using kit and the active form of DRP1 was analyzed using western blot.

Results: TNFα treated human ASM cells demonstrated enhanced form factor, aspect ratio, and mitochondria density compared to untreated cells whereas FICZ treatment blunted the TNFα effect. Furthermore, TNFα exposed cells showed upregulation of DRP1 (fission protein) while downregulation of OPA1 (fusion protein). While, FICZ treatment restored the expressions of these proteins. Also, TNFα enhanced the expression of active DRP1 in mitochondrial fraction which was reduced by FICZ.

Conclusion: To conclude we found activation of AhR in human ASM cells protects from inflammation induced-alteration in mitochondrial dynamics, especially fission. This work is clinically significant as it has potential to bring new therapeutic targets to control mitochondrial dynamics in ASM during inflammation and asthma.

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Investigating the Antibiotic and Allelopathic Properties of Moss

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Natural plant extracts have long been studied for their potential antimicrobial and allelopathic properties. Understanding these properties can contribute to sustainable agricultural practices and the development of natural antimicrobial agents. This study investigates the antibiotic and allelopathic effects of extracts from three moss species—cat-tail moss (*Leucobryum glaucum*), sphagnum moss (*Sphagnum spp.*), and fern moss (*Thuidium spp.*)—alongside walnut (*Juglans spp.*) extract, which serves as a positive baseline control.

For the allelopathic analysis, lettuce (*Lactuca sativa*) seeds were germinated on agar plates treated with the extracts, and root and shoot growth was measured to evaluate any inhibitory effects. The experiment consists of 24 agar plates in total, with three plates per treatment and three plates per control. The treatment plates contain the respective extracts, while the control plates do not include any extract, serving as a negative control, following the agar sandwich plating method.

Preliminary results indicate that walnut extract, known for its juglone content, exhibits significant allelopathic effects, serving as a positive control for comparison. Predictions for the moss species are as

follows: *Leucodon sciuroides* is anticipated to demonstrate antimicrobial properties, particularly with methanolic extracts, which are obtained using methanol as a solvent to extract bioactive compounds such as phenolics and flavonoids. The three moss species are expected to exhibit both antimicrobial and allelopathic properties due to their production of secondary metabolites such as phenolics, flavonoids, and antimicrobial peptides. These compounds may inhibit bacterial or fungal growth, influencing seed germination and plant competition.

This research seeks to bridge gaps in knowledge about moss chemical interactions and inform future studies on the ecological roles of these species in their respective environments.

Examining the role of checkpoint kinase target sites within Replication Factor A2 upon challenge with chemotherapy-like DNA damaging agents

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Replication Factor A (RFA) is a heterotrimeric single-stranded DNA (ssDNA)-binding protein complex in all eukaryotic cells (from yeast to humans) that is essential for DNA replication, repair, and recombination. RFA is composed of three subunits, Rfa1 (70 kDa), Rfa2 (32 kDa), and Rfa3 (14 kDa), each of which plays a distinct and important role in maintaining genomic stability. The formation of ssDNA is an unstable DNA intermediate, and Rfa1 acts primarily as a sensor of this intermediate by binding to the ssDNA. Rfa2 regulates key cellular processes such as the DNA damage response and the cell cycle, which directs and allows time for the restoration of the DNA back to its stable double-stranded form. Notably, when DNA damage occurs, Rfa2 undergoes phosphorylation primarily at serine's and threonine's within the N-terminal phosphorylation domain of Rfa2. It has long been thought that this post-translational modification plays a crucial role in preventing mutations and ensuring proper cell division, ultimately reducing cellular dysfunction and disease occurrence. In our study, we investigated whether additional serine residues in Rfa2 within the target SQ (serine-glutamine) motif of the checkpoint kinases Mec1 and Tel1 (ATR and ATM, respectively in human cells) influence the cellular response to DNA damage. We performed a plasmid shuffle technique to introduce site-specific Rfa2 mutations that replaced these serine's with alanine's (non-phosphorylatable). These Rfa2 mutant cells are then subjected to DNA-damaging agents (not unlike those found in chemotherapeutics). Our findings provide insights into the broader regulatory mechanisms of RFA phosphorylation and its role in genomic maintenance. These results will also contribute to a deeper understanding of how cells safeguard their genetic integrity, which has significant implications for disease prevention and therapeutic strategies.

Soy protein-based crosslinked 3D printable electroconductive hydrogel for wearable biomedical devices

GAVIN VAGTS
Mechanical Engineering
Project Mentor: Long Jiang, Ph.D., Mechanical Engineering

Hydrogels have become increasingly popular in research studies due to their high biocompatibility and wide biomedical applications. Specifically, injectable hydrogels show promising benefits like ease of use and 3D printability, thanks to their shear-thinning feature and hydrophilic 3D network. The change from injectable liquid to gel state is commonly initiated through external stimuli such as heat or irradiation, which can be difficult to control and makes the process more strenuous. Therefore, we constructed a hydrogel system with cross-links that strengthens the shear-thinning ability, eliminating the need for additional stimuli. Utilizing a cross-linked soy protein isolate and cellulose nanofiber structure, our hydrogel exhibits elevated mechanical strength as well as maintaining high biocompatibility. Currently our results suggest that through the addition of MXene, our hydrogel demonstrates good electrical conductivity with no loss in biocompatibility or 3D printing ability. This could have great 3D printing applications, such as a wearable electrical device or myocardial tissue restorative film.

Other contributors: Raj Shankar Hazra, Long Jiang

Inclusion of lubabegron and betaine in beef feedlot diets and impacts on yield and palatability of strip steaks

AMY VOLK
Animal Science
Project Mentor: Kasey Carlin, Ph.D., Animal Sciences

The objectives of this study were to evaluate the impacts of lubabegron and betaine supplementation on carcass characteristics and meat quality of beef strip loins. Sixty steers (476 kg ± 5.3 kg initial BW) were stratified by weight and randomly assigned to treatment in a 2 × 2 factorial arrangement: Control (no supplementation, n = 16), lubabegron (0.032% of DM for 56 days, starting 63 days before slaughter, followed by a 7-day withdrawal, n = 14), betaine (0.28% of DM for 7 days before slaughter, n = 15), and lubabegron+betaine (n = 15). Steers were fed a diet containing 10% forage (corn silage and grass hay) and 90% concentrate (dry-rolled corn, DDGS, urea, limestone, salt, vitamin and trace mineral mix, and monensin). After harvest at a commercial processing plant, carcass data was collected, and strip loins (n = 53) were transported to NDSU Meat Science Laboratory and aged for 14 days at 4C. After weighing for purge loss, loins were fabricated into four 2.5 cm thick steaks for tenderness evaluation by Warner-Bratzler Shear Force (WBSF) on d14 and d21 aged steaks and drip loss percentage. Shelf-life was evaluated on steaks displayed in a retail cooler for 14 days where measurements were taken with a colorimeter daily. Data were analyzed as a randomized complete block design, with marketing date as the block for effects of lubabegron, betaine, and the lubabegron×betaine interaction. Lubabegron increased ($P = 0.03$) hot carcass weight, ribeye area, 14-day purge loss, and d21 WBSF. Lubabegron decreased ($P < 0.05$) marbling score, USDA Yield Grade, and a* values after d10. Betaine increased ($P < 0.05$) USDA Yield Grade and 12th rib backfat and tended ($P < 0.08$) to decrease purge loss and drip loss. When lubabegron was supplemented, betaine decreased ($P < 0.03$) a* and b* on d2 of shelf-life display. Based on these results, lubabegron increased lean yield but decreased measures of palatability, whereas betaine decreased lean yield and tended to increase water-holding capacity.

Exploring the Role of Nitrosylation in Insulin Resistance

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Biology
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S-nitrosylation is a post-translational modification which occurs when nitric oxide (NO) attaches to a cysteine thiol. S-nitrosylation plays an important role in regulating many biological processes. Further elucidating the exact methods of its functions can prove valuable in the field of pharmaceutical sciences. In this study we aimed to better understand the relationship between s-nitrosylation and insulin resistance in mice. The groups of mice were fed either a standard diet or a high-fat diet for a period of 6 months. At the end of the treatment, Insulin Tolerance Tests (ITT) and Glucose Tolerance Tests (GTT) were conducted, confirming the development of insulin resistance in mice fed the high fat diet. Tissue samples were then collected, and Western Blots were conducted to collect data on possible proteins of interest to confirm or refute the hypothesized relationship between insulin resistance and s-nitrosylation. Assays were then used to determine the prevalence of these proteins. S-nitrosylation has been shown to have protective effects on other roles of the body. Therefore, it is expected that it will correlate with insulin resistance as an effect of its potential as a protective stress regulator in the body. We aim to further understand the mechanisms in which s-nitrosylation can be induced by insulin resistance and to explore its additional mechanisms of action. Further research can be done to explore the other roles s-nitrosylation plays in the body as well as developing possible methods of treatment utilizing the potential protective effects of s-nitrosylation.

Investigating Lower Lethal Limits of *Tetanops Myopaeformis*, the Sugarbeet Root Maggot

AARON WATLAND
Biological Sciences
Project Mentors: Kendra Greenlee, Ph.D., Biological Sciences and Madison Floden, Biological Sciences

The Red River Valley, stretching across eastern North Dakota and midwestern Minnesota, is responsible for approximately 45% of all sugarbeet production in the United States (1). Unfortunately for sugarbeet growers, there exists the *Tetanops myopaeformis*, commonly known as the sugarbeet root maggot (SBRM). The maggots reside in the soil of sugarbeet fields and feed on the taproot and surface of the beet, leading to inhibited and abnormal growth. This results in significant crop loss, making the SBRM a significant source of economic strain as the United States has the highest level of sugar consumption per person in the world (2). The maggot must survive the harsh winters within the soil of these fields. They do so by employing a strategy known as "freeze tolerance" where the larvae can survive ice formation within the body. Understanding the underlying mechanisms of this adaptation may prove to be beneficial for pest control of the insect and for cryobiology.

To determine the lowest temperatures that the maggots could survive, we exposed maggots (N=90) to 6 treatment temperatures (0°C, -10°C, -20°C, -30°C, -40°C, -50°C) for one week. Survival was recorded over the course of a week post-treatment. A general trend in survival was observed with an LT50 of ~ -20°C. Mass was monitored with the maggot's body weights being taken before and after treatment. In addition to LT50 determination, vitrification capabilities were assessed (safe, glass-like ice formation rather than crystallized, which is sharp, pointed and can damage cells), as other insect species have been shown to vitrify through accumulation of ice-nucleators and cryoprotectants within the hemolymph. SBRM hemolymph was extracted and observed within a cryoscope to determine its supercooling points and whether vitrification occurred. This data can be utilized as a baseline for future experiments exploring the freeze tolerant capabilities of the sugarbeet root maggot.

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Transcriptome Response of *Myotis lucifugus* and *Eptesicus fuscus* to White-Nose Syndrome over a Spatial and Temporal Gradient

KARLIEGH WATTIER
NDSU CHANGE Program: Research and Mentoring for Postbaccalaureates in Biological Sciences
Project Mentor: Mandy Guinn, MS, United Tribes Technical College

White-Nose Syndrome (WNS), caused by the psychrophilic fungus *Pseudogymnoascus destructans* (Pd), has been decimating certain bat populations across the United States and Canada since its discovery in 2006. First identified in New York, Pd has spread westward at a rate of 200 miles per year, killing up to 90-100% of the bat populations it infects. While highly susceptible species like *Myotis lucifugus* experience high mortality, other species, such as *Eptesicus fuscus*, show little to no response to the fungal infection with low mortality. To investigate the immune responses to WNS across a spatial and temporal gradient, we collected tissue samples from both *M. lucifugus* and *E. fuscus* across the northern United States. Samples were taken during hibernation, when WNS was active, and in late summer, post infection to act as a control. RNA was extracted to compare the transcriptome responses of infected and uninfected areas of the wing to determine whether the response was localized or systemic. We hypothesize that 1) eastern *M. lucifugus* populations infected with WNS will exhibit different transcriptome responses compared to western populations that are more naive to the infection, and 2) *E. fuscus* will display different transcriptomic responses from *M. lucifugus* due to differences in their susceptibility.

Where the elk roams: genomics and individual-based demographic modeling reveal the status of connectivity between small, isolated elk herds

ZACHARY WHALEY
NDSU CHANGE Program: Research and Mentoring for Postbaccalaureates in Biological Sciences
Project Mentor: Travis Seaborn, Ph.D., Natural Resource Management

Despite significant population declines following colonization, populations of elk (*Cervus canadensis*) across North America have rebounded from historic lows. In the past century, elk have returned to portions of North Dakota, Minnesota, and Manitoba, where

they represent a culturally important game species. These elk herds are characterized by small sizes and relative geographic isolation from other herds, increasing herd vulnerability to environmental stochasticity and loss of genetic diversity. Assessments of genetic diversity and gene flow between herds are therefore important for estimating the viability of these herds and informing management of disease and hunting. We used tissue and fecal samples collected from 2008 to 2023 to extract DNA from 42 elk in North Dakota, 286 in Minnesota, and 56 in Manitoba. After DNA sequencing of the samples, we will evaluate genetic diversity and gene flow across herds. We will then use the program Cost-Distance Meta-POPulation (CDMetaPOP) to simulate individual-level genomics, demographics, and dispersal across sampled herds. Finally, we will identify deviations from expectation by comparing measures of population genetic diversity between simulated and real genomic data. We predict that assessments of genetic structure will result in two population clusters, one spanning Minnesota and Manitoba and another in North Dakota. These hypothetical clusters are separated by relative geographic distance and human infrastructure, including an interstate highway. We additionally predict that the potential cluster in North Dakota will have greater genetic diversity and lower inbreeding than the cluster in Minnesota and Manitoba, potentially due to the proximity of unsampled Canadian herds and larger population sizes based on published surveys. This research will inform managers of an international population of elk whether management is needed to improve genetic diversity. It will also determine whether this population is a single, panmictic population or a metapopulation.

Exploring the Relationship Between Protein Content and Color Pigmentation in Durum Wheat Kernels

KAYDEN WERLINGER
Food Science
Project Mentor: Frank Manthey, Ph.D., Plant Sciences

Durum wheat (*Triticum durum*) has a critical role in food production, yet the relationship between kernel color pigmentation and protein content remains unclear. This project aims to explore the potential relationship between protein content of the wheat and color pigmentation of durum wheat kernels. Samples from North Dakota and Montana were analyzed using yellow and brown pigment tests and seed color testing with the Minolta colorimeter. The protein content was determined by using a near infrared spectroscopy (NIR) method. Statistical analysis was used to compare the results from pigment, color, and protein tests.

Previous research has established a relationship between the grain protein content and the yellow color of semolina, suggesting that color pigmentation could serve as an indicator of the protein content. Interestingly, results of this project indicate that grain protein content did not relate with grain color. There was not a relationship between grain protein content, yellow pigments, brown pigments, or seed color values. Further research will be needed to better understand the underlying mechanisms behind grain color and protein content in durum wheat.

Exploring Division I Student Athletes' Perceptions of Desirable Leadership Styles

KAMRYN WIESE
Sports Management
Project Mentor: Seungmin Kang, Ph.D., Health, Nutrition, and Exercise Sciences

Student-athletes face substantial challenges in balancing athletic competition with academic and professional preparation during their university years. In NCAA Division I, this challenge is intensified because coaches often prioritize developing athletes' sports skills over preparing them for post-sport careers (Turick et al., 2021). Coaches significantly influence student-athletes' success both on and off the field, yet existing research primarily focuses on leadership styles related to athletic identities. A notable gap remains in understanding how coaches' leadership styles impact student-athletes' dual career development, particularly in balancing athletic and academic/professional goals.

To address this gap, this study explores NCAA Division I athletes' perceptions of desirable leadership characteristics in head coaches, focusing on how these styles support both athletic and non-athletic development. By putting a spotlight on student-athletes' opinions, this research contributes to existing literature by identifying effective leadership styles that benefit student-athletes in highly competitive environments.

Given the exploratory nature of this study, a qualitative research design is employed (Merriam & Tisdell, 2016). Data collection is ongoing and expected to be concluded by April 2025 once data saturation is achieved. NCAA Division I student-athletes from a Midwest university are being recruited using purposive sampling for semi-structured interviews (Creswell, 2014). Data analysis will involve an inductive coding process (*Saldaña*, 2021). To ensure the trustworthiness of the findings, member checking and peer debriefing will be conducted (Smith & McGannon, 2017).

The findings of this study are expected to provide insights into student-athletes' perspectives of desirable leadership styles, considering factors including sport type (individual vs. team) and participation in revenue or non-revenue generating sports. These insights will inform more comprehensive and balanced coaching practices and administrative decisions, helping to align them with student-athletes' needs and support their dual career development.

The Evidence Base for Museum Sensory Hours Lacks the Perspectives of People with Autism

KIERGON WILKINS
Psychology
Project Mentor: Katherine Duggan, Ph.D., Psychology

Museum sensory hours (times when the environment is less stimulating) have been developed based on the assumption that people with Autism Spectrum Disorder (ASD) are easily overstimulated. Though this is grounded in some truth, sensitivity to stimuli in ASD can manifest as hyper- or hypo-reactivity, and such sensitivities are only one of at least four symptoms in the behaviors, interests, and activities category for autism. Thus, it is plausible that museum sensory hours may not meet the needs of a majority of people with ASD.

The goal of this study is to learn what neurodivergent people, particularly those with ASD, want out of their museum experiences, if anything different at all. Additionally, most research on ASD uses

deficit-based frameworks, which focus primarily on the challenges, impairments, and atypical behaviors associated with the diagnosis. While research thus far has identified where those with ASD require support and intervention, it often overlooks the capacities, strengths, and adaptive strategies people with ASD possess. By adopting a resilience framework when considering ASD and museum design, we can shift the focus from deficits in ASD (such as an assumed need for less stimulation) to helping individuals with ASD leverage their strengths to excel.

In developing the study, a cross-disciplinary literature search was conducted considering current ASD assessments; aesthetic experiences; learning and sensory stimulation; museum design principles; museum websites; and consulting professional experts. Critically, only two of the eight scales included some assessment of positive experiences with ASD, and these two scales still had primarily negatively valenced items. Additionally, none of the fifteen museum websites consulted included any scholarly evidence supporting their reasoning for sensory hours. Thus, our planned study includes not just current scales measuring museum experience and ASD symptoms but also experiences with museums and other social institutions, preferences for socialization and stimulation in and outside of museums, and open-ended questions focused on strengths. Overall, this ongoing project represents a new approach to understanding the experiences of people with ASD through a resilience-based framework. It will also provide sound data that can be used to modify or support the inclusion of sensory hour practices.

The impact of social networks on life satisfaction in older adults

ALYSSA WILLIS
Psychology
Project Mentor: Heather Fuller, Ph.D., Human Development and Family Science

Social connectedness is a key component of wellbeing across the lifespan, but less is known about how the size and composition of social networks are associated with wellbeing, specifically among older adults. The aim of this project was to identify correlations between older adults' life satisfaction and social network makeup. In order to investigate this, I used data from Wave 2 of the Social Integration and Aging Study (Fuller, 2013-2023). In this survey, 320 adults aged 56-100 (mean=81) responded to questions about their interpersonal connections, social integration, wellbeing, and demographic characteristics. Social network size was assessed through a name generator technique in which participants could identify up to 20 people important to them. Proportion of family in network was calculated by dividing the number of family members reported by total network size. Life satisfaction was assessed with Diener's 5-item Satisfaction with Life scale. The main questions I aimed to answer were: 1) Are social network size and proportion of family in network correlated with life satisfaction, and 2) Do network size and proportion of family in network function together to predict life satisfaction? Results of a Pearson's correlation indicated significant, moderate correlations between network size and proportion of family in network ($r(301)=-.30$, $p<.01$) and between network size and life satisfaction ($r(303)=.12$, $p<.05$), whereas proportion of family in network was not correlated with life satisfaction ($r(300)=.03$, $p>.05$). An analysis of variance analysis (ANOVA) comparing the life satisfaction of those with small networks with low family proportion, small networks with high family proportion, large networks with low family proportion, and large networks with high family proportion. The results indicate network size and proportion family do not significantly function together to predict life satisfaction ($F=2.249$, $p=0.83$). Identifying the relationship between network size, network composition, and wellbeing of older adults is a crucial step in understanding how social factors impact healthy aging throughout the lifespan. Understanding the association of these factors will allow for more effective interventions to be designed to foster beneficial social supports among older adults.

participants

gamma sigma delta

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POSTER PRESENTATIONS

Optimization of Drying Conditions for Enhanced Soybean Quality

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Agricultural and Biosystems Engineering
Advisor: Clairmont Clementson, Ph.D., Agricultural and Biosystems Engineering

Soybeans are among the world's most important protein sources, playing a crucial role in combating hunger, particularly in densely populated and underdeveloped regions. Ideally, soybeans dry naturally in the field until they reach a moisture content of approximately 13% wet basis. However, climate variability presents a significant challenge to soybean production. Unpredictable weather, such as early frost before maturity or rainfall during harvest, can disrupt optimal growing and harvesting conditions. This challenge is especially pronounced in the Northern Plains, where the growing season is limited by frost-free days and early winter onset. Adverse weather during harvest may necessitate the collection of soybeans at high moisture levels, often exceeding 20% wet basis. In such cases, mechanized drying becomes essential. Due to the high moisture content and the impracticality of air or low-temperature drying, high-temperature drying may be required. This study investigated the optimal drying temperature for soybean seeds. The effects of initial moisture content (17%, 20%, 23%), drying temperatures (70, 105, and 140 °F), airflow rates (45 and 70 cfm/bu), and drying time on seed quality specifically seed coat cracking, breakage, and removal were evaluated. Results showed that seed coat cracking increased with higher drying temperatures, airflow rates, and drying duration. Higher airflow rates led to greater moisture loss, reducing drying time but increasing seed coat cracking. However, seed breakage and seed coat removal remained minimal across all drying conditions.

Identification of Resistance Loci for Oxalic Acid Tolerance and Sclerotinia BSR in Cultivated Sunflower lines

SRUSHTIDEEP ANGIDI
Plant Pathology
Advisor: Julie Pasche, Ph.D., Plant Pathology

Basal stalk rot (BSR) of cultivated sunflower is caused by a necrotrophic fungal pathogen, *Sclerotinia sclerotorium*, causing significant yield losses worldwide. Typical symptoms of BSR include wilting in aerial tissues and basal stem lesions, which are mimicked by treatment with oxalic acid (OA). This study focuses on understanding the role of OA in BSR development and identifying genetic factors responsible for OA tolerance. Our prior investigation identified OA tolerance in the sunflower inbred line HA 61, which also exhibited partial resistance to BSR while HA 89 was identified as susceptible to both BSR and OA. To advance this research, a recombinant inbred line (RIL) population was developed from the cross HA 61 × HA 89 to 1) map quantitative trait loci (QTL) contributing to BSR resistance, 2) map QTL contributing to OA tolerance, 3) assess the correlation between OA tolerance and BSR resistance. The preliminary results indicated that phenotyping for BSR in the RIL population had been completed, revealing an average panel score of 13.56 mean days to death. Transgressive segregation was observed for disease response in this population, as anticipated for quantitative resistance to basal stalk rot. Additionally, the first replication of the OA phenotyping trial has been concluded, and further replications are underway.

These findings highlight progress toward achieving the study objectives and will provide valuable insights into the genetic mechanisms governing resistance to BSR and the specific genes responsible for OA tolerance. Understanding the genetic basis of OA tolerance can potentially lead to the development of BSR-resistant crop varieties, offering a sustainable solution to mitigate the economic impact of this devastating disease.

Investigating molecular biocontrol potential of bacteria against different *Fusarium* spp.

SURUCHI ARYAL
Plant Pathology
Advisor: Malaika Ebert, Ph.D., Plant Pathology

Root rot is a devastating disease in pulse crops and is caused by a complex of soilborne pathogens, including *Fusarium* spp., *Rhizoctonia* spp., *Aphanomyces* euteiches, and *Pythium* spp. Among them, Fusarium is the predominant genus. Our research aims to explore the biocontrol potential of a specific bacterial strain against different *Fusarium* spp. To assess the effect on sporulation, we conducted in vitro assays for which we grew six different *Fusarium* spp. in spore producing conditions either in the presence or absence of the bacterial strain. After 7 days, we counted the macroconidia and microconidia using a hemocytometer. Our preliminary data show that overall spore production was reduced when the fungus was grown in the presence of the bacteria compared to *Fusarium*-only cultures. Based on these preliminary data, we are planning on investigating the expression of genes involved with the production of asexual spores in *Fusarium* spp. and compare their expression levels in presence and absence of the bacteria. Additionally, we are interested in identifying the biochemical compounds produced by the bacteria that are interfering with spore production in the fungus. Eventually, this research is aimed to advance the identification of an environmentally friendly alternative to manage root rot in pulse crops.

Long-Term Soil pH Changes in Southwestern North Dakota

MARIA BATOOL
Soil Science
Advisor: Larry Cihacek, Ph.D., Soil Science
Soil acidification has been increasing in many parts of North Dakota, including Major Land Resource Area 54 (MLRA 54) – the Rolling Shale Plain of southwestern North Dakota. We have accessed archived soil samples collected at known sites during 1991-1992 and again

in 2010. We resampled 11 of the previously sampled georeferenced sites in 2023. These sites are paired with undisturbed grassland and long-term cropland sites on the same or similar soil series. Most soils originally ranged in pH between 6.0 and 7.5 in the original sampling. We have observed that (long-term (30 years) land use intensification in croplands contributes to increased soil acidity in the top 30 cm of soil depth beginning in the 1992–2010 time frame (as compared to grasslands). Additionally, new soil profile descriptions show a change in the depth of Ap horizons compared to the 1992 soil description. This suggests that the soil pH trend might be related to soil profile changes. We have also observed that the pH changes intensified between the 2010 and 2023 resampling. We hypothesized that long-term no-till combined with crop mix changes requiring greater N fertilizer use along with surficial application of N fertilizers may, in part, be responsible for the lowering of soil pH in this region. Further research is needed to identify the extent of soil acidification across the state and to develop strategies to reduce and mitigate its effects on crop production.

Integrative Multi-Omics Analysis Reveals Epigenomic and Transcriptomic Signatures Provides Insights into Common Bean Heat Tolerance.

WEI DAI
Plant Sciences
Advisor: Zhikai Liang, Ph.D., Plant Sciences

Tepary bean (*Phaseolus acutifolius* A. Gray), native to the Sonoran Desert, exhibits high adaptation to drought and heat stress compared to its sister species, the common bean (*Phaseolus vulgaris* L.), a critically important vegetable protein source whose production is increasingly threatened by climate change. Extensive collinearity and shared gene content between these two Phaseolus species offer promising opportunities for transferring stress-resilient traits from tepary bean to common bean. This study aims to identify key regulatory elements within non-coding genomic regions that mediate heat stress adaptation in tepary beans and potentially enhance heat tolerance in common bean species. To reveal the genomic and epigenomic mechanisms underlying tepary bean's enhanced heat tolerance, we conducted short-read and long-read RNA sequencing alongside whole-genome bisulfite sequencing (WGBS) on plants exposed to heat stress conditions, using normal temperature as the control. Additionally, comprehensive phenotypic measurements were performed, including photosynthetic efficiency, pigment absorption (chlorophyll), chlorophyll index, anthocyanin index, NDVI, leaf color parameters, and morphological traits. RNA-seq analyses identified distinct transcriptional responses to heat stress, uncovering novel transcription start sites (TSS) and alternative splicing events. WGBS analysis revealed differentially methylated regions (DMRs) and unmethylated regions (UMRs) predominantly within regulatory and non-coding genomic regions, correlated with differential gene expression. Integrative analyses revealed candidate regulatory elements in which heat-induced methylation or demethylation correlated with transcriptional changes. Phenotype–gene expression association analyses identified key gene expression under heat stress significantly correlated with physiological traits, especially photosynthetic efficiency and chlorophyll content. Additionally, epigenetic–phenotype association analyses demonstrated transparent relationships between DNA methylation patterns at regulatory elements and specific phenotypic changes, further highlighting the epigenetic regulation in heat tolerance. Our comparative genomic approach between tepary and common beans highlighted conserved genomic regions containing candidate genes and regulatory elements, providing potential targets for improving heat tolerance in common beans via genetic modification.

Response of plants to soil compaction and soil water content.

VIOLET EAGLE
Soil Science
Advisor: Thomas DeSutter, Ph.D., Soil Science

Among pipeline remediation challenges soil compaction is a major issue that decreases productivity of landscapes. Possible solutions include enhancing root establishment to assist disturbed soils by increasing available bio-pores, root biomass, and depth. Separate growth chamber experiments utilizing oats (*Avena sativa* L.) and western wheatgrass (*Pascopyrum smithii*) were conducted to define the interactions of factors common to western North Dakota and post-installation of pipelines. Two soil textures (loam vs. sandy loam), three water contents based on percentage of soil field capacity contents(100%, 50%, 25%) and three soil bulk densities (1.3, 1.5, 1.7 g soil cm-3) were combined to induce differential root mechanical resistant environments. This resulted in XX treatments which were replicated three times for each plant species. After a 21-day growth cycle penetration resistance (PR) of the soil was determined, above ground biomass (AGBM) was harvested, roots were washed then analyzed for length by WinRhizo, and gravimetric soil water was measured. Separate three-factor ANOVAs were run on PR, root length, and AGBM by corresponding plant species. Oats had an average of twice as much biomass as western wheatgrass. Across all metrics western wheatgrass was more sensitive to water content. Results for the loam soil were more distinct across all metrics as compared to the sandy loam. Root length was significantly correlated with soil bulk density ($P = 0.006$). Above ground biomass was most correlated with water content ($P < 0.005$) for both texture class soils and plant types. Penetration resistance ranged from 0 – 1.65 MPa before and after the growth cycle with the loam soil having greater variability than the sandy loam soil. This work reaffirms the importance of moisture considerations for remediation establishment and underlines the importance of plant rooting behavior in the interest of soil compaction reduction strategies.

Predictability of heat stress susceptibility: Correlations between baseline biomarkers and performance indicators in chronically heat-stressed feedlot wethers.

SAMANTHA EKSTROM
Animal Sciences
Advisor: Rachel Gibbs, Ph.D., Animal Sciences

Heat stress disproportionally impacts finishing livestock. Variation in susceptibility causes difficulty in identifying animals at increased morbidity and mortality risk. This study aimed to identify baseline biomarkers predicting growth efficiency and physiological stress responses in chronically heat-stressed feedlot wethers. Circulating metabolites, stress biomarkers, and immune factors were analyzed from Polypay-crossbred wethers (n=25) before heat stress (40°C, THI=86 for 12 h/d; 35°C, THI=82 for 12 h/d). Bodyweights, ultrasound-estimated back fat (BF) thickness, respiratory rate (RR),

and rectal temperature (RT) were evaluated. Correlation analyses was performed to evaluate baseline biomarker associations with growth efficiency metrics: average daily gain (ADG), gain-to-feed ratio (GF), and percent change (Δ%) in ultrasound-estimated loin eye area (LEA) and BF thickness and with physiological heat stress response metrics: Δ%RT, Δ%RR, and Δ% plasma tumor-necrosis factor-alpha (TNFa) from baseline to 30 d. All circulating metabolites were and tended to be correlated with growth efficiency (r = ±0.38–0.57) and physiological responses (r = ±0.38–0.51). Triglycerides and insulin negatively correlated with GF and tended to negatively correlate with ADG. Insulin-like growth factor-1 negatively correlated with Δ%LEA. Triglycerides, plasma urea nitrogen, and insulin tended to positively correlate with Δ%TNFa, Δ%RR, and Δ%RT, respectively. Cholesterol tended to negatively correlate with Δ%RR. Stress biomarkers were or tended to be correlated with growth efficiency (r = ±0.36–0.56). Partial pressure CO2 positively correlated with ADG and GF, and CO2 and cortisol tended to positively correlate with Δ%LEA. Cortisol tended to negatively correlate with ADG and GF. Epinephrine tended to positively correlate with GF. Immune factors were or tended to be correlated (r = ±0.35–0.41) with physiological responses. Granulocytes and monocytes positively correlated, and granulocyte-to-lymphocyte ratios tended to positively correlate with Δ%RT. Lymphocytes positively correlated with Δ%TNFa. Initial bodyweight tended to negatively correlate with ADG and GF, and RT tended to negatively correlate with Δ%BF thickness. RR negatively correlated with GF and Δ%RR, positively correlated with Δ%BF and Δ%RT, and tended to negatively correlate with ADG. Initial BF thickness negatively correlated with Δ%LEA. These findings indicate that baseline biomarkers exhibit varying correlation strengths with growth efficiency and physiological responses to chronic heat stress.

Using Genomic Prediction to Improve Nutritional Content in Dry Bean (*Phaseolus vulgaris* L.)

CARLY GEORGE
Plant Sciences
Advisor: Juan Osorno, Ph.D., Plant Sciences

As an important crop in global food systems, dry beans (*Phaseolus vulgaris* L.) play a crucial role in food security, making the improvement of their nutritional profile essential for maximizing their benefits to consumers. Known for their rich sources of plant protein, dietary fiber, and minerals, dry beans are widely recognized as a highly nutritious food source. However, combining key agronomic, seed quality, and nutritional traits into a single dry bean cultivar remains a challenge. To address this, genomic selection has emerged as a promising tool which leverages genetic information to predict traits of economic importance in crops such as dry beans, saving time compared to traditional selection methods. Genomic selection uses genome-wide molecular markers and statistical models to estimate the genetic potential of breeding lines before they get tested in the field. This approach has been successfully applied to traits such as seed yield and disease resistance, improving selection efficiency in some cases by 30-49%, especially at earlier breeding stages. This study aims to evaluate the nutritional content of approximately 420 breeding lines within the North Dakota State University (NDSU) dry bean breeding program plus check cultivars to assess the effectiveness of genomic selection models in improving selection for protein, oligosaccharides, and mineral content. These phenotypic traits will be measured using Near Infrared Reflectance (NIR) and other standardized methods, while genotyping will be conducted utilizing a custom single nucleotide polymorphism (SNP) chip containing 4K SNP markers. Genomic prediction models, including genomic best linear unbiased prediction (G-BLUP) and Bayesian regressions, will be tested for predictive accuracy. Environmental data will be incorporated to improve the accuracy of genotype-by-environment (GxE) interaction modeling. A genome-wide association study (GWAS) will be conducted to identify significant SNPs and candidate genes in relation to key nutritional traits. This research hopes to identify the most accurate genomic selection approach for selecting dry bean lines with enhanced nutritional profiles.

Effect of Wheat Flour Gluten Strength on the Incorporation of Intermediate Wheatgrass (*Thinopyrum intermedium*) in Bread Formulations

MD AHMADUL ISLAM
Cereal Science
Advisor: Shahidul Islam, Ph.D., Cereal Science

Intermediate Wheat Grass (IWG), a perennial grain crop, is rich in dietary fiber, minerals, and antioxidants, making it a potential healthy food ingredient. However, its effects on end-product quality are not well studied. The impact of IWG on starch and protein functionality in bread making and its nutritional quality was investigated. IWG flour had lower total starch, damaged starch, and amylose content compared to commercial all-purpose and hard red spring wheat (HRS) flour, leading to lower pasting viscosities. Despite higher protein content, it showed lower unextractable polymeric protein and protein aggregation energy. Its gluten, dominated by α/β and ω gliadins, and low in high molecular weight glutenin, resulted in poor protein network formation, negatively affecting loaf volume. However, IWG flour increased dietary fiber, polyols, total phenolic content, and antioxidant activity. IWG flour substitution up to 20% can enhance nutritional properties without affecting dough and baking quality.

Quantitative Analysis of Sucrose, and Moisture Content in Sugar Beets Utilizing Hyperspectral Imaging and Advanced Machine Learning Techniques

NALOVA LISINGE IVANNA MOJOKO
Natural Resource Sciences
Advisor: Ewumbua Monono, Ph.D., Agricultural and Biosystems Engineering

Sugar beets account for 20-25 percent of the global sugar demand. Due to its high moisture content and microbial activities during post-harvest operations, sucrose is sometimes degraded to other compounds that are not suitable to form sugar crystals. Accurate and timely monitoring of these parameters is essential to minimize sucrose loss during post-harvest operations. Traditional laboratory methods are time-consuming, complex, destructive, expensive, and labor-intensive. Therefore, developing a rapid analytical method using hyperspectral imaging will solve these limitations. To ensure sample variability, beets were collected from three locations: Moorhead and Renville in Minnesota, and Wahpeton, North Dakota. Samples were washed, cut at 15 mm thickness, and spectral images were acquired using the Specim SWIR camera in the spectral region of 1,000-2,500 nm. Sucrose and moisture content were measured using standard laboratory procedures which involved oven drying, crushing the dried sample and using acid to break down the plant cell wall to measure sucrose using the HPLC. Images were subjected to radiometric

correction to remove noise and any illumination variations. The pre-processed signals obtained were combined with results obtained from using standard procedures to form a single dataset. Dataset was then split into 6:2:2 as training, validation and testing data. Various machine learning and deep learning algorithms were used for classification. The results showed that Linear Discriminate Analysis (LDA) and Random Forest (RF) models performed best. Models showed F1 scores of 0.60 – 0.74 and 0.955 respectively. Our results support the claim that ML models trained on spectral signatures can non-destructively predict sucrose, raffinose, and moisture content in sugar beets.

Sensitivity of Sugar beet-derived *Cercospora beticola* Isolates to different Fungicide Classes

SUSHMITA KALIKA-SINGH
Plant Pathology
Advisor: Luis Mendoza, Ph.D., Plant Pathology

Cercospora leaf spot (CLS), stemming from the hemi-biotrophic fungus *Cercospora beticola*, is a severe foliar disease affecting sugar beet (*Beta vulgaris* L.) in the Red River Valley, leading to significant reductions in yield and sucrose content, potentially up to 50%. Managing CLS effectively often involves using resistant cultivars and timely fungicide application, but *C. beticola* has developed resistance to triphenyltin hydroxide (TPTH), demethylation inhibitors (DMI), and quinone outside inhibitor (QoI) fungicides. This study investigated the response of 40 C. beticola isolates obtained from leaf samples gathered from a sugar beet field in Foxhome, Minnesota, during the 2022 growing season. The isolates were grown on CV-8 media amended with 0.01 to 10 ppm of the fungicides, Proline (DMI), Champ®WG, Manzate Max, and Supertin (TPTH). After incubating the plates in darkness at 23°C for 14 days, the diameter of resulting mycelial colonies was measured. This replicated experiment was conducted twice. The EC50 for Manzate Max and Supertin were 8.1 and 1.6 respectively. EC50 could not be calculated for Champ®WG, and Proline. Sensitivities to the latter fungicides were reassessed as described using concentrations ranging between 25 and 800 ppm. The results showed their EC50 were 69.8, and 496.1, respectively. Future research will encompass greenhouse dose-response studies and mutational analysis to further elucidate the responses of *C. beticola* to these fungicides.

Short Term Impacts of Grazing Cover Crops on Profitability and Soil Health

KATRINA KRATZKE
Natural Resource Sciences
Advisor: Miranda Meehan, Ph.D., Animal Sciences

Cover crops (CC) as part of an integrated crop livestock system (ICLS) may extend the grazing season in the Northern Great Plains and off-set the costs of CC establishment. The objective of this study was to determine the effects of grazing CC on soil health and profitability. At Central Grasslands Research Extension Center nine 1.78 ha plots were assigned one of three treatments: dual (fall and spring) grazing (DG), spring grazing (SG), and control, which was divided into no graze (NG) and no winter rye (NR). Winter rye was planted following cash crops fall 2022 (foxtail millet hay), spring 2023 (soybeans), and spring 2024 (corn silage). In fall 2022, spring 2023 and 2024 CC were grazed for 0.6 animal unit months (AUMs), 3.36 AUMs, and 0.98 AUMs, respectively, per plot. Fall 2023 and 2024, DG plots were not grazed due to late seeding that led to low forage production. Winter rye was evaluated pre- and post-grazing for biomass production. Fall grazing did not impact spring CC production or percent bare ground. Grazing did not alter soil chemical properties or negatively impacted soil physical properties. Cover crops significantly reduced weed cover. Weed suppression was unaffected by grazing. Cash crop performance was evaluated mid-season by staging and stand counts, and at harvest by yield. There were no differences in crop performance between treatments 2023 or 2024. Production economics were estimated by partial budgeting that accounted for cost of CC establishment and total savings in feed and yardage costs compared to if dry lot management were used. The cost of establishing a CC each year was approximately $17.4/ha. Grazing either resulted in a net income or provided a return on CC investment across all years. Grazing CC is heavily dependent on planting date, temperature, and precipitation, but can extend the grazing season in the spring reducing feeding costs without negatively impacting soil health or crop performance.

Heritability of Fruit Quality Traits in a population of North Dakota hardy grapes

ELIZABETH KRAUSE
Plant Sciences
Advisor: Harlene Hatterman-Valenti, Ph.D., Plant Sciences

North Dakota's short growing season makes winegrape fruit ripening challenging. To address this challenge, a half-diallel population bred from five red-fruiting cold-hardy parents ('ES10-18-58', 'Frontenac', King of the North', 'Marquette', and Sabrevois') was used to calculate heritability of fruit quality traits. Fruit samples were collected every two weeks through the ripening period. Titratable acidity, °Brix, pH, yeast-accessible nitrogen, ammonia, malic acid, alpha amino data were determined using an FTIR (OenofossTM) machine. Analysis of variance (ANOVA) in R with the package "lmdiallel" was used to calculate variances, Broad sense heritability was found by dividing the variance due to general combining ability by the total variance. Narrow sense heritability was calculated by adding the variance of general and specific combining ability, then dividing by the total variance. The most heritable traits included pH (broad sense heritability 0.5), titratable acidity (broad sense heritability 0.47), and malic acid (broad sense heritability 0.4). The least heritable traits included ammonia (broad sense heritability 0.34) and berry weight (broad sense heritability 0.38). General combining ability was far more likely to be significant than specific combining ability. This suggests that the contributions from each individual parent matter more than the unique effects of crossing specific parents. These results will help cold-climate grape breeders make better crossing decisions, which will lead to more cultivar options for our grape growers.

How bacteriophages and bacteria affect the production of volatile fatty acids and gas (biogas and methane) in vitro

GABRIELA MAGOSSI
Microbiology
Advisor: Samat Amat, Ph.D., Microbiology

The rumen environment enables the microbial fermentation of feed components, producing volatile fatty acids (VFAs) as an energy source

for the host. However, this process also generates methane (CH_4), which represents an energy loss of 2–12% of the total intake. Reducing methane production could improve feed efficiency and energy conservation in livestock. This study aimed to evaluate the effects of bacteriophages, their bacterial hosts, and combined phage-bacteria treatments on total biogas, methane production, and fermentation parameters in ruminal fluid (RF) cultures in vitro. Ruminal fluid was collected from four Jersey cows, pooled, and incubated with a high-forage diet and artificial saliva buffer. Treatments included phages (targeting *Solibacillus* spp., *Rhodococcus* spp., *Bacillus licheniformis*, and *Escherichia coli*), bacterial hosts, and a combination of both. Samples were incubated at 39°C for 24 and 48 hours. Total gas was extracted, pH measured, and methane and VFAs analyzed using gas chromatography. Differences among treatments were assessed via Kruskal-Wallis tests with Dunnett's correction ($P \leq 0.05$). Overall, phage and bacterial treatments had minimal effects on total gas and methane production. However, pH decreased slightly in RF treated with *Solibacillus* spp. and *E. coli* phages at 24 hours (6.81 to 6.7) and in the bacteria + phage cocktail at 48 hours. VFA concentrations varied, with isobutyrate, isovalerate, and valerate increasing after 24 hours in treated RF, but this effect persisted only in the bacteria + phage cocktail after 48 hours. These preliminary findings suggest that phage and bacterial inoculations can selectively alter ruminal fermentation, affecting pH and VFA profiles in the short term. This microbiome modulation could serve as a tool for optimizing ruminal fermentation and improving feed efficiency in livestock.

Competition-induced changes to molecular mechanisms of intercropped alfalfa with sunflower

MARIA MAZALA
Plant Sciences
Advisor: Marisol Berti, Ph.D., Plant Sciences

Alfalfa (*Medicago sativa* L.) is a perennial forage crop with high nutritive value. Because establishment of alfalfa can be costly and limits early economic returns, it often discourages widespread grower-adoption. Research has shown that intercropping with sunflower (*Helianthus annuus* L.) provides a viable solution for establishing alfalfa and provides an additional source of income and overall profitability. Analyzing gene expression patterns and linking differentially expressed genes (DEGs) to molecular physiology could reveal factors influencing yield responses and physiological traits associated with intercropping. The aim of this study is to analyze the transcriptomes of intercropped alfalfa and sunflower and gain a better understanding of its impact on physiological and molecular mechanisms underlying plant-plant interactions associated with improving alfalfa establishment, crop yield, nitrogen (N_2) fixation, and overall crop utilization. Alfalfa and sunflower leaf and root tissue samples were collected in Prosper and Hickson in 2021 and Hickson and Red Lake Falls in 2022. Samples were collected from five treatments: Alfalfa alone, sunflower alone at row spacing 76-cm, sunflower alone row spacing 152-cm, sunflower row spacing 76-cm intercropped with alfalfa and sunflower row spacing 152-cm intercropped with alfalfa. RNA was extracted and cDNA libraries were constructed and sequenced. A quality control summary after sequencing of treatments showed ~50,000,000 averaged raw reads and ~0.015 error, an indication of good samples (a good sample should be > 6 million raw reads and the error is the base error rate (< 0.05%)). Intercropping alfalfa with sunflower is expected to enhance stress tolerance, improve nutrient use efficiency, and increase biomass production through inter and intraspecies interactions in both crops. Additionally, distinct gene expression patterns between leaf and root tissues will be revealed, with DEGs related to photosynthesis, stress response, and carbon metabolism being more prominent in leaves, while genes associated with nutrient uptake, root architecture, and symbiotic interaction will be more differentially expressed in roots. Thus, the knowledge may give breeders options to manipulate these targets and processes in alfalfa and sunflower using established modern gene editing technologies.

The Health Benefits of Indigenous Foods: Phenolic Bioactives from Juneberry and Indigenous Colored Corn for Glycemic Control and Diabetes Management

MERCEDES MORIN
Environmental and Conservation Science
Advisor: Kalidas Shetty, Ph.D., Plant Sciences

Native Americans experience the highest rates of diabetes among ethnic groups, and past research has not effectively addressed this health disparity. In response, many tribal communities are prioritizing culturally relevant nutritional solutions for diabetes prevention and management. This study investigates the phenolic bioactive compound content and antioxidant activity of juneberry and Indigenous corn varieties under different extraction methods and stress conditions for glycemic control relevant for diabetes management. Five juneberry selections—two wild (1-5, 1-4) and three commercial cultivars (Par90, Parkhill, Buffalo)—were harvested from the NDSU arboretum (2024) and the Turtle Mountain Band of Chippewa Reservation (2023). Three extraction methods (hot water, ethanol, acetic acid) were used, and total soluble phenolics (TSP) content was determined via the Folin-Ciocalteu assay. Antioxidant activity was assessed using ABTS and DPPH radical scavenging assays, while α-glucosidase and α-amylase inhibitory activities were evaluated for glycemic control potential relevant for anti-diabetic properties. Juneberries demonstrate high TSP levels, antioxidant capacity, and enzyme inhibition across all varieties. Additionally, bioactive differences were examined in two Indigenous colored corn varieties (IFL Blue, Cherokee Black Eagle) and two commercial varieties (glyphosate tolerant and conventional) during sprouting under temperature stress (4°C, 25°C, 37°C). Corn seeds were sterilized, soaked, and incubated for up to nine days, with extracts obtained using water and ethanol. TSP content and antioxidant activity were analyzed using Folin-Ciocalteu, ABTS, and DPPH assays. Preliminary results indicate that Indigenous colored corn exhibits higher antioxidant activity and enzyme inhibition relevant for glycemic control compared to commercial corn, with TSP levels increasing over storage time. These findings highlight the potential of Indigenous crops as functional foods for glycemic control for diabetes management.

Salinity affects seed germination and vigor in spring and winter camelina

MARISOL MOROCHO
Plant Sciences
Advisor: Marisol Berti, Ph.D., Plant Sciences

The upper Midwest and northern Great Plains have soils with high salinity, where some crops cannot be grown or have limited yields. Camelina (*Camelina sativa* L.) has been reported to have salinity tolerance; however, little information exists regarding salinity

tolerance differences between spring- and winter-biotypes. This study examines salinity effects on seed germination and vigor for spring (C046) and winter (Joelle) camelina. A group of 50 and 15 seeds were germinated in Petri dishes saturated with NaCl, $CaCl_2$, and Na_2SO_4 at concentrations of 0, 40, 80, 120, and 160 mM L-1. Seeds were counted daily for 7 days to calculate seed germination, germination rate, vigor index, corrected germination index (CGRI), germination velocity, biomass, and dry weight, as well as hypocotyl and radicle length. Seed germination averages for the winter- and spring-biotype across all salts were 90% and 94.2%, respectively, and was significant ($p \leq 0.05$) for salt type, salt concentration, variety, and for salt type by salt concentration interaction. A significant reduction in germination rates was observed with Na2SO4 at concentrations >120 mM L-1. The vigor index for both biotypes decreased as salt concentrations increased, but the winter biotype had a lower vigor index compared to spring biotype. Sodium sulfate significantly reduced CGRI; the winter biotype showed lower CGRI than the spring biotype for all salt types and concentrations > 40 mM L-1. Germination velocity was significantly better for the spring biotype. Seedling biomass was significant for all main effects and interactions, whereas dry weight was significant for the triple interaction between salt type, variety, and salt concentration, as well as for salt type and concentration. Hypocotyl length decreased as NaCl concentration increased for both biotypes and Na_2SO_4 almost inhibited growth at concentrations > 80 mM L-1 in the winter biotype, while $CaCl_2$ caused less reduction in hypocotyl growth. Radicle length decreased as salt concentrations increased for all salt types, but Na_2SO_4 drastically reduced radicle growth at 40 mM L-1. Results suggest winter biotype Joelle is more sensitive to salinity than the spring biotype C046, and Na_2SO_4 is more damaging to hypocotyl and radicle growth compared to NaCl and $CaCl_2$.

Companion Cropping Barley, Oat, and Spring Wheat with Kernza Perennial Grain Improves Forage Biomass Production and Maintains Grain Yield

TAONGA MSIMUKO
Plant Sciences
Advisor: Clair Keene, Ph.D., Plant Sciences

Establishing Kernza (*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey) in spring poses challenges for farmers, as it does not yield grain in the seeding year due to the need for vernalization to trigger flowering and seed set. Consequently, there are no economic returns from grain during the establishment year following spring seeding. This study aimed to assess whether establishing Kernza™ alongside barley (*Hordeum vulgare* L.), oat (*Avena sativa* L.), and spring wheat (*Triticum aestivum* L.) as companion crops can improve the total forage and grain yield of these cropping systems (Kernza, barley, oat and spring wheat monocrops, and Kernza dual cropped with barley, oat, or spring wheat). Evaluations of forage yield from both Kernza and small grains took place in Prosper and Fargo, ND, in August 2024. Grain yield was measured solely for the small grains. Preliminary results indicated that grain yield for small grains was similar in monoculture and dual cropping systems at both locations, suggesting no negative impact on annual small grain yield due to companion cropping. The Kernza monoculture yielded more biomass than the dual-cropped Kernza. The Kernza monoculture yielded 627 kg ha-1 of dry biomass, which is low compared to alfalfa, which can yield about 1,500 kg ha-1 from the first cut. Notably, Kernza™ and barley together achieved a total forage yield of approximately 9,700 kg ha-1, exceeding the yield from Kernza™ monoculture at both locations, indicating that growing Kernza™ with barley may be the best combination for increasing total forage yield during establishment.

Exploring free-living nitrogen fixers in the corn field and identifying their interactions with corn root under varying fertilization and tillage conditions

MOHAMMAD AL MAHMUD UN NABI
Microbiology
Advisor: Barney Geddes, Ph.D., Microbiology

The nutrient availability in plants depends on the interaction between the roots of the plants and their associated microbial communities of the root. Unlike legumes, cereal plants do not establish symbiotic relationships with nitrogen fixing microbes in the soil by forming nodules. However, there are free living diazotrophs which can fix nitrogen in the rhizosphere and enhance the nitrogen availability in the soil and the cereal plants might get indirectly benefitted from there. The objective of this study was to investigate the free-living nitrogen fixing microbes found in the soil which are very closely attached to the root of the corn plant. Corn root samples were collected from plot trials in Carrington, ND, including high versus low nitrogen fertilizer application and till vs no-till conditions. The microbial community composition of the rhizosphere was investigated and found to shift with nitrogen availability. Furthermore, a High Throughput Cultivation (HTPC) was performed to establish a representative culture collection of abundant corn root microbiota. The isolates from HTPC were grown on solid medium to ensure a pure culture by three more subcultures, and they were verified by full 16S sanger sequencing. In total, 91 unique amplicon sequence variants (ASVs) were cultured that could also be readily quantified in the microbial community dataset. Among them, a surprising amount (around 32%, n=29) of the isolated ASV showed the ability to grow on nitrogen deficit media and almost all of them were also positive for the presence of the nitrogen fixing gene (nifH) by Polymerase Chain Reaction (PCR). The results suggest that there may be a strong association between free-living nitrogen fixers in the soil with corn plants in agricultural fields. For further study, the abundance of the nitrogen fixers isolated from HTPC will be observed among different treatment groups in the microbial community data. The nitrogenase enzyme activity of the microbes will be measured by acetylene reduction assay. The interaction between the nitrogen-fixing microbes and the corn plant will be observed by using radio-labeled nitrogen.

Azospirillum brasilense and pea seedling exudates as a biocontrol strategy against Pseudomonas syringae in pea plants

BIDYA OJHA
Microbiology
Advisor: Birgit Pruess, Ph.D., Microbiology

Peas (*Pisum sativum*) are highly susceptible to bacterial blight caused by *Pseudomonas syringae*, leading to significant yield losses. *Azospirillum brasilense*, as a plant-growth-promoting rhizobacteria (PGPR) can be a promising alternative for suppressing pathogen, but its biocontrol potential, especially in combination with pea seedling exudates as a prebiotic enhancer, remains largely unexplored. This study hypothesizes that plants inoculated with *A. brasilense* will exhibit reduced disease symptoms following *P. syringae* infection, and that the addition of prebiotic exudates will further enhance disease resistance. While the ultimate goal is to test against *P. syringae* pv. *pisi* (specific to peas), this preliminary study was conducted using

P. syringae pv. tomato as a model pathogen. The experiment was conducted in a controlled greenhouse setting with eight treatment groups, including combinations of *A. brasilense*, *P. syringae*, and pea seedling exudates. Pea seeds were germinated in water agar, with and without exudate; exudate-treated groups received 1 mg/mL of exudate. At planting, plants were inoculated with 10^3 to 10^4 CFU of A. brasilense, and after three weeks, challenged with 3×10^7 CFU of *P. syringae* pv. tomato DC3000 in 2-liter MgCl2 solution. Disease severity was assessed one week post-inoculation through visual scoring, while microbial populations were quantified via serial dilution and plating on selective media. Results showed that plants treated with both *Azospirillum* and exudate had the lowest disease severity (27%) compared to *Azospirillum* (35%) and exudate alone (32.5%). Microbial counts confirmed this trend, with *Pseudomonas* log10 CFU/gm levels reduced to 1.47 in the combined treatment, compared to *Azospirillum* (3.57) and exudate (3.25) alone. Tomato strain, therefore, had an overall moderate amount of disease symptoms in peas. Additionally, *Azospirillum* promoted plant health, as indicated by a percentage increase in chlorophyll content at 4 weeks in *Azospirillum* treated (p=0.01) and *Azospirillum* and exudate (p=0.04) groups compared to controls. These findings support that *A. brasilense* and pea seedling exudates can work synergistically to enhance disease resistance in pea plants, offering a sustainable strategy to improve plant health. Future studies will focus on applying this biocontrol method against *P. syringae* pv. *pisi*, to further validate its agricultural potential.

Increasing forage productivity by establishing perennial legumes with sorghum in an intercropping system

FRANKLIN OMEYE
Plant Sciences
Advisor: Marisol Berti, Ph.D., Plant Sciences

Alfalfa (*Medicago sativa* L.) forage yield in the seeding year is usually less than half of what is produced in the first production year, this deters farmers from growing alfalfa since it is not cost-effective and takes up space that could be used for other income crops, also monocropping does not promote high biodiversity hotspots. This study was conducted to evaluate implications of integrating alfalfa or sainfoin (*Onobrychis viciifoli*a) in an intercropping system with forage sorghum (*Sorghum bicolor* L.) (FS) with the aim of increasing the alfalfa acreage and productivity in means that is most economical and sustainable. This experiment was conducted in Fargo and Prosper, ND, USA in 2023-2024, and the design was a randomized complete block and four replicates. Treatments used in this study include (1) alfalfa alone (2) alfalfa intercropped with FS at 40N (3) alfalfa intercropped with FS at 80N (4) sainfoin alone (5) sainfoin with FS at 40N (6) sainfoin with FS at 80N (7) FS alone. Alfalfa, sainfoin and FS were planted on 12 May in 2023 and 10 June in 2024 at both locations. Alfalfa establishment in an intercropping system with FS was successful and was evident in the second year with doubled forage yield. The different nitrogen rate in the two treatment were alfalfa was intercropped with sorghum had no significant on the forage yield but was seen to be greater when compared with the treatment where FS was alone. The difference nitrogen rate had no effect on the average forage yield of alfalfa and FS. More insects were attracted by alfalfa alone, followed by alfalfa-FS, sainfoin-FS, and FS alone and also insect abundance increased when alfalfa was included in a cropping system. It was observed that soil erosion was pointedly higher in the treatment of FS alone when compared with the treatment of alfalfa intercropping with FS. With the challenges of establishing alfalfa especially in the seeding years this study has demonstrated the advantages of incorporating alfalfa in our cropping system as well as the nutritional value and profitability of forage growers in the Midwest of the United States.

A global assembly of landrace and founder oat (*Avena sativa*) accessions is a discovery resource for adaptive variation, association mapping, and trait deployment

AFRINA RAHMAN
Plant Sciences
Advisor: Michael McMullen, Ph.D., Plant Sciences

Crop adaptation to climate change will require genetic resources that are different from those currently deployed. The rapid global shift to both a warmer climate and unpredictable climactic events must be considered in developing new breeding populations for local environments. Oats (*Avena* spp.) are annual grasses that represent a diversity of species and ploidy levels. The most notable, spring oat (*A. sativa* L.), is a heart-healthy and gluten-free cereal crop that is grown worldwide as a source of food, feed, and cosmetics products. In the past decade, global oat production has been increasingly challenged by environmental changes and its economic value has suffered due to competition with other high-value grain crops. Although genomic resources are growing for spring oat, there is limited information about the landraces that served as founders to modern varieties. To improve knowledge of adaptive genetic variation and phenotypic diversity of spring oat founders, a set of 761 global *A. sativa* landrace accessions in the National Small Grains Collection was investigated, herein dubbed the Oat Landrace Diversity (OLD) Panel. High-depth genotyping-by-sequencing was conducted to assess genetic diversity, perform genome-wide association mapping for quantifying allelic associations with bioclimatic and soil properties, and to provide insight into whether quantitative trait loci identified in the OLD Panel are still important in elite cultivar populations. Finally, we highlight the significance of leveraging genetic variation attributable to environmental adaptation to reinforce plant breeding programs for developing cultivars that are better suited to the changing environment.

Resistance assessment and population dynamics of a new root-lesion nematode species (*Pratylenchus dakotaensis*) on soybean

SIDDANT RANABHAT
Plant Pathology
Advisor: Guiping Yan, Ph.D., Plant Pathology

Pratylenchus dakotaensis, a recently discovered species of root-lesion nematode, demonstrated high infection and reproduction in soybean in North Dakota, posing a potential threat to soybean production. Identifying and utilizing resistant cultivars is one of the best approaches for managing this nematode disease. However, no cultivars tested have been identified as resistant to this new nematode species. Additionally, information regarding its reproduction and population dynamics remains limited. Therefore, the objectives of this research were to evaluate the responses of soybean cultivars to *P. dakotaensis* and to compare the nematode populations in soil and root habitats at fifteen weeks after planting. Two greenhouse experiments, each having ten test cultivars, a positive control 'Barnes', and an unplanted negative control in five replicates were conducted. The experiments were set up

in a completely randomized design using naturally infested soil and both experiments were repeated. Experiment 1 was harvested at nine weeks after planting, and Experiment 2 was harvested fifteen weeks after planting. The nematodes in the soil and roots were extracted and quantified. The cultivar 'Barnes' used as a positive control showed the highest average population density across all experiments, and was selected as the susceptible check. A ratio was calculated for each cultivar by dividing the final nematode population density of the test cultivar to that of final population density of the susceptible check to classify the cultivars as resistant, moderately resistant, moderately susceptible, or susceptible. Based on the collective results of both experiments, six cultivars were classified as moderately susceptible, three as susceptible, and one cultivar as moderately resistant. However, none of the cultivars were found to be resistant. Furthermore, at fifteen weeks after planting, nematode population in the soil was significantly higher than nematode population in the roots, signifying the migratory nature of *P. dakotaensis* which moves from the root habitat to the soil when plants becomes old at the late growth stage. These findings provide insights for growers in selecting least susceptible soybean cultivars for cultivation in infested fields and offer better understanding of its migratory behavior, aiding in effective management strategies.

Optimization of *Rhizoctonia solani* Inoculation Techniques for Resistance Screening in Canola

SHAFI ALAM TIPU
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Advisor: Luis Del Rio Mendoza, Ph.D., Plant Pathology

North Dakota leads the nation in canola production, contributing an estimated 40.04 billion pounds in 2024. *Rhizoctonia solani*, the causal agent of damping-off and root rot of canola, poses a significant threat to the canola industry of the state. When *R. solani*-induced disease incidence exceeds 70% at the seedling stage, canola establishment fails in 80–100% of cases. The identification of effective inoculation techniques is paramount to the efforts to identify sources of resistance against this pathogen. This study aimed to identify effective inoculation techniques for *R. solani* under greenhouse conditions. For this, canola cultivar 'Westar' was inoculated using five methods: agar block, root dip, direct pipette, and colonized grains of wheat and barley. The agar block method involved placing 0.5 cm^2 agar plugs from a 3-day-old culture onto the seedling stem. The root dip and direct pipette methods involved immersing the roots of 1 week old seedling in a mycelial suspension with 104 CFU/mL for 45 minutes or depositing 1 ml of that suspension to the soil near the root of 1 week old seedling, respectively. Inoculation with *R. solani*-colonized wheat or barley grains was conducted by placing a single colonized seed approximately 1 inch to the side of the seeds at planting time. Among these methods, wheat-based grain inoculation exhibited the highest efficacy in disease establishment, as indicated by disease incidence and mortality rates recorded at 21 days post-inoculation. This method demonstrates strong potential for use in resistance screening programs aimed at identifying and developing *R. solani*-resistant canola germplasm.

ORAL PRESENTATIONS

Mining for new source of stem rust resistance loci in worldwide diverse genetic resources of spring wheat

MD AL MAMUN
Plant Pathology
Advisor: Upinder Gill, Ph.D., Plant Pathology

Stem rust, caused by *Puccinia graminis* f. sp. *tritici* (Pgt), is a devastating disease that threatens wheat (*Triticum aestivum* L.) production worldwide and its ability to rapidly evolve new virulent races makes it one of the most challenging biotrophic fungal diseases. Developing resistant wheat varieties is crucial, as genetic resistance provides a more sustainable approach than chemical control. In this study, we evaluated 365 genetically diverse spring wheat accessions for resistance to four Pgt races, TMLKC, QFCSC, HKHJC, and LBBLC which can overcome many known resistance (R) genes. Seedling responses varied widely, with most genotypes showing susceptibility. However, a subset exhibited strong resistance: 17.5% against TMLKC, 24% against QFCSC, 11.5% against HKHJC, and 23.5% against LBBLC. Significant differences in the response of the wheat accessions to the four Pgt races were revealed by ANOVA, with a strong correlation between each race infection responses based on Pearson's coefficient. To identify genetic loci associated with resistance, we conducted a genome-wide association study (GWAS) using phenotypic data combined with 302,524 high-quality single nucleotide polymorphisms (SNPs). This analysis revealed 34 significant marker-trait associations (MTAs) for stem rust resistance, distributed across 13 wheat chromosomes. The most significant MTAs are on chromosome 6A, 6B, 3B and 1B respectively for the race TMLKC, QFCSC, HKHJC, and LBBLC. Candidate genes for stem rust resistance were also suggested by screening genes located within linkage disequilibrium (LD) block of each MTA. Our study will provide information on SNP markers and genes to develop stem rust-resistant wheat varieties.

High-temperature Drying behavior and Mass transfer properties of corn

EMMANUEL BAIDHE
Agricultural and Biosystems Engineering
Advisor: Clairmont Clementson, Ph.D., Agricultural and Biosystems Engineering

High-temperature drying reduces water activity, inhibiting microbial growth and extending shelf life for high moist corn. This study examined the effect of drying conditions – temperature (65–100 °C), air velocity (2–3.66 ms-1), and initial moisture content (17–25% wb) on the drying behavior of corn. Mass transfer properties, including Biot number, Dincer number, effective moisture diffusivity, and convective mass transfer coefficient, were analyzed. Drying data were fitted to four (4) mathematical models, with the Midilli et al. model providing the best fit. The drying process occurred in the falling-rate stage, with initial moisture content and temperature significantly influencing effective diffusivity. Average drying rates ranged from 1.1 × 10-3 to 3.1 × 10-3 gs-1, while final moisture content varied between 7.4 – 14.1% wb after 120 minutes. Both effective moisture diffusivity and convective mass transfer coefficient were significantly influenced by initial moisture content and temperature. Additionally, higher air velocity increased the Dincer number and decreased the Biot numbers.

These findings enhance the understanding of moisture transfer mechanisms in corn and provide valuable insights for optimizing drying system efficiency.

Evaluation of Oryzalin to Induce Polyploidy in Ussurian Pear (*Pyrus ussuriensis*)

PRATIK SUNILDATTA BANKAR
Plant Sciences
Advisor: Todd West, Ph.D.,Plant Sciences

Pyrus ussuriensis (Maxim), Ussurian or Mongolian pear, is a non-native tree that is utilized for commercial and residential landscaping. It is also utilized in municipal plantings throughout the Midwest region in the United States because it is classified as a "utility friendly" boulevard tree. There are several cultivars of Ussurian pear including one developed by the North Dakota State University Woody Plant Improvement Program called 'MorDak' (Prairie Gem®). Prairie Gem® is fire blight resistant and has the highest level of winter hardiness of all the ornamental pears including other *P. ussuriensis* cultivars. One significant issue with *P. ussuriensis* is that it produces numerous fruits which can be messy, and produces viable seed. Other pear species such as *Pyrus calleryana*, Callery pear, has been shown to be an invasive plant in many regions of the United States. *P. ussuriensis* has not been utilized as much or for as long but potentially could be classified as an invasive plant. One method to deal with invasiveness is to produce a sterile triploid cultivar through ploidy manipulation. To develop a triploid selection, a tetraploid variety needs to be produced. This tetraploid can be bred with the original diploid tree ultimately producing a triploid offspring. To develop the tetraploid, ploidy manipulation must occur, and this potentially can be accomplished using chemicals like colchicine or oryzalin for chromosome doubling. The advantages of a sterile *P. ussuriensis* would be the potential for reduced fruit set and seed viability which ultimately would reduce the mess and potential invasiveness. The aim of this research is to develop a protocol for polyploidy induction utilizing oryzalin in *P. ussuriensis*.

Variant filters using segregation information improve mapping of nectar-production genes in sunflower (*Helianthus annuus* L.)

ASHLEY BARSTOW
Plant Sciences
Advisor: Brent Hulke, Ph.D., U.S. Department of Agriculture Research Service

Accurate variant calling is critical for identifying the genetic basis of complex traits, yet filters used in variant detection and validation may inadvertently exclude valuable genetic information. In this study, we compare common sequencing depth filters, used to eliminate error-prone variants associated with repetitive regions and technical issues, with a biologically relevant filtering approach that targets expected population-level Mendelian segregation. The resulting variant sets were evaluated in the context of nectar volume QTL mapping in sunflower (*Helianthus annuus* L.). Our previous research failed to detect a significant interval containing a strong candidate gene for nectar production (HaCWINV2). We removed certain hard filters and implemented a Chi-square goodness-of-fit test to retain variants that segregate according to expected genetic ratios. We hypothesized that this will enhance mapping resolution and capture key genetic regions previously missed. We demonstrate that biologically relevant filtering retains more significant QTL and candidate genes, including HaCWINV2, while removing variants due to technical errors more effectively, and accounted for 48.55% of phenotypic variation. In finding nine putative homologs of Arabidopsis genes with nectary function within QTL regions, we demonstrate that this filtering strategy, which considers biological contexts, has a higher power of true variant detection than the commonly used variant depth filtering strategy.

Long-term effects of tillage systems and N management on soil physical properties

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Soil Science
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Soil health management systems are key for increasing agricultural sustainability. However, improvements in soil health are seen with time, and long-term studies are essential for identifying what is achievable. Furthermore, farming practices such as tillage and fertilization can impact soil structure. The objective of this study was to evaluate the effect of tillage systems and Nitrogen (N) management on soil aggregate stability and bulk density. A long-term cropping system trial located near Carrington, ND, has been conducted since 1987 (37 years) to evaluate the effects of different tillage systems, crop rotations, and N management. Two tillage systems (no tillage (NT) and conventional tillage (CT)) and two N management (50 lb N acre-1 in the form of urea (MF) and 50 lb N acre-1 in the form of cattle manure (OF)) were selected from a four-year crop rotation (Hard red spring wheat (HRSW; *Triticum aestivum*), field pea (*Pisum sativum*), corn (*Zea mays*), and soybean (*Glycine max*). Soil samples were taken at 0-5 cm and 5-15 cm depth in the Fall of 2024 after soybean was harvested. Samples from a native grassland (NG) near Carrington, ND were also collected. Aggregate stability was assessed by the wet-sieving method (10 minutes), and macroaggregates were separated using a 0.250 mm sieve. Soil cores with a 4.78 cm diameter were taken for bulk density analysis. The NT system increased the amount of macroaggregates at 0-5 cm depth, while the CT system had fewer macroaggregates, indicating a lack of soil structure. The OF treatment resulted in higher aggregation for both tillage operations compared to the MF. At the 5-15 cm depth layer, there was no difference between treatments. Although NT alone improved soil aggregate stability, OF was key for macroaggreagation. No-till with organic fertilizer had the lowest bulk density of all treatments at 0-5 and 5-15 cm soil depth, followed by NG at 0-5 cm and CT-OF at 5-15 cm. Overall, NT-OF demonstrated a synergistic effect on improving soil physical health.

Drone-Imagery Phenotyping Using Machine Learning Approaches to Estimate Harvest Maturity in Dry Beans

MARIA DE OLIVEIRA
Plant Sciences
Advisor: Juan Osorno, Ph.D., Plant Sciences

Crop maturity estimation is a necessary trait to be measured since it is an important factor for geographic adaptation and harvest management. The incorporation of new technologies, such as unmanned aerial systems (UAS), into plant breeding, can help to improve selection efficiencies by allowing the implementation of

high-throughput phenotyping (HTP) approaches, which include capturing traits, image processing, and machine learning technologies. Therefore, the overall goal of this study was to investigate the potential of predicting harvest maturity dates of dry bean breeding lines using UAS-based data. A total of 834 belonging to different field trials, with three replicates, planted in 2022 in Hatton and Prosper, ND, were used on this study. The maturity dates of 139 dry bean advanced breeding lines belonging to pinto, black, navy, great northern, slow darkening pinto, and red and pink market classes was determined through visual ratings. Simultaneously, aerial RGB and Multispectral images were captured weekly four times in September. Excess Green Index (ExGI) was calculated from the orthomosaic, and statistics (mean, median, max, min, sum, sd, pct90, and range) were generated for each individual plot. These metrics were then compared to the ground truth data taken visually. In addition, we assessed the predictive performance for estimating dry bean maturity using a five-fold cross-validation approach with the Random Forest (RF) and Support Vector Machine (SVM) methods. Preliminary results from the 2022 season showed a strong relationship between the variables excess green index (UAS data) and days to maturity, with navy beans showing the highest value (r= 0.7960). The correlation coefficient for other market classes ranged from 0.46 to 0.66. Our results showed similar prediction ability for the RF and SVM models (0.75) with a root mean square error (RMSE) value of approximately 5 days. An assessment of the results by specific market classes showed RMSE values of 2 days for pinto beans and 4 days for navy beans. Additional data is being collected during the 2023 growing season. Furthermore, we will assess whether the utilization of RGB or multispectral imagery enhances the predictive ability of the models.

Exploring molecular interactions within the chickpea-*Fusarium* spp. disease complex

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Advisor: Malaika Ebert, Ph.D., Plant Pathology

North Dakota accounts for 12.82% of the total U.S. chickpea production in 2024, making it rank fourth after Montana, Washington and Idaho. Generally, chickpea yield is highly affected by diseases such as root rot, a disease which is caused by multiple pathogens including *Fusarium* spp., *Rhizoctonia solani, Pythium* spp. and *Aphanomyces euteiches*. In the northern great plains, the genus *Fusarium* is the most prevalent pathogen in this disease complex. In 2022 and 2023, we conducted surveys to identify which *Fusarium* species can be found in chickpea fields in the North Dakota. The *Fusarium* isolates were isolated and characterized to the species level using molecular genotyping of internal transcribed spacer (ITS) and translation elongation factor 1-alpha gene (TEF 1-α) sequences. These isolates can be assigned to six *Fusarium* species namely: *F. oxysporum*, *F. solani*, *F. acuminatum*, *F. equiseti*, *F. redolens*, and *F. avenaceum*. Preliminary findings on *Fusarium* spp. infecting lentil have shown that some *Fusarium* spp. inhibit each other when inoculated at the same time. This led us to test how different combinations of *Fusarium* species that infect chickpea perform in greenhouse inoculation studies. The *Fusarium* isolates were tested in greenhouse assays to determine their level of virulence, and the most virulent strain of each species has been selected for the chickpea-fusarium spp. co-inoculation experiments. We are interested in identifying the *Fusarium* spp. combinations that inhibit each other and characterizing the action mechanism behind it.

A Wireless Sensor Platform for Sensing Stress Levels of Honeybees

SUDIPTA DAS GUPTA
Agricultural Education
Advisor: Sulaymon Eshkabilov, Ph.D., Agricultural and Biosystems Engineering

According to the UN Environment Program, bees play a critical role not only in biodiversity but also in the survival of humanity. According to the USDA statistics, 2.5 million honeybee colonies annually pollinate over $15 billion worth of crops in the USA. Temperature, humidity and CO2 are the importance variables to determine the status of bee colonies. Therefore, we investigated these variables inside beehives for summer (foraging period) and winter (hibernation period). External disturbances, transportation, environmental fluctuations, Infestation and infections severely affect their health and productivity, Between June 2024 and February 2025 over 62% of bee colony decline has occurred in the USA. This study introduces a novel wireless sensor network (WSN) for real-time monitoring of honeybee colony health and environmental conditions. The system is built with robust and reliable NDIR-based SCD30 sensors for CO2, temperature, and humidity monitoring, integrated with a custom-designed two-layer PCB and a Particle ArgonTM microprocessor for Wi-Fi communication protocol.

Comparative Genomics to Identify phage-resistance gene in Rhizobia

TANIA GUPTA
Microbiology
Advisor: Barney Geddes, Ph.D., Microbiology

Rhizobia is an agriculturally important bacteria due to its ability to fix atmospheric nitrogen in symbiosis with legume crops. Bacteriophages significantly impact the composition of rhizobia in the rhizosphere by positively selecting phage-resistant strains. Identifying phage resistance genes in rhizobia could facilitate investigations into fitness tradeoffs that may impact symbiotic nitrogen fixation, enable improved strain selection for agriculture, or lead to novel biotechnology tools such as restriction enzymes or CRISPR-Cas. Here, we took a comparative genomics approach to identifying phage resistance genes in a population of 185 strains of *Sinorhizobium meliloti*, a natural alfalfa symbiont. A pan-GWAS analysis identified several candidate genes, and 22 of them were cloned in four gene clusters based on their blast results and genomic location. Clusters were tested with a gain-of-function approach, revealing cluster 2 conferring resistance. Future work will pinpoint the specific resistance gene through finer-scale cloning of cluster 2 and loss-of-function studies.

Optimizing Herbicide Retention with Polyelectrolyte Complexes

MD FAHAD HASAN
Plant Sciences
Advisor: Md Mukhlesur Rahman, Ph.D., Plant Sciences

We propose to enhance herbicide retention on plant leaf surfaces by using in-situ precipitation of polyelectrolyte complexes (PEC). Conventional herbicide application suffers from poor retention

capacity of the aerobic surfaces due to hydrophobic cuticles, leading to around 50% of applied herbicide ending up in soil, contaminating environments, and disrupting the ecosystem. Oil-based adjuvants has limited effectiveness because of diffusion limitations, decreased interfacial tension- making the liquid absorption difficult. Instead of Hydrogen bonding between adjuvants and plant surface, we investigate the electrostatic interaction of oppositely charged polyelectrolytes to create hydrophilic defects on the leaf surface, improving the herbicide deposition and reducing bouncing effects. Two polyelectrolyte systems- Chitosan-Alginate (CHIT-ALG) and Polyethyleneimine-Polyacrylic acid (LPEI-PAA) were evaluated through dynamic light scattering (DLS) for particle size and zeta potential. Contact angle measurement has shown that CHIT-ALG reduced the static contact angle on Abutilon theophrasti (velvet leaf), from 89.03° (water) to 71.38°, while LPEI-PAA reduced it further to 69.92°, indicating improved wettability. Surface Free Energy (SFE) in the leaf surface of Cirsium arvense (Canada thistle) showed decrease from 105.34 mN/m (water) to 21.42 mN/m (CHIT-ALG), while LPEI-PAA showed even more reduction in SFE supporting enhanced adhesion. Layer-by-layer deposition demonstrated sustained PEC retention on leaf surface, while 5-Carboxyfluorescein release study showed a pH-dependent diffusion with 98% release with 120 minutes at pH 4.5 compared to 180 on pH 7.0, highlighting the range of release of PEC for herbicide. These results established PECs as a viable alternative to traditional adjuvants, offering enhanced herbicide retention, reduced environmental impact, and showing a tremendous potential for precision agricultural application.

Nitrogen Fertilization Strategies to Enhance Grain Quality, Antioxidant Properties, and Nutritional Composition of Hard Red Spring Wheat.

MD NAJMOL HOQUE
Cereal Science
Advisor: Shahidul Islam, Ph.D., Plant Sciences

Hard Red Spring (HRS) wheat is a major wheat class valued for its high protein content and versatility in global food production, including whole wheat products. While nitrogen (N) fertilization is essential for maximizing yield, its effects on the health benefiting components in wheat remain largely unexplored. With increasing consumer interest in the health benefits of food, understanding how N fertilization influences bioactive components in wheat grain is crucial. Although wheat contains lower levels of health-promoting compounds, such as antioxidants, compared to fruits, vegetables, and meats, it remains a significant source of those due to its widespread and consistent consumption as a staple food. This study examined the effects of N fertilization rates (0, 100, and 150 lb/acre) on the antioxidant profile, phytic acid content, and key grain quality traits in three HRS wheat varieties grown in North Dakota and Minnesota, USA. Results showed a significant increase in protein content (20–24%; $p<0.05$) with higher N rates, along with strong genotype-by-environment (G×E) interactions. Phytic acid levels decreased significantly (from 8.5 to 5.5 mg/g; $p<0.05$) with increasing N application, exhibiting a strong negative correlation ($r = -0.8^{***}$). However, both free and bound phenolic and flavonoid contents increased significantly ($p<0.05$) in response to N fertilization, enhancing antioxidant activities as confirmed by DPPH and ABTS assays. Total FRAP activity also improved, though free and bound FRAP changes were less pronounced due to G×E effects. These findings emphasize the dual benefits of optimized N fertilization in enhancing protein content and antioxidant potential while reducing antinutritional factors such as phytic acid. This study highlights the critical role of nitrogen management in improving the nutritional and functional quality of HRS wheat, offering valuable insights for sustainable production strategies across diverse agro-environments.

Enhancing resilience in annual crop rotations by including perennial and cover crops

OGECHUKWU IGBOKE
Environmental and Conservation Science
Advisor: Marisol Berti, Ph.D., Plant Sciences

Integration of perennial crops and cover crops practice into annual cropping systems are promising alternatives to achieve climate-smart agriculture. This study aims to establish different cropping systems into conventional annual crop rotations based on eight crops in three North Dakota locations (Fargo, Hickson, and Prosper) in 2021–2024): alfalfa (*Medicago sativa* L.), forage sorghum (*Sorghum bicolor* (L.) Moench), wheat (*Triticum aestivum* L.), corn (*Zea mays* L.), winter camelina (*Camelina sativa* L. Crantz.), sunflower (*Helianthus annuus* L.), soybean (*Glycine max* (L.) Merr), and sainfoin (*Onobrychis viciifolia*). Five cropping systems were considered: 1) integrating alfalfa and winter camelina into wheat-sunflower-soybean rotations; 2) establishing alfalfa or sainfoin in an intercropping system with sorghum; 3) establishing alfalfa or sainfoin in an intercropping system with sunflower; 4) establishing alfalfa in corn or forage sorghum; and 5) establishing spring-wheat-winter camelina-sunflower sequence. The following environmental impact categories were assessed using SimaPro software: global warming potential (GWP), ozone layer depletion (OLP), fossil energy consumption (FEC), abiotic depletion potential (ADP), ecotoxicity potential (terrestrial, freshwater, and marine) (EP), terrestrial acidification potential (AP), and eutrophication potential (EP). From the preliminary results, all systems that included alfalfa reduced EP, AP, and EP compared with other cropping systems. This result underscores the importance of alfalfa as leguminous crop with the ability to biologically fix nitrogen, which reduces the excess application of chemical nitrogen in the cropping systems. This research is being funded by USDA-NIFA-SAS R-CAP Award #2021-68012-35917.

Intercropping: Enhancing Forage Yield, Soil Health, and Biodiversity with Alfalfa, Sainfoin, and Sunflower

MD SHAZZADUL ISLAM
Plant Sciences
Advisor: Marisol Berti, Ph.D., Plant Sciences

The growing concerns surrounding soil degradation, food security, and environmental sustainability highlight the urgent need for resilient agricultural practices. As economic, environmental, and biological pressures intensify, exploring innovative agronomic strategies becomes imperative. One promising approach is intercropping, particularly integrating alfalfa (*Medicago sativa* L.) and sainfoin (*Onobrychis viciifolia* Scop.) with sunflower (*Helianthus annuus* L.). This system not only enhances crop yields but also leverages the deep-rooting abilities of alfalfa and sainfoin to efficiently absorb nitrates, minimizing leaching into groundwater. Their extensive root networks also contribute significantly to soil stabilization, reducing erosion and improving overall soil health. This study evaluates the feasibility

of intercropping alfalfa and sainfoin with sunflower compared to conventional monoculture systems, assessing its effects on cash crop yield and forage production in the following year. Conducted in Hickson and Prosper (2023) and Prosper alone (2024), North Dakota, USA, the experiment followed a randomized complete block design with four replicates. Seven treatments were tested: (1) alfalfa alone, (2) alfalfa + sunflower (40 kg N/ha), (3) alfalfa + sunflower (80 kg N/ha), (4) sunflower alone, (5) sainfoin + sunflower (40 kg N/ha), (6) sainfoin + sunflower (80 kg N/ha), and (7) sainfoin alone. Results showed that intercropping alfalfa with sunflower had no significant impact on sunflower grain yield (averaging 2302 kg/ha) or the forage yield and nutritive quality of alfalfa, whereas sainfoin-intercropped treatments exhibited reduced forage production. Notably, intercropped plots attracted more beneficial insects, highlighting an increase in biodiversity. In the Upper Midwest, integrating sunflower with alfalfa or sainfoin presents a forward-thinking solution that allows for simultaneous forage and sunflower production while mitigating soil erosion, improving groundwater quality by reducing nitrate leaching, and enhancing biodiversity. This intercropping system stands out as a sustainable agricultural strategy that promotes ecological balance, strengthens soil conservation, and supports long-term crop productivity.

Assessing fungal contaminants in the raw diffusion sugarbeet juice: A microbiome-driven analysis.

SABINA KC
Plant Pathology
Advisor: Zhaohui Liu, Ph.D., Plant Pathology

Microbial contaminants in raw diffusion sugarbeet juice cause sucrose loss and create technical challenges during juice filtration, purification, evaporation and crystallization. However, limited information is available regarding the status of fungal contaminants in raw sugarbeet juice and its quality in the U.S. In this study, we aim to profile fungal communities present in raw sugarbeet juice during the sugar extraction process in factories across the U.S. Juice samples were collected at four time periods from September through April during the 2023-2024 processing campaign. Genomic DNA was extracted from 59 juice samples received from 20 sugarbeet processing factories. Fungal rRNA gene covering partly the ITS and LSU rRNA region was amplified, sequencing libraries were prepared and sequenced by using MinION long-read Sequencing Platform (Oxford Nanopore Technologies, Inc., Oxford, UK). Sequence reads were retrieved and performed bioinformatic analysis to determine taxonomic designation of microbiome reads. The sequencing results showed that complex fungal communities are present in raw sugarbeet juice with Basidiomycota and Ascomycota being dominant phyla. Importantly, known sugar fermenting yeast genera (*Mrakia*, *Pichia* and *Candida*) and pathogenic fungi (*Tausonia* and *Geotrichum*) have been identified as the most dominant contaminants. Among the four time periods, the relative abundance of *Mrakia* is highest in period 4 followed by period 3 while the abundance is similar in both period 1 and period 2. The findings of our study provide insights on major fungal contaminants during factory processing. This knowledge will be important for timely implementation of management strategies to minimize the microbial populations and increase the profitability for sugarbeet industry.

The effects of oxidizing air purification technology on swine barn air quality and piglet complete blood counts during the nursery phase of production.

KEARA LEONG-MACHIELSE
Animal Sciences
Advisor: Christopher Byrd, Ph.D., Animal Sciences

The effects of oxidizing air purification technology on swine barn air quality and piglet complete blood counts during the nursery phase of production. Keara Leong-Machielse1*, Jennifer M. Young1, Xiaoyu Feng2, Samat Amat3 and Christopher J. Byrd1 1Department of Animal Sciences, North Dakota State University, Fargo, ND 2Department of Agricultural and Biosystems Engineering, North Dakota State University, Fargo, ND 3Department of Microbiological Science, North Dakota State University, Fargo, ND *Presenting author The objective of this preliminary study was to investigate the effect of CereneAir™ oxidation purifying technology on swine barn air quality and piglet complete blood counts during the nursery phase of production. Ninety piglets from 9 litters were divided into two treatments and housed in either a nursery room equipped with two CereneAir™ purifying units (CA, n=45) or a nursery room without CereneAir™ purifying units (CON, n=45). Additionally, within each litter, half of the piglets received oxytetracycline at processing while the other half did not. Pigs in this experiment were previously exposed to CereneAir™ units during the farrowing phase; therefore, pigs were sorted into nursery pens before weaning to balance for previous CereneAir™ exposure, oxytetracycline status, and sex. Air samples were collected to measure the concentrations of ammonia, water vapor, and hydrogen sulfide from both treatment rooms during the nursing phase on experimental d 0, 4, 11, and 18, while whole blood collection was done on two pigs per nursery pen on experimental days 0, 5, 12, and 19, with d 0 being the date that pigs were moved into the nursery rooms. Whole blood samples were sent to the Animal Disease Research and Diagnostic Laboratory at South Dakota State University to be analyzed for complete blood counts. Results showing air quality parameters within each room treatment, as well as piglet complete blood counts will be presented.

Identification and Evaluation of Biological Control Agents from North Dakota Soybean Fields for the Control of *Sclerotinia sclerotiorum*

MADEEHA MATLOOB
Plant Pathology
Advisor: Richard (Wade) Webster, Ph.D., Extension Plant Pathology

Sclerotinia sclerotiorum is a fungal pathogen resulting in significant yield and economic losses globally. In 2023, it caused a 32.3 million bushels loss in North Dakota soybean due to Sclerotinia stem rot. To improve disease management, we have been exploring biological control agents (BCAs) derived from bulk soil collected from North Dakota soybean fields as an alternative to chemical control. This study aims to isolate and characterize BCAs collected for across North Dakota. So far, 218 fungal isolates from six counties sampled in 2023 were screened for biological control activity against *S. sclerotiorum*. Preliminary results from dual culture and detached leaf assays indicate nine fungal isolates inhibit the growth of *S. sclerotiorum*. Based on molecular identification, eight belong to *Aspergillus*, *Clonostachys*, *Penicillium*, and *Fusarium* genera and one is still unknown. Some identified BCAs exude unknown compounds that hinder fungal

growth while others compete for resources, suppressing *S. sclerotiorum* mycelial and sclerotial development. Liquid chromatography-mass spectrometry will be used to identify these antifungal compounds. This ongoing study shows progress in discovering and characterizing bioagents from soil ecosystems as efficient antagonists against *S. sclerotiorum*.

Characterization of volatile signatures of post-harvest pathogens as biomarkers for early detection and identification - A major tool in sugar beet rot management

KELLY NKANPIRA
Environmental and Conservation Science
Advisor: Ewumbua Monono, Ph.D., Agricultural and Biosystems Engineering

Postharvest rots in sugar beets can lead to significant sucrose losses during storage and processing, resulting in considerable economic losses for the U.S. sugar industry. Pathogens such as *Penicillium* and *Leuconostoc* species have been recognized as major culprits of storage rot in beet piles. Early detection of pathogen infection in sugar beet roots offers a promising approach for implementing effective disease control strategies. This study aimed to profile the volatile organic compounds (VOCs) emitted during the infection process of key storage pathogens in sugar beet roots. An in vitro assay was performed to evaluate the VOC profiles of sugar beet root tissues inoculated with common storage pathogens, including *Penicillium expansum*, *Penicillium paneum*, and *Leuconostoc mesenteroides*. VOC samples were collected on days 0, 3, 7, 14 and 21 post-inoculations at 30°C using solid-phase microextraction (SPME), followed by analysis with gas chromatography-mass spectrometry (GC-MS). More than twenty VOCs were detected. Ethanol, dimethyl ether and methyl lactate were most prominent in both inoculated and control (uninoculated) sugar beet root samples. Infections by *Penicillium expansum* and *P. paneum* led to increased ethanol production compared to *Leuconostoc mesenteroides*. Additionally, ethyl acetate was detected only in the inoculated tissues, while both ethyl acetate and acetic acid were exclusive to *Leuconostoc mesenteroides*-infected sugar beet roots. These compounds could serve as potential biomarkers for the development of smart sensors to enable early detection of pathogen infections.

Evaluation of breeding lines for resistance to soybean cyst nematode, a devastating pest in soybean

DINESH POUDEL
Plant Pathology
Advisor: Guiping Yan, Ph.D., Plant Pathology

Soybean cyst nematode (SCN; *Heterodera glycines*) is a devastating pest affecting soybean production in the US. Host resistance is the primary management strategy; however, SCN populations have evolved virulence adaptations, overcoming previously effective resistance sources. This necessitates continuous screening of soybean lines to identify new resistance sources. To evaluate host resistance to SCN, 279 soybean breeding lines were screened in 2022-2024 for their resistance reactions to two prevalent SCN populations (HG type 7 and 2.5.7) in North Dakota. For each SCN population, four plants of each line were grown in controlled growth chamber conditions and inoculated with 2,000 SCN eggs. White females on roots and soil were extracted and counted 30 days post-inoculation (DPI). Resistance response was classified based on the female index [FI= (average number of females on a tested line/average number of females on Barnes, a susceptible check) ×100%] as resistant, moderately resistant, moderately susceptible, or susceptible. Higher FI indicates higher SCN reproduction on the tested line. Significant differences in FI were observed among the breeding lines for both SCN populations. For HG type 7, 34 lines were classified as resistant, 95 as moderately resistant, 43 as moderately susceptible, and 107 as susceptible. In contrast, for HG type 2.5.7, no lines were resistant, 102 were moderately resistant, 33 were moderately susceptible, and 144 were susceptible. These results indicate that HG type 2.5.7 is more virulent than HG type 7 in most cases. The FI values for the two SCN populations were positively correlated (R2=0.855), suggesting a relationship between the resistance responses. However, several lines resistant to HG type 7 exhibited higher FI values for HG type 2.5.7, indicating that effectiveness against one SCN population does not necessarily confer resistance to another. Among 34 lines found resistant to HG type 7, 33 were moderately resistant and one was moderately susceptible to HG type 2.5.7. The resistant and moderately resistant breeding lines identified in this study provide valuable genetic resources for soybean breeding programs to develop new soybean cultivars with improved resistance to different SCN populations, addressing the ongoing challenge of SCN virulence shifts in soybean production.

Apothecial Risk Models to Predict Sclerotinia Stem Rot in Soybean Fields

SARITA POUDEL
Plant Pathology
Advisor: Richard Webster, Ph.D., Extension Plant Pathology

Sclerotinia sclerotiorum, the causal agent of Sclerotinia stem rot (SSR), is a devastating fungal pathogen that led to the loss of over 11 million bushels in northern US soybeans in 2022. Although various management strategies are currently employed, fungicide application remains the predominant method for the control of SSR. It is very important to make these applications during the flowering period when apothecia are present on the soil surface for the management of SSR. Improper fungicide application timing can lead to ineffective disease control. The accurate prediction of apothecial risk can provide precise timing for fungicide application. In 2018, the University of Wisconsin-Madison developed six logistic regression models for irrigated and non-irrigated fields to detect the probability of *S. sclerotiorum* apothecial development, incorporating different variables in each model. There is a need to further validate the models in multiple locations for effective management and this research aims to validate these logistic regression models and determine the appropriate action threshold for the Northern Great Plains. The models were validated through apothecial scouting and disease monitoring in commercial fields across North Dakota, most of which were non-irrigated. To enhance predictive accuracy, probabilities from each of the non-irrigated logistic regression models were averaged to develop an "ensemble" model. The performance of individual models and the ensemble model were evaluated. Our results revealed that the ensemble model achieved the highest accuracy, with 78%, in predicting end-of-season disease incidence (DI, %) across all fields with a 10% DI threshold and a 35% risk probability action threshold. In 2025, we will conduct multi-location validations to further refine the models. These results will be used to improve the accuracy of disease risk predictions, reducing unnecessary chemical applications while advising critical application times for ND soybean growers.

The Impact of Leucine Supplementation in Milk Replacer on Muscle Proteome and Metabolism in Neonatal Dairy Calves

KAZI SARJANA SAFAIN
Cellular and Molecular Biology
Advisor: Kendall Swanson, Ph.D., Animal Sciences

Background: Early-postnatal nutritional interventions are crucial for muscle growth and metabolism. Leucine, a branched-chain amino acid, activates the mTOR signaling pathway, regulating protein synthesis and anabolic processes. However, its effects on the muscle proteome and metabolism in neonatal dairy calves remain underexplored. This study investigates how leucine and alanine supplementation in milk replacer (MR) influence muscle development by analyzing proteomic alterations at day 28 of treatment.

Methods: A total of 35 newborn Holstein heifer calves were randomly assigned to one of three treatment groups: Control (no added amino acids), Leucine-supplemented (5% in the milk replacer), and Alanine-supplemented (isonitrogenous to the Leucine treatment). Supplementation was incorporated into the MR, which was fed in equal amounts to all calves for 56 days. At day 28, muscle biopsies were collected for proteomic analysis. Data-Independent Acquisition (DIA) proteomics was conducted using an Orbitrap Exploris 480 mass spectrometer, with protein identification and quantification performed using Spectronaut software. Protein–protein interaction (PPI) networks and Gene Ontology (GO) enrichment analyses were carried out using STRING v12.5.

Results: In the Leucine-supplemented vs. Control group, 25 proteins were upregulated ($P \leq 0.05$), and in the Leucine-supplemented vs. Alanine-supplemented group, 15 proteins were upregulated ($P \leq 0.05$), with enrichment in amino acid metabolism (alanine, aspartate, glutamate), nucleotide metabolism, and purine biosynthesis proteins (FDR < 0.05), indicating enhanced protein synthesis, cell proliferation, and metabolic activity. Moreover, steroid hormone response proteins (dehydroepiandrosterone, estradiol, progesterone) and casein proteins were enriched in both Leucine-supplemented vs. Control and Leucine-supplemented vs. Alanine comparisons (FDR < 0.05), suggesting a potential role for hormonal regulation in muscle growth and nutrient metabolism. In the leucine-supplemented groups, proteins associated with catabolic processes were downregulated (FDR < 0.05), suggesting a shift towards anabolic metabolism.

Conclusion: Leucine supplementation in MR promoted anabolic metabolic shifts, enhancing muscle protein synthesis and development while reducing catabolic pathways in neonatal dairy calves. These findings provide novel insights into early-postnatal nutritional programming, demonstrating that leucine might enhance muscle proteome remodeling and metabolic efficiency. Future studies integrating hormonal profiling (insulin, IGF-1) and long-term productivity assessments will help optimize early nutrition strategies to improve growth efficiency in dairy calves.

Optimization of CRISPR Cascade Cas 3 mediated targeted gene deletions in Rhizobia

GAYATHRI SENANAYAKE
Microbiology
Advisor: Barney Geddes, Ph.D., Microbiology

Creation of large gene deletions using traditional molecular biology approaches such as site directed homologous recombination in Rhizobial genera like Mesorhizobium and Bradyrhizobium is inefficient, time consuming and sometimes not a possibility. This limits the ability to perform large scale genome manipulations, for example to rapidly identify regions of the genome associated with important traits such as the nitrogen-fixing symbiosis. Type I Cascade Cas3, which is the most abundant CRISPR system in nature, has previously been shown to create larger deletions efficiently and fast in Pseudomonas in comparison to smaller deletions created by Cas9 and Cas12. To test the Cas3-based unidirectional and processive nuclease activity in Rhizobia, a well-studied strain Sinorhizobium meliloti (RmND230) was targeted with a crRNA after assembling an all-in-one plasmid with Cas proteins (Cas3, Cas5 Cas7 and Cas8), and a crRNA into Gm resistant back bone pNDGG060 which is maintained in Rhizobia due to an R6K origin of replication. Results showed a 104 fold successful recovery of mutants that lacked the protospacer target and large deletions varying from 90kb to 293kb in the mutants that had the protospacer target. The two promoters tested (pRhaBAD and pTau) showed constitutive CRISPR activity, even in the absence of inducers. A homology directed repair mechanism was utilized to create deletions of controlled sizes. A higher repair frequency was observed when the size of the deletion was reduced. This increases the efficacy of the Cas3 system in Rhizobia for creating desired deletions. Finally, iterative deletions were created by targeting a second protospacer and substituting the vector backbone with a different antibiotic resistant pNDGG072 back bone (Tc). 92% of the resulting colonies indicated the plasmid used for the first deletion was successfully swapped by incompatibility with the second deletion plasmid based on a shift in the antibiotic resistance from Gm to Tc. These pioneering results conclude the first report of CRISPR Cas3 mediated gene deletions in Rhizobia. The data can be further directed to expand the tools to be utilized in Mesorhizobium and Bradyrhizobium genetic manipulations, opening up paths for vast number of applications.

Combined Effects of Azospirillum brasilense and Root Exudates on Pseudomonas syringae Colonization and Disease Suppression in Tomato Plants.

JANICE TAGOE
Microbiology
Advisor: Birgit Pruess, Ph.D., Microbiology

Background. Pseudomonas syringae pv. tomato (Pst), the causative agent of bacterial speck disease, is a major pathogen threatening tomato crops worldwide. Current methods for disease management often rely on chemical pesticides, which pose environmental risks. While it is already established that Azospirillum brasilense (Abra) promotes plant growth and enhances defenses, this study examines whether combining Abra with tomato root exudate(EX) or its compounds such as cytidine (CYD) can further enhance disease suppression and limit pathogen colonization. Methods. Tomato seeds were germinated with water agar, root exudate, and cytidine and inoculated with A. brasilense during planting. After four weeks, plants were dip-inoculated with Pst to simulate natural infection. Bacterial speck disease symptoms were observed after 4-7 days of inoculation and disease severity was measured with a 100-0 disease severity (%) rating scale. Treatments included controls (-Abra + Ps), *A. brasilense* alone, (+Azo + Ps), and *A. brasilense* combined with root exudate alone and cytidine (+Abra +Ex + Ps and +Abra +CYD +Ps). Results. Untreated control plants (-Abra + Ps) exhibited between 70 to 100% severity, demonstrating the virulence of Pst. In contrast, plants treated with *A. brasilense* alone (+Abra + Ps) showed reduced mortality.

The addition of root exudate (+Abra +Ex + Ps) or cytidine (+Abra CYD + Ps) further enhanced survival, reducing disease severity rates to less than 10% in some cases ($p < 0.01$). These results indicate a synergistic effect between *A. brasilense* and tomato root exudates in suppressing *Pseudomonas syringae*-induced disease. Conclusion. This study demonstrates that *A. brasilense*, especially when combined with tomato root exudates, can significantly mitigate disease severity and improve plant survival. These findings highlight the potential of integrating beneficial microbes and plant-derived compounds into sustainable biocontrol strategies for managing bacterial infections in tomato crops.

Optimizing Phosphorus for Soybean: Impacts on Yield and Arbuscular Mycorrhizal Fungi

DAYNE TALLIER
Soil Science
Advisor: Lindsay Malone, Ph.D., Natural Resource Sciences

There is a need for a reevaluation of phosphorus (P) recommendations in North Dakota. In general, soil test P values are lower in ND than other states, necessitating more careful P-management and potentially more frequent applications. Recent research showed increases in soybean yield with P-application in Minnesota on soils with moderate P-levels, but not in North Dakota. Therefore, current ND recommendations only recommend P-applications to soybean to fields with low or very low P-levels. This project sought to reassess these recommendations with a coordinated statewide P-rate study in soybean. In addition, fertilizer P-rates recommended at low soil test P (STP) may be greater or less than what is profitable. There were 8 sites total across the state in 2023, with a repeated study in 2024. Each site had five P-rates applied and soybean yield and soil test P was measured at all sites. Of the 16 site-years, 3 sites in responded positively to fertilizer application ($p < 0.05$). Combined site data across fall P classifications shows that maintaining STP within optimum range (8-14 ppm) can significantly improve soybean yield. We also looked at arbuscular mycorrhizal fungi (AMF) at 5 of the 16 sites and found that fertilizer applications did not have any impact on both colonization or soil fungal populations. When combining trials across location, we saw no impact of soil P measurements on AMF biomass, but saw a small ($R2 = 0.12$) negative correlation between colonization and spring test P. We also saw a negative relationship ($R2 = 0.11$) between soybean relative yield and AMF colonization, but positive relationships ($R2 = 0.16$; $R2 = 0.20$) between colonization and spring P and Mehlich-3 P respectively. Preliminary data will be presented for both 2023 and 2024.

Comparison of novel grazing technology efficacy within intensively grazed paddocks.

JOSHUA WIANECKI
Natural Resource Sciences
Advisor: Miranda Meehan, Ph.D., Animal Sciences

Intensive grazing management can increase grazing efficiency which allows for greater stocking rates compared to extensive grazing practices. While intensive grazing requires increased labor and infrastructure, virtual fencing (VF) may be able to reduce these demands. Virtual fencing utilizes wireless communication protocols, GPS tracking, and wireless technologies to track and manage livestock. Livestock are managed remotely through audible and electrical stimuli that serve as warnings as they approach remotely assigned VF pasture boundaries. While virtual fencing offers convenient management, the efficacy of livestock containment is unproven within small grazing allotments. This study evaluates the influence of grazing management technologies on cattle containment, forage harvest efficiency, livestock performance and grazing behavior. Pastures at three locations were established with an annual forage mix and divided into four paddocks. Paddocks were randomly assigned to VF, automated gates (AUTO), manual electric fence (MAN) or continuous graze (CONT). The VF, AUTO, and MAN paddocks were divided into eight strips for intensive grazing management. Cattle were fitted with VF collars to collect GPS location data during the grazing period. GPS location was used to determine if individual cattle were within the allotted grazing strip. Mean daily containment rates did not differ ($P = 0.533$) between technologies at 77.4% in AUTO, and 81.0% in MAN, 77.5% in VF. Containment varied based on location and individual animal. Forage utilization rates did not differ between AUTO, MAN or VF. Forage utilization was significantly reduced in CONT compared to MAN ($P = 0.012$). Stocking rates tended ($P = 0.094$) to be greater within intensively grazed paddocks, with an average increase of six grazing days within AUTO and MAN and three grazing days within VF compared to CONT. With similar containment rates to conventional fencing VF can be a valuable tool for grazing management.

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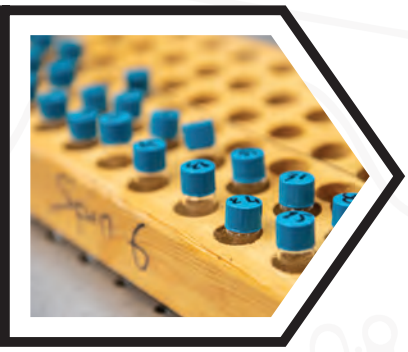

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thank you!

Resilience and Cost Analysis of Autonomous Trucks: An Alternative to Rail for Grain Export

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Advisor: Ranjit Godavarthy, Ph.D., Transportation and Supply Chain

The reliance on rail transport for grain export in the United States is increasingly challenged by disruptions such as weather events, strikes, and accidents, which undermine supply chain resilience and efficiency. This paper examines the potential benefits of autonomous trucks as an alternative mode of transport for grain export, focusing on corn as a case study. By leveraging synthetic datasets that simulate production volumes, transport networks, and cost parameters, we compare the cost, time efficiency, and resilience of autonomous trucks with traditional rail transport. Route optimization models are developed using Python-based tools (e.g., PuLP, OR-Tools) to minimize transport costs and time for both modes, while accounting for constraints such as transshipment requirements for rail and platooning advantages for autonomous trucks. The results indicate that autonomous trucks offer significant cost savings by eliminating labor expenses and enhancing fuel efficiency through platooning, while also reducing transport time by bypassing intermediate grain elevators required by rail.

Mechanisms of RAGE dependent vemurafenib resistance in melanoma

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Background: Melanoma, a malignancy of skin melanocytes, poses significant treatment challenges, particularly after metastasis. In 2025, the American Cancer Society estimates approximately 104,960 new melanoma diagnoses and 8,430 related deaths in the USA. Melanoma is an aggressive form of skin cancer, frequently harbors BRAF mutations, leading to constitutive activation of the MAPK pathway. While BRAF inhibitors like vemurafenib have shown promise in treatment, drug resistance remains a significant challenge. The Receptor for Advanced Glycation End-products (RAGE) has been implicated in cancer progression and therapy resistance through various mechanisms, including increased cell proliferation, migration, and regulation of autophagy. We hypothesize that RAGE inhibition enhances the sensitivity of melanoma cells to BRAF inhibitor vemurafenib by reducing chronic ER stress-induced autophagy and increasing apoptosis. Method: We investigated the synergistic effects of vemurafenib in combination with the small molecule RAGE inhibitor FPS-ZM1 in the WM115 human melanoma cell line. Cell viability was assessed using Alamar Blue, and drug synergy was analyzed using the Combenefit software. Changes in the levels of the autophagic markers LC3-I/-II and p62, the ER stress marker SAPK/JNK and cell proliferative markers Erk 1/2, Akt are currently being evaluated by Western blot analysis. Results: Our data suggest that, RAGE inhibition sensitize BRAF mutated melanoma cells to vemurafenib treatment and we observed the strongest synergistic effects with 30μM vemurafenib and 10μM FPS-ZM1. Our initial Western blot results suggest that the drug combination reduces the autophagic flux. We are currently investigating the changes in the levels of the ER stress markers and proliferative markers.

Belongingness and Loneliness Among First-Generation College Students: Exploring Emotional Well-Being Through the Dual Continuum Model

ZAINAB ALVANDI-TABRIZI
Developmental Science
Advisor: Carmen Kho, Ph.D., Human Development and Family Science

Belongingness and loneliness stem from the fundamental human need for connection (Asher & Weeks, 2013; Maslow, 1943) and profoundly influence various aspects of life, such as identity, autonomy, satisfaction, and emotional well-being (Allen, 2020). The predictive role of belongingness and loneliness in emotional well-being can be explained through theoretical frameworks like the Belongingness Hypothesis and is supported by empirical findings (Baumeister & Leary, 1995; Barroso et al., 2021; Igbokwe et al., 2020). Emotional difficulties are common among college students, particularly as belongingness and loneliness take on new dimensions during this transitional period. College introduces unique challenges as students navigate the shift from home to a new social environment, often struggling to build relationships and integrate into campus life (Asher & Weeks, 2013). These challenges are particularly significant for first-generation college students, who lack parental guidance on navigating college experiences, further complicating their ability to establish a sense of belonging to college (Cataldi, Bennett, & Chen, 2018). Most research on belongingness and loneliness, both generally and in college environments, examines these concepts separately, leaving the mechanisms linking them unclear. Furthermore, studies examining both concepts often present divergent perspectives on their relationship. For instance, some suggest that loneliness mediates the link between the need for belonging and satisfaction (Mellor et al., 2008), while others propose that belongingness moderates the relationship between peer acceptance and loneliness (Baskin et al., 2010). These inconsistencies highlight the necessity for further investigation into the dynamic and interconnected roles of belongingness and loneliness. To address these complexities, we adopt the Dual Continuum Model proposed by Lim et al. (2021). This model challenges the traditional view of belonging and loneliness as simple opposites, arguing that they can coexist across four distinct social states. This model offers a new way to understand the connection between belongingness and loneliness, but, to our knowledge, it has never been tested. This gap shows the need for more research to confirm these categories and explore their impact on emotional well-being.

Enabling Ternary Compute with 2T Ferroelectric FETs

MADISON ASHBACH
Electrical and Computer Engineering
Advisor: Sumitha George, Ph.D., Electrical and Computer Engineering

Ternary storage and computation are emerging as popular techniques for reducing model size while maintaining accuracy in AI applications. We propose a compact ferroelectric FET (FeFET)-based ternary compute- enabled cell demonstrating signed ternary multiplication and an array capable of multiply-and-accumulate operations. Our design utilizes only 2 transistors in the cell compared to the previous design, which uses 8 transistors. We introduce a novel ternary encoding scheme and leverage programmable threshold states of FeFETs to achieve a 75% reduction in the number of transistors. We verify the functionality of the proposed design through simulation.

Hydrogen Production and Value-Added Chemicals from Electrolysis of Aqueous Polymer and Biomass Solutions for Cost-Effective Energy Solutions

MUHAMMAD MUZAMAL ASHFAQ
Mechanical Engineering
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Low-cost, low-temperature (LT) production of high-purity hydrogen (H2) is the bottleneck of contemporary hydrogen-based clean energy technologies. This study was to investigate hydrogen production and its energy efficiency via LT-electrolysis of polyethylene oxide (PEO) and lignin solutions. Comparative experimental studies were explored using a lab-scale proton-exchange membrane (PEM) electrolyzer: (a) PEO solutions (1.0 and 2.0% w/v) at operating temperatures of 29 and 32°C, and (b) lignin solutions at 25, 35, and 80°C. In electrolysis of PEO, H_2 production rates were 36.3, 19.7, and 31.3 ml/min at 29°C, and 52.3, 32.9, and 38.5 ml/min at 32°C for 1.0% PEO, 2.0% PEO, and distilled water, respectively. Energy savings of up to 26.50% were observed compared to pure water electrolysis, with the specific energy consumption ranging from 29.01 to 31.71 $kWh.kg^{-1}$. In the lignin experiments, H_2 production rates increased from 1 ml/min at 25°C to 40 ml/min at 80°C, while the specific energy consumption decreased from 255 $kWh.kg^{-1}$ to 5.5 $kWh.kg^{-1}$. FTIR was utilized to confirm the formation of new chemicals in electrolysis. The results demonstrate that both PEO and lignin solutions can enhance H_2 production and reduce energy consumption compared to traditional water electrolysis.

Sustainable Phosphate Adsorption with Chitosan Beads for Cleaner Water Solutions

UMER ASLAM
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Advisor: Achintya Bezbaruah, Ph.D., Civil, Construction and Environmental Engineering

Excessive phosphate levels in water bodies are a major environmental concern, contributing to the widespread issue of eutrophication, and threaten aquatic life. This study explores the effectiveness of chitosan beads as adsorbents for removing phosphate. Two types of beads were examined: standard chitosan and iron-doped chitosan. The iron-doped beads exhibited a higher removal efficiency (97%) compared to the other (56%). The adsorption capacity of these beads was ~57 mg/g. SEM analysis showed near to spherical shaped beads and EDS confirmed the adsorption of phosphate. Isotherms and kinetics' data fitted better with Langmuir and pseudo-second-order model, exhibited monolayer adsorption and chemisorption, respectively. Interference studies indicated a competition for the adsorption sites from polyvalent ions such as CO_3^{2-}, SO_4^{2-} and SiO_3^{2-}, especially at the higher concentrations. According to response surface methodology, dose and time were identified as the most significant factors influencing phosphate removal. The findings suggest that iron-doped chitosan beads offer a promising and straightforward approach to reducing phosphate contamination in water. Their ability to be regenerated for multiple cycles enhances their reusability and could be repurposed as a valuable phosphate-rich fertilizer.

eDNA Metabarcoding as a Tool for Understanding Insect Diversity and Visitation in the Western Prairie Fringed Orchid

TRINITY ATKINS
Environmental and Conservation Science
Advisor: Steven Travers, Ph.D., Biological Sciences

The rarity of many prairie plants results from habitat loss, high mortality, and limited recruitment, contributing to the threatened status of the western prairie fringed orchid (*Platanthera praeclara*). This federally threatened species is endemic to the northern tallgrass prairie and may depend on nocturnal Lepidoptera (hawkmoths) for pollination. However, the full diversity of arthropods visiting and potentially pollinating this species remains uncertain. Direct observation of orchid pollination is challenging, which limits our understanding of its primary floral visitors and how orchid population characteristics influence arthropod visitation. To address this gap, we used environmental DNA (eDNA) metabarcoding to survey arthropod visitation to orchids and plant visitation by pollinators. Orchid swabs of arthropod DNA were collected across five sites in Minnesota, North Dakota, and Manitoba. We swabbed between 2 and 33 orchids per population depending on population size. Twelve moths were captured by blacklighting at the sites and swabbed for plant DNA. Additionally, orchid traits and forb community composition were surveyed at each site to characterize plants and communities sampled. High-throughput sequencing of the COI barcode region revealed a diverse array of arthropod visitors, including numerous Lepidoptera, across all sites. Bray-Curtis dissimilarity and NMDS ordination analyses demonstrated significant variation among sites in arthropod community composition on orchids. Indicator species analysis identified unique plant taxa at each site. *Lythrum salicaria* and *P. praeclara* were linked to Burnham, *Anemonastrum canadense* and *Zizia aurea* to Godfrey, *Euphorbia esula*, *Trifolium pratense*, and *Amorpha canescens* to Manitoba, and *Symphyotrichum ericoides* to Ulen. Arthropod richness on orchids increased with latitude, peaking at northern sites like Manitoba. Statistical analyses further confirm that northern and orchid-rich locations sustain more diverse assemblages. Our results detected hawkmoth visitation at two sites, including the spurge moth, supporting hypotheses of sphingidae and identifying. These findings highlight eDNA metabarcoding as a valuable non-invasive tool for characterizing pollinator-plant interactions.

Harnessing Large Language Models to Assist Eating Disorder Communities

SRIRAM ATLURI
Computer Science
Advisor: Lu Liu, Ph.D., Computer Science

Eating Disorder (ED) is a serious health disease with physical, mental, and psychological effects, which may ultimately lead to death. Traditional clinical methods offer limited service due to cost and availability to treat the vast population of people affected by EDs, which is estimated to be 9% of the US population by a report released in June 2020. The pervasiveness and comparable affordability of advanced computer-support technologies mandate the development of advanced machine learning methods to comfort or assist ED patients. Therefore, we propose three novel studies. The first study is proposed to collect and preprocess many posts and comments from social media (e.g. Reddit) and online forums on EDs and construct a large high-quality question-and-answer Ed dataset. The second proposed research is meant to harness Large Language Models for assisting people who are experiencing eating disorders and related health issues. While traditional healthcare favors client-doctor or client versus healthcare interaction, Large Language Models supplements this by overcoming the daily time limitations with a user interaction feature that is responsive virtually at any time and accommodating repeat questions without hassle. The second research study focuses on fine-tuning LLMs on the dataset from the first study. The third study is proposed to develop a Retrieval-Augmented Generation (RAG) infrastructure to utilize the dataset from the first study and compare its performance with fine-tuned LLMs. IF proposed projects are carried out successfully, they will propel the customized LLMs for assisting and comforting EDs patients in daily life.

Assessing General Parent Education Program Effectiveness in North Dakota

DAMARIS BIBI
Human Development and Family Science
Advisor: Sean Brotherson, Ph.D., Human Development and Family Science

Addressing the well-being of family members and children is a significant priority for NDSU Extension and the network of Parent and Family Resource Centers (PFRC) in North Dakota. Parent Education Programs provide a direct mechanism for supporting families and are designed to facilitate healthy parent-child relationships and boost the health and well-being of family members and children in North Dakota. The purpose of this study was to investigate the effectiveness of parent education programs with participants in North Dakota. Data was collected during the 2022-24 program year. This study examined Parent Education Program data gathered through surveys done with participants by NDSU Extension Parent and Family Resource Centers in North Dakota. Nine PFRC centers are involved in the Parent Education Network in North Dakota. During the 2022-24 year, 392 participants who were enrolled in DHS-funded, multi-session programs responded to post-program evaluation surveys. This study utilized a post-program retrospective study design to assess participant perceptions of their program experience and outcomes. Questionnaires specific to the ND Parent Education Network programs were utilized to gather data and included single-item questions, Likert-type scales and open-ended response questions. Specific variables of interest that were assessed include perceptions of program quality and value, knowledge of healthy parenting, and family communication efforts. Specifically, this study compared results from five different parent education classes focused on general parenting knowledge and skills. In summary, the findings indicate that collectively the parent education classes offered In North Dakota in 202-24 had a largely positive and significant effect in helping participants become closer to their families, more involved with their children, and more skilled in their child raising efforts

Shrinking sparrows: How climate change impacts avian morphology and fitness

RACHEL BOCKRATH
Biological Sciences
Advisor: Britt Heidinger, Ph.D., Biological Sciences

Changes in climate are expected to alter selective forces on species throughout their lifetimes. Bergmann's rule describes the well documented pattern of body sizes being smaller on average at lower latitudes compared to higher latitudes. This is hypothesized to result from the increased effectiveness of heat dissipation on the larger surface area to volume ratio of smaller body sizes. Similarly, Allen's rule describes the phenomenon of species in hotter climates possessing longer limbs compared to those in colder climates, which is also associated with increased effectiveness of excess heat dispersion. Although smaller body sizes are often assumed to be adaptive based on the worldwide trend of reduced avian body sizes with increased average global temperatures since the 1960s , such conclusions are often drawn from adults. It is unclear whether reduced body sizes are driven by weather conditions experienced during the developmental phase, or through selection as adults. In the current study, we used 30 years of body size records of over 10,000 house sparrows (Passer domesticus) from a population in Lexington Kentucky, USA, and concurrent local weather data to investigate the link between temperature and body size during development and changes in body size over decades. Nestlings may be particularly affected due to their rapid growth, inability to regulate their own body temperature during early life, and confinement to the nest environment . However, if Bergmann's rule and Allen's rule were followed, we would predict the development of smaller nestlings with longer limbs during high temperatures. Using linear mixed models, we found that house sparrow nestlings and adults have both gotten significantly lighter since 1993 ($p<0.01$), though tarsus length has not changed significantly during that time. However, nestlings did grow significantly longer tarsi ($p<0.01$) under higher temperatures, regardless of year, while mass was unaffected by developmental temperature directly. Our study suggests that the factors influencing house sparrow growth and development are multi-faceted and may be more heavily influenced by other environmental factors such as food availability than previously appreciated. Identifying adaptive and non-adaptive changes in body size is critical to understanding the long-term fitness impacts of global warming.

Enhancing Soybean Meal for Edible 3D-Printing Ink: A Study on Enzymatic Hydrolysis and Ball Milling

QIONG CHEN
Cereal Science
Advisor: Minwei Xu, Ph.D., Cereal Science

Introduction: Soybean meal is a by-product of the plant oil industry. Soybean meal is rich in protein, offering the potential to be transformed into plant-based protein gels -- key components in extrusion-based 3D-printing inks. However, the presence of insoluble fiber in soybean meal can adversely impact the protein's gelling properties and subsequently, its printability. Enzymatic hydrolysis presents a gentle approach to convert insoluble fiber into soluble fiber. Additionally, ball milling effectively reduces the soybean meal's particle size to the nano-scale, enhancing enzymatic hydrolysis efficiency. Our previous research achieved a 70% conversion of insoluble fiber into soluble fiber in soybean meal. This project's objective is to refine soybean meal into an edible 3D-printing ink, utilizing enzyme hydrolysis complemented by ball milling. Methods: The soybean meal was ground into flour, and ball-milled at 34 Hz for two hours. A combination of cellulase, xylanase, and pectinase enzymes was applied to hydrolyze the insoluble fiber in the soybean meal, at a temperature of 40°C for 8 hours. Post-hydrolyzation, 0.5% xanthan gum was incorporated as the edible binder in the ink. The ink's gelling properties and rheological characteristics were assessed using established methods. Moreover, the texture profile and structural integrity of the 3D-printed products were evaluated using a Texture Profile Analyzer (Texture Technologies Corp., White Plains, NY, USA) and Microfocus X-ray computed tomography (GE Sensing & Inspection Technologies GmbH, Germany), respectively. Anticipated results: We expect that the amalgamation of modified soybean meal with edible gels will yield a stable ink suitable for 3D printing. This study will report enhancements in the ink's gelling properties and rheological characteristics following hydrolyzation. We aim to determine the optimal formula for the 3D-printing ink based on texture analysis. Furthermore, the correlation between gelling properties and printability will be explored. Significance This research offers valuable insights into the impact of rheological properties on the printability of 3D-printing inks. It lays the groundwork for the development of commercially viable, edible 3D-printing inks. Additionally, the enhanced utilization of soybean meal as a value-added product promises significant benefits for the soybean industry.

Cover Crops, Corn, and Climate: Using Spatial Data Fusion to Identify Correlations in North Dakota Agroecosystems

ANNIKA CHRISTENSEN
Soil Science
Advisor: Lindsay Malone, Ph.D., School of Natural Resource Sciences

Cover crops are a well-known method of promoting soil health. In the northern Great Plains/ upper Midwest, cover crop management is complicated by short growing seasons, low precipitation, and cold temperatures. Resulting in failure or variability in cover crop emergence, stand, and vigor that can affect the Corn (Zea mays) development and potential yield. A path analysis was performed to quantify the indirect and direct interactions between cover crops, environmental conditions, and agronomic outcomes using high-resolution UAV imagery, soil physical/chemical, topography, climate, and yield data collected throughout the 2024 growing season. While results are still being analyzed, this approach will provide information on key drivers of variability in corn performance within cover-cropped systems. Understanding these ecosystem dynamics could help inform precision management strategies that optimize soil health benefits while maintaining or improving crop productivity in cover-cropped agroecosystems.

Resilience and Cost Analysis of Autonomous Trucks: An Alternative to Rail for Grain Export

KWABENA DADSON
Transportation and Supply Chain
Advisor: Ranjit Godavarthy, Ph.D., Transportation and Supply Chain

The reliance on rail transport for grain export in the United States is increasingly chal-lenged by disruptions such as weather events, strikes, and accidents, which undermine supply chain resilience and efficiency. This paper examines the potential benefits of autonomous trucks as an alternative mode of transport for grain export, focusing on corn as a case study. By lever-aging synthetic datasets that simulate production volumes, transport networks, and cost parameters, we compare the cost, time efficiency, and resilience of autonomous trucks with traditional rail transport. Route optimization models are developed using Python-based tools (e.g., PuLP, OR-Tools) to minimize transport costs and time for both modes, while accounting for constraints such as transshipment requirements for rail and platooning advantages for autonomous trucks. The results indicate that autonomous trucks offer significant cost savings by eliminating labor expenses and enhancing fuel efficiency through platooning, while also reducing transport time by bypassing intermediate grain elevators required by rail. Furthermore, autonomous trucks demonstrate superior resilience by mitigating risks associated with rail disruptions. These findings suggest that railroads could augment their services by integrating autonomous truck fleets, thereby improving supply chain resilience and reducing operational costs. This study contributes to the growing literature on autonomous vehicles in freight transport and provides actionable insights for policymakers and industry stakeholders. Future research should explore scalability, regulatory challenges, and environmental impacts of adopting autonomous truck technology.

Metabolism/Obesity

RAZIA DAWLATY
Microbiology
Advisor: Glenn Dorsam, Ph.D., Microbiology

VIP deficient mice are resistant to diet-induced obesity (DIO); sex-specific differences dependent on genotype and time of diet exposure Razia Dawlaty, Savanah Klegon, Teala Matiur, Joshua Ebert, and Glenn P. Dorsam. Department of Microbiological Sciences, North Dakota State University, Fargo, ND 58102 Obesity is a 21st-century epidemic that afflicts more than 42% of adults worldwide, and is associated with several comorbidities, including type 2 diabetes and heart disease. Vasoactive intestinal peptide (VIP) is a metabolic gut hormone involved in energy homeostasis. Research has revealed that VIP's amino acid sequence is 100% identical across most mammals, including humans, rodents and livestock. Our lab reported in 2019 that VIP-deficient mice exhibited gut microbiota dysbiosis consistent with microbiome shifts observed in inflammatory bowel disease mouse models, which also suffer from weight loss. Moreover, VIP-

deficient mice are leaner compared to wild-type (WT) littermates, prompting us to hypothesize that VIP-deficient mice are resistant to diet-induced obesity (DIO). To this end, we placed male and female VIP WT, heterozygous (HET) and homozygous mutant (KO) mice (n=5/group, 30 total) on low- and high-fat diets ad libitum for 12 weeks, monitoring food and water consumption, and body weights weekly for 12 weeks. At the conclusion of the diet regimen (week 17), blood, tissues, and fecal samples were harvested. Our data revealed that VIP KO mice were highly resistant to DIO gaining only ≈40% body weight compared to WT littermates ($p \leq 0.0001$). Also, we observed a sex-specific difference with male HETs resistant to DIO ($p \leq 0.01$), while female KO mice gained more weight early (weeks 1-4), but less weight later (weeks 8-12, $p \leq 0.0001$) than males. These data strongly support our hypothesis, and understanding the role of VIP in DIO could provide a promising therapeutic.

Adaptive Hazard Zone Model for Improved Safety in Highway Work Zones

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Advisor: Youjin Jang, Ph.D., Civil, Construction and Environmental Engineering

Highway work zones present hazardous conditions where worker safety is at constant risk due to interactions with construction equipment. In such environments, accurately defining hazard zones around equipment is vital for timely detection and prevention of incidents. Traditional static hazard zone models, often relying on simple geometric shapes, fall short as they cannot adapt to changes in equipment speed and movement, leading to either inadequate safety coverage or frequent false alarms. This study proposes a dynamic hazard zone model that leverages a probabilistic approach based on bivariate Gaussian distribution to generate adaptive and realistic hazard zones. Real-time data from GPS and inertial measurement unit (IMU) sensors enable the model to adjust hazard zone dimensions dynamically in response to equipment behavior, improving both accuracy and responsiveness. Simulations conducted in Webots software demonstrated that the proposed model achieved 93% accuracy in hazard detection, significantly outperforming the 60% accuracy of static circular zones tested in the same environment. The findings underscore the potential of dynamic hazard zone modeling to enhance safety in highway work zones, providing a practical and effective approach for reducing risks.

P2Y1 or P2Y12 receptor blockade prevents platelet sequestration and intestinal damage in female mice in intra-abdominal sepsis

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Pharmaceutical Sciences
Advisor: Elisabetta Liverani, Ph.D., School of Pharmacy

Intra-abdominal sepsis, a severe intestinal infection with high mortality, disrupts the immune response and compromises the intestinal barrier, resulting in excessive inflammation and tissue damage. Preserving barrier integrity is essential for restoring immune balance and improving outcomes. Platelets, as key mediators of inflammation, contribute to sepsis by releasing cytokines and modulating immune responses. Our prior research showed that blocking platelet P2Y1 or P2Y12 receptors reduced cytokine secretion and enhanced bacterial clearance in a sex-dependent manner. However, the role of platelets in intestinal inflammation and barrier disruption during sepsis has not been thoroughly investigated. To address this, we examined sex-specific sepsis treatments in female C57BL/6J mice. Sepsis was induced using cecal ligation and puncture (CLP) or sham surgery, with platelet secretion inhibited via P2Y1 or P2Y12 antagonists. Analysis of intestinal tissue samples 24 hours post-surgery revealed increased damage in CLP mice, assessed through H&E staining, fluorescence microscopy, and western blot analysis. Blocking P2Y1 or P2Y12 partially mitigated tissue damage, platelet sequestration, and altered protein levels. These findings suggest that MRS2279 or Ticagrelor, a P2Y1 or P2Y12 antagonist respectively may offer a localized therapeutic strategy to ameliorate intestinal inflammation in septic females.

Within-Leaf Spatial Responses to Heat Stress Reveal Varied Genetic Mechanisms in Hordeum vulgare

EDWARD CEDRICK FERNANDEZ
Genomics, Phenomics & Bioinformatics
Advisor: Zhikai Liang, Ph.D., Genomics, Phenomics & Bioinformatics

Global climate warming poses a major challenge to crop production by altering growing conditions, disrupting agricultural systems, and ultimately threatening global food security. Barley (Hordeum vulgare), traditionally cultivated in cool temperate regions, thrives under moderate temperatures that optimize its growth and development. As a species adapted to cold climates, it is highly susceptible to elevated temperatures that can severely disrupt its physiological and developmental processes. However, the continuous rise in global temperatures is expected to further amplify these negative impacts. Since heat stress significantly impacts barley by disrupting photosystems and reducing photosynthetic efficiency, we aim to monitor these effects by comparing alterations in photosynthetic traits at the individual leaf level under optimal and heat-stressed conditions. However, the linear-lanceolate shape of barley leaves inherently introduces complexity, as different regions within a single leaf (i.e. base, middle, and tip) can exhibit varying sensitivities and adaptive responses to heat stress. This spatial variation adds a layer of complexity to the study and dissection of the genetic mechanisms underlying heat stress responses. By subjecting a subset of the International Barley Core Collection (BCC) to heat and optimal environments, we observed a strong variation of physiological and non-photochemical quenching (NPQ) kinetics traits across the leaf gradient from base to tip of individual leaves. By integrating these findings with existing genomic variants, we uncovered potentially distinct genetic mechanisms driving heat-stress responses in specific leaf segments. Leaf segments from similar conditions were further investigated through transcriptomic analysis, revealing distinct gene sets across segments that could be involved in heat stress regulations. Our findings provide novel perspectives on refining the genetic understanding of heat stress responses and offer valuable strategies for selecting heat-resilient barley, with implications for improving the heat tolerance of other crop species.

A Benchtop Ultrasound Study of Immiscible Drop Transport in a Collapsable Tube

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Mechanical Engineering
Advisor: Yan Zhang, Ph.D., Mechanical Engineering

The movement of immiscible fluid drops through a flexible duct is a complex phenomenon in blood-circulation processes like blood-clot transportation, drag delivery, and cardiovascular treatment. The delicate, pliable nature of duct walls allows them to buckle or collapse under imbalanced pressure conditions such as muscle contraction or strain. Despite extensive optofluidic studies on drop formation and dynamics, kinetic of sizeable drops in the collapsible passage under naturally deformed conditions are overlooked. This study explores the formation and dynamics of immiscible droplets in a deformable thin-walled tube, modeled as a pseudo blood vessel. A co-flow fluid injection system is used to initiate immiscible silicone-oil drops through the steady flow of water and glycerin mixture, ensuring neutral buoyancy as the droplets travel through the confined, swelled tube. An ultrasound imaging system (Versasonics Vantage NXT) was used to visualize droplet motion. Flow rate and pressure were observed and the velocity profile was delineated. The experimental results show that that droplet bulk size, position and dripping transition to jetting region rely on both Weber number and outer Capillary number. The collapsing and deformation of the tube restrict the droplet transport, resulting in changes to tube geometry, and reduced transport competency. The experiments demonstrate that the benchtop research ultrasound system is an excellent non-optical tool to study multiphase biological fluid transport phenomenon.

Removal of Fluoride Using Hydroxyapatite Supported on Polyvinyl Alcohol

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Materials and Nanotechnology
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Fluoride contamination of water poses significant health risks globally, affecting populations in over 100 countries and necessitating effective remediation strategies. In this study, we evaluated the efficiency of composite beads made from hydroxyapatite (HAP), polyvinyl alcohol (PVA), and sodium alginate as adsorbents for fluoride removal. HAP, a calcium phosphate mineral, serves as the primary active phase by facilitating ion exchange, wherein fluoride ions replace hydroxyl groups to form fluorapatite. The incorporation of PVA enhances the mechanical strength and flexibility of the beads, while alginate improves their stability and porosity by offering additional binding sites through its carboxylate groups. Batch adsorption experiments conducted under varying conditions of pH, contact time, and adsorbent dosage revealed that the beads achieved fluoride removal efficiencies above 85%, with adsorption equilibrium reached at approximately 480 minutes. Kinetic analysis indicated that the adsorption process follows pseudo-second-order kinetics, suggesting that chemisorption is the rate-limiting step and confirming the strength and specificity of the interactions between fluoride ions and the active sites on the composite. Furthermore, the equilibrium data were best described by the Langmuir isotherm model, which implies monolayer adsorption on a homogenous surface. Notably, the presence of competing anions such as chlorides, sulfates, and phosphates had minimal impact on the fluoride removal efficiency, underscoring the selectivity of the composite beads. Overall, the synergistic integration of HAP, PVA, and alginate yields an effective, durable, and selective adsorbent for fluoride removal, offering promising potential for practical water treatment applications.

Environmental Testing of Compression Molded PET/ Fiberglass Composites

MALACHI HEDSTROM
Mechanical Engineering
Advisor: Chad Ulven, Ph.D., Mechanical Engineering

Fiber-reinforced composites materials (FRC's) consist of reinforcing fibers within another material known as the matrix. The fibers are often incorporated to improve the mechanical properties of the matrix. The most common matrix materials are thermosetting polymers. However, in many applications such as in the automotive field another class of polymers, thermoplastic polymers, have shown promise as an alternative matrix material in FRC's. This is because thermoplastic composites offer useful advantages such as higher recyclability and toughness, as well as faster production times over their thermosetting counterparts. One potential thermoplastic matrix material is polyethylene terephthalate (PET). PET is the most recycled plastic in the world, and one of the most abundant – an example of its use being water bottles. A possible obstacle faced in implementing PET as an FRC matrix is its lower thermal stability in comparison to traditional materials. For this reason, in assessing its viability it is important to evaluate such a composite's mechanical properties in different environments. It is the aim of this study to mechanically characterize a PET fiberglass composite over a range of temperatures from extreme cold to high heat following MIL 810. To do this a composite will be made from E-glass and PET fibers in the form of a plain weave fabric of long continuous fiber from Concordia Composites, which will be placed in a steel mold and heated under high pressure in a process known as compression molding. Specimens will then be machined with a waterjet from this material and subjected to flexural, tensile, and impact testing at a variety of temperatures. The resulting data can then identify suitable temperature ranges in which the composite may be used effectively.

Differential Speed Control of Continuous Fiber Reinforcement Moving Bed 3D Printer

NICCOLO JEANETTA-WARK
Mechanical Engineering
Advisor: Chad Ulven, Ph.D., Mechanical Engineering

Modern commercial 3D printers create desirable products using a gcode, which is a set of sequential instructions that describe how to print a model one layer at a time. Continuous fiber reinforcement (CFR) printing is a printing process where a single strand of material, often carbon fiber, is coated in a composite or polymer resin that enhances strength along the fiber direction. These printers utilize a technique called stationary bed-dropper printing, which fixes the nozzle in place while the print bed moves and rotates around it. One challenge with this approach is that diagonal motion requires differential speed control between two motors in order to create straight lines. Traditionally, printers handle this by including specific motor speeds inside the gcode that allow for different speed settings at each stage of printing. However, this involves modifying

a gcode to include extra variables. Instead, this poster presents the differential speed control function as a way to process separate motor speeds without requiring any additional gcode variable inputs. The effectiveness of this approach is evaluated by analyzing the cross-sectional void density and surface topology of carbon fiber resin prints to determine if there is a significant difference between the experimental function and the literature-accepted method of directly inputting speeds inside the gcode. The presentation will then conclude with a statement on future testing and methods for expanding the scope of the topic.

Blocking P2Y12 and PD-1 in Tumor-Associated Macrophages inhibits pancreatic cancer cell growth and migration through the TGF-B1/Smad2 pathway

YING KANG
Pharmaceutical Sciences
Advisor: Elisabetta Liverani, Ph.D., School of Pharmacy

Background: Pancreatic ductal adenocarcinoma is the third leading cause of cancer-related mortality worldwide. The immunosuppressive tumor microenvironment (TME) significantly restricts the effectiveness of immunotherapies in pancreatic cancer. Tumor-associated macrophages (TAMs), the most abundant cell type in TME, express immune checkpoints and mediate tumor progression and immune escape. Blockade of the immune checkpoint, programmed cell death protein 1 (PD-1)/PD-1 ligand 1 (PD-L1), on TAMs, reduces pancreatic tumor growth in mice, however, it is not clinically efficient. Blocking other immune-regulatory pathways could serve a complementary role to enhance anti-PD-1/PD-L1 efficacy. We have identified P2Y12, an ADP receptor expressed in macrophages, and P2Y12 antagonists promote phagocytosis. We aim to investigate a co-treatment that blocks PD-1/PD-L1 and P2Y12 on TAMs. Methods: TAM-like cells were generated in vitro by culturing THP-1 monocytes with PMA (10 ng/mL, 24 hours), followed by incubation with cancer cell-conditioned media for 48 hours. We used PANC-1, BxPC-3, and patient-derived human pancreatic cancer cells (HPCCs). We used BMS-1 to block PD-1/PD-L1, cemiplimab to block PD-1, and ticagrelor to block P2Y12, alone or in combination. We investigated TAM phagocytosis and cancer cell proliferation and migration in the TAM-cancer cell co-culture. ELISA and western blot were performed to investigate the underlying mechanisms. Results: Co-treatment of ticagrelor and cemiplimab promotes the phagocytic ability of TAMs induced by PANC-1 and BxPC-3 and inhibits the TAM-induced growth and migration of PANC-1 and BxPC-3. Co-treatment of ticagrelor and cemiplimab synergistically increases the phagocytic ability of TAMs induced by HPCCs and decreases the TAM-induced migration of HPCCs. The combination of ticagrelor and cemiplimab prevents TGF-b1 release from TAMs and Smad2 phosphorylation in cancer cells. Conclusion: Co-treatment with ticagrelor and cemiplimab inhibits pancreatic cancer cell growth and migration by inhibiting the TGF-b1/Smad2 signaling pathway. This co-treatment has the potential to be an effective treatment strategy for pancreatic cancer.

Embryo Transfer Outcomes and Placental Vascular Development in Sheep: Effects of Breed Interactions

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Animal Sciences
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Infertility, or the inability to establish and maintain a pregnancy, remains a major challenge in livestock production, affecting reproductive efficiency and economic viability. Early pregnancy is a critical period for placental vascular development, which supports embryonic survival and fetal growth. This study aimed to evaluate the individual and interactive the effects of embryo and ewe breed on pregnancy establishment and placental vascular development in sheep. A total of 85 embryo transfers (ET) were performed using straight-bred and reciprocal embryo transfers between Rambouillet (Rambo) and Romanov (Romo) ewes. Pregnancy success was assessed on day 24 of gestation, revealing significant breed-dependent differences. The greatest pregnancy success rates were observed in straight-bred groups (Embryo Breed × Ewe Breed), with Rambo × Rambo at 31.3% and Romo × Romo at 26.7%, the reciprocal Rambo × Romo group had the lowest success rate (11.8%), while the Romo × Rambo group was intermediate (22.7%), suggesting a tendency for breed effects ($P = 0.10$). To investigate the underlying mechanisms, cross-sections of the uterus were collected on day 25 of gestation. At this early stage, the embryo undergoes elongation and initial attachment to the uterine tissue. The vascularity was assessed via CD31 and CD34 immunofluorescent staining, with capillary area density (CAD) and capillary number density (CND) quantified in the caruncle (CAR), fetal membrane (FM), and inter-caruncular (ICAR) regions. The Rambo × Romo group exhibited increased CAD in CAR and ICAR regions compared to all other Embryo × Ewe breed combinations ($P < 0.01$). The Romo × Romo group showed decreased CND in CAR region compared to Rambo × Rambo and Romo × Rambo ($P < 0.05$), while Rambo × Romo was intermediate and not significantly different from Romo × Romo. indicating altered vascular development. These findings suggest that reduced pregnancy success in the reciprocal ET groups may be associated with altered placental vascularization, potentially affecting fetal-maternal interactions necessary for pregnancy maintenance. This study links fertility, measured by pregnancy establishment, to early placental vascular development. Further analysis will clarify underlying mechanisms, aiding targeted interventions to enhance reproductive efficiency and optimize livestock breeding strategies.

Computational Study Of The Energy Of Heterogeneous Random Graph

MAHARUKH KHAN
Statistics
Advisor: Mingao Yuan, Ph.D., Statistics

A plethora of articles have been published based on graph energy. It is useful in identifying important graph vertices and revealing network patterns and relationships, such as community structure and clusters. In this research, we are investigating the energy of heterogeneous random graphs through simulation to achieve better insights into the structure and properties of a network. This research aims to explore the graph energy under a specific random model and helps to understand the impact of parameters on the structure and complexity of the network. We find that graph energy scales with n3 2 (n is the

number of nodes), and graphs with higher heterogeneity have lower energy. The outcome of this research reveals that homogeneous networks are higher in energy, indicating that they are more regular than heterogeneous networks. This reveals that the energy of the graph is helpful for measuring the heterogeneity of real-world networks.

Patchy Solutions to Thatchy Problems: Heterogeneity-based Management Negates the Impact of Invasive Grass Thatch

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Natural Resource Sciences
Advisor: Kevin Sedivec, Ph.D., School of Natural Resource Sciences

Non-native plants invade and degrade rangelands, suppressing native plant diversity. Many rangelands in the northern Great Plains (NGP) have been invaded by exotic grasses, primarily Kentucky bluegrass (Poa pratensis; hereafter 'bluegrass'). Bluegrass invades rangelands and suppresses native plants by accumulating a dense litter mat that over time compresses and degrades into a novel layer between the vegetation and soil profile called thatch. Thatch is considered the main mechanism promoting bluegrass in the NGP. However, little is known about how thatch impacts native plant diversity. To better understand the relationship between native plants and bluegrass thatch, we collected plant community composition data, as well as thatch depth in 12 pastures managed with either patch-burn grazing (PBG), modified twice-over rest-rotation grazing (MTORG), and season-long grazing (SLG) for three years in south-central North Dakota. We compared how richness, evenness (Evar), and diversity (Simpson) changed in response to thatch depth and management practice. We found that thatch depth in PBG was significantly shorter than SLG (1.89 ± 0.11 cm vs. 2.53 ± 0.18 cm) but was not different from MTORG (1.96 ± 0.09 cm). This contrasts existing work which has only shown PBG, and not MTORG, to decrease thatch depth. Richness and diversity varied by treatment with PBG and MTROG having greater richness and diversity than SLG. Additionally, increasing thatch depth led to a decrease in both richness and diversity in SLG, but not PBG or MTORG. Evenness was not impacted by management or thatch depth. This would suggest that the main impact that thatch has on native plant diversity is limiting the number of species that are in plant communities. Furthermore, this impact appears to be mitigated by MTORG and PBG, suggesting that either MTORG or PBG should be used to promote native species germination and negate the negative effects of bluegrass thatch.

Generation of Conditional Hepatic VPAC1 Deficient Mice for Insulin Resistance Analysis

SAVANAH KLEGON
Microbiology
Advisor: Glenn Dorsam, Ph.D., Microbiology

Generation of Conditional Hepatic VPAC1 Deficient Mice for Insulin Resistance Analysis Savanah Klegon, Razia Dawlaty, Teala Matiur, Joshua Eberts, Kaley Quam and Glenn Dorsam, Department of Microbiological Sciences, North Dakota State University, Fargo, ND 58102 Diabetes, the eighth leading cause of death in the United States, affects approximately 38.4 million people and incurs over 300 billion dollars in annual healthcare costs. This metabolic disorder elevates blood glucose levels, leading to widespread, systemic complications due to glucose toxicity. Vasoactive intestinal peptide (VIP) influences many biological processes, including immunology, circadian rhythm, and metabolism. Previously, our laboratory reported that VIP and VPAC1 deficient mice are lean and have gut microbiota dysbiosis; while others have observed a pre-diabetic state with elevated blood glucose and insulin in VIP deficient mice fed a regular chow diet. It is well established that continuous glucose production by the liver due to hepatic insulin resistance drives diabetes progression. In addition, VPAC1, one of two VIP receptors, is exclusively expressed on hepatocytes and its expression increases in mice fed a high-fat diet (HFD). However, the underlying mechanisms remain unclear. Given the role of VIP in metabolism and glucose homeostasis, we hypothesize that hepatic VPAC1 signaling contributes to insulin resistance on a HFD. To investigate this, a conditional hepatic VPAC1 knockout was generated using the Cre-lox system. The confirmation of this was completed using qPCR and western blotting techniques to monitor the presence of VPAC1 mRNA and Cre recombinase protein, respectively. Future studies with these mice will focus on elucidating the contribution of hepatic VPAC1 signaling to the development of insulin resistance, including single cell RNAseq of hepatocytes, and proinflammatory assessment of infiltrating liver macrophages.

Self-Esteem as a Mediator of the Association between Helping Others and Wellbeing in Older Adults

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A growing body of research suggests that generativity positively affects the overall well-being of older adults. However, it remains unclear whether generative acts, such as providing help, directly influence their well-being. The current study examines the potential mediating influence of self-esteem in the association between helping others and wellbeing among older adults. The data is drawn from the first wave (2013) of the Social Integration and Aging Study, a study on community-based older adults (60+) in the Upper Midwest (N=418). The quantity of giving help to others was measured by three Likert-type items (frequency of giving help to family, friends and neighbors) combined into a single scale (alpha =0.7). The Rosenberg Self-Esteem scale (10 items) was used as a mediator variable. Wellbeing was assessed using two different measures: Depressive Symptoms (10-item Geriatric Depression Scale) and Life Satisfaction (Diener's 5-item Satisfaction with Life scale). Demographics (age, gender, marital status, income) and Activities of Daily Living (ADL) were used as control variables in the models. Mediation analysis was conducted using PROCESS MACRO Model 4. A complete mediation of self-esteem was found on the association between helping others and life satisfaction (path a=1.37 p=.018, path b=-0.05 p <.001, path c= .15 p=.021, path c'=.083 p=.153). However, self-esteem only had an indirect association between helping others and depression (path a=1.37 p=.018, path b=-0.13 p <.001, path c=-0.25 p=.091 path c'=-0.07 p=.572). The findings suggest that improving self-esteem in older adults is crucial for improving their overall wellbeing. Future research should explore the longitudinal causal effects and examine additional factors that might impact self-esteem in older adults, such as social relationships, control beliefs, and participation in meaningful activities. Understanding these relationships can help develop interventions to strengthen self-esteem and, in turn, enhance their wellbeing.

In-nozzle impregnation-based 3D printing of thermoset composites using a UV light assisted printing process

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Mechanical Engineering
Advisor: Chad Ulven, Ph.D., Mechanical Engineering

Continuous carbon fiber-reinforced (CCFR) thermoset composites offer superior strength-to-weight ratios, high stiffness, and exceptional thermal stability, making them highly desirable for high-performance applications in industries such as automotive and aerospace. 3D printing has introduced new possibilities for manufacturing CCFR thermoset composites, enabling greater design flexibility, reduced material waste, and on-demand production. The ultraviolet (UV) light-assisted printing process is considered a promising method for manufacturing CCFR thermoset composites with enhanced mechanical properties. However, higher filament count fiber tows often face insufficient resin impregnation, leading to voids and weak interfacial bonding. The overall objective of this research was to demonstrate a UV light-assisted printing process for CCFR composites that enhances resin impregnation within the fiber tow and to compare the printing performance of metal and plastic nozzle tips. In this study, a 3K continuous carbon fiber tow was passed through a resin-filled syringe, having a tip of diameter 1.6 mm, before being deposited onto the print bed. A commercially purchased photocurable resin (Peo-Poly Nylon-like Tough) was used as the print ink. The novelty of this research lies in the use of a liquid resin-filled syringe as the print head. The syringe, approximately 80 cm long, provides an extended path and a larger resin reservoir, facilitating enhanced fiber impregnation. In this study, the syringe functions as a resin bath, allowing the fiber to be thoroughly impregnated before deposition. The fiber carries a certain amount of resin before being laid onto the print bed which was cured by a 405 nm UV laser light employed. Moreover, 3D printed specimens using the metal tip demonstrated higher mechanical properties than those printed with the plastic tips. Additionally, specimens printed with the metal tip showed better surface finish and fewer surface irregularities. By addressing impregnation challenges and optimizing syringe tips, this study enhances the reliability and effectiveness of 3D printing for CCFR thermoset composites, contributing to improved mechanical properties and surface quality in printed components.

The impact of pollen and nectar availability on insect communities of cultivated sunflowers

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The availability of floral rewards (i.e., pollen and nectar) influences their consumption by insects in flowering plants such as cultivated sunflowers (*Helianthus annuus* L.). Wild bees are attracted to sunflowers with greater nectar accessibility and pollen, although how floral rewards affect other insects is understudied. Many insect pests of sunflower heads feed on pollen as larvae and many natural enemies consume pollen and nectar in addition to prey. We established a field experiment using near-isogenic sunflower lines varying in pollen availability and lines differing in floret length (nectar accessibility) to determine how floral rewards affect visitation by pollinators and natural enemies and inhabitation by insect pests. There were four replications of six treatments: male-fertile (pollen present) with short florets, cytoplasmic male sterile (CMS, pollen absent) with short florets, male-fertile with long florets, CMS with long florets, and two control groups, one wild sunflower line and one line with extra-long florets. The insect community was sampled using clear sticky traps for small insect visitors, vial capture for larger insect visitors, destructive sampling of sunflower heads for resident pests, and floral eDNA collection by wash for the overall insect community. We expect that insect visitation and inhabitation will be greatest in the male-fertile lines with short florets. The results from this experiment will elucidate how floral rewards affect different insect functional groups and could be used to enhance pollinator-plant interactions, minimize insect pest damage, and reduce the use of pesticides through the attraction of natural enemies.

Productivity, LAND Equivalent Ratio, and Carbon Intensity in a Spring Wheat-Winter Camelina-Sunflower Sequence

HOUSTON LINDELL
Plant Sciences
Advisor: Marisol Berti, Ph.D., Plant Sciences

Winter camelina (*Camelina sativa* (L.) Crantz) is an oilseed crop that is grown in limited acres across the country. Camelina requires less inputs than other oil crops, but also yields about half as much as similar crops, such as canola (*Brassica napus* L.). To determine if certain crop sequences can improve camelina seed yield, as well as providing many other benefits to the environment, field experiments were conducted in Hickson and Prosper, ND in 2023. The crops include early maturing sunflower (*Helianthus annuus* L.), spring wheat (*Triticum aestivum* L.), and soybean (*Glycine max* (L.) Merr). In 2023, sunflower and spring wheat were planted in the spring and winter camelina was planted in the fall. Soybean and sunflower will be double cropped in 2024 of certain treatments. Evaluations include soil total carbon and nitrogen and bulk density, plant height, seed and oil yield, seed oil and nitrogen content, plant biomass nitrogen content, and fatty acid profile. Wheat yields showed no significant differences between treatments, averaging 8.7 Mg/ha in Hickson and 8.9 Mg/ha in Prosper. Sunflower yield varied, as bird damage, sunflower midge (*Contarinia schultzi*), and white mold (*Sclerotinia sclerotorium*) damaged plots. Sunflower yield averaged 2,832 kg/ha and 3,536 kg/ha in Hickson and Prosper, respectively. Oil content showed no significant differences, averaging 41.6 and 41.8% in Hickson and Prosper, respectively. Winter camelina stand counts were taken in the spring 2024 and were 107 and 121 plants/m2 in Prosper and Hickson, respectively. Camelina oil content and crude protein was not significant in any sequence or location. In Prosper, camelina yields were highest following sunflower, particularly in unfertilized treatments (788 kg/ha). Stand counts were reduced in Hickson, likely due to residual herbicide use. This data will allow for a better understanding of where winter camelina can benefit common northern Great Plains crop sequences.

Regulation of Piezo ion channels by Apelin/APJ signaling in hypertension

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Advisor: Chengwen Sun, Ph.D., School of Pharmacy

Background: Apelin regulates vasocontractility and vascular remodeling by acting directly on APJ receptors in vascular smooth

muscle cells (VSMCs). However, the ionic mechanisms underlying this action at the cellular level remain unclear. Piezo channels are mechanosensitive cation channels that contribute to vasoconstriction. The aim of this study was to investigate the role of Apelin and Piezo channel in VSMCs in the development of hypertension. Methods: The localization of Piezo channels in mesenteric arteries were examined in Wistar Kyoto (WKY) and Spontaneously Hypertensive (SHR) Rats using immunohistochemistry techniques. The vascular contractility was examined using wired myograph in isolated mesenteric arteries of SHR as compared with WKY rats. VSMCs were dissociated from mesenteric arteries using enzymatic digestion approach and primarily cultured to investigate the effect of Apelin on Piezo channel expression and activity. Results: Our immunohistochemistry study using specific antibodies against Piezo channel and α-smooth muscle actin (SMA, a VSMC marker) has demonstrated that Piezo1 and Piezo 2 channels are dominantly expressed in VSMCs of mesentery arteries. APJ receptors are also expressed in the VSMCs of these arteries and colocalized with α-SMA. Using VSMC cultures, Piezo1 was localized on cell membrane, in contrast, Piezo2 localized in the nucleus. In myograph study using denuded mesenteric arteries, Apelin-13 induced a dose-dependent vasoconstriction in arteries from both SHR and WKY rats. However, the Apelin-induced vasoconstriction is enhanced in SHR arteries. More interestingly, the vascular response to Apelin-13 was mimicked by Yoda-1, an agonist of Piezo 1 channel. Conclusion: Apelin receptor APJ and Piezo channels are localized in VSMCs of mesenteric arteries. Stimulation of Piezo channel or APJ receptor induces vasoconstriction; this vascular response is enhanced in SHR. The effect of Apelin on Piezo channel opening will be examined in the future study. Therefore, by understanding Apelin's role in Piezo channel-induced vasoconstriction could provide new therapeutic targets for treating hypertension.

Targeting Tumor Survival: A Selective Approach to Pancreatic Cancer Therapy Targeting COPZ1

ALLANA MARTINS
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Advisor: Roberto Gomes, Ph.D., School of Pharmacy

Pancreatic ductal adenocarcinoma (PDAC) remains one of the most lethal malignancies due to its late-stage diagnosis and lack of effective treatment options. This study aims to explore COPZ1, a component of the coatomer protein complex (COPI), as a novel therapeutic target for PDAC. COPZ1 is critical for cellular processes and PDAC cells exhibit dependency on COPZ1 for survival, while normal cells rely on its paralogous COPZ2. We hypothesize that inhibiting COPZ1 will disrupt COPI vesicle formation, leading to endoplasmic reticulum (ER) and Golgi complex disorganization, and subsequent programmed cell death in PDAC cells. In this study, we identified and synthesized small-molecule COPZ1 inhibitors, evaluated their selectivity and efficacy in vitro, and investigated the underlying molecular mechanisms driving tumor cell death, including Golgi stress and ferroptosis. Molecular docking was performed to predict potential COPZ1 inhibitors, followed by the synthesis of lead compounds. After preliminary in silico studies, 4 compounds were selected as leading compounds based on their performance, and interactions between the inhibitor and the amino acids within the binding site of the enzyme. Also, RT-qPCR confirmed that the two isoforms COPZ1 and COPZ2 are expressed at similar levels in normal cells, while COPZ2 is downregulated in tumor cell lines. To assess the effects of COPZ1 inhibitors on PDAC cells viability and proliferation, we performed an MTT assay. Interestingly, the selected 1-4 compounds showed cellular growth inhibition of pancreatic tumor cell lines (MIA PaCa-2 and AsPC-1), but not for the normal cell line (HPNE). We also investigated Golgi's function and oxidative stress after treatment. Compounds induced the Lipid Droplet formation, and the Lipid Peroxidation experiment showed that normal pancreatic epithelial cells (HPNE) were resistant to lipid oxidative damage, as no significant lipid peroxidation was observed. In contrast, the pancreatic cancer cell line MIA PaCa-2 displayed a marked increase in lipid peroxidation upon treatment with the test compounds, indicating that the compounds induced oxidative stress in the cancer cells. This research could not only establish COPZ1 as a promising target but also pave the way for targeted therapies that selectively suppress PDAC cells, improving treatment outcomes and survival rates for patients.

VIP Receptor Deficiency negatively impacts Gut Epithelial and Immune Cell Homeostasis.

TEALA MATIUR
Microbiology
Advisor: Glenn Dorsam, Ph.D., Microbiology

Vasoactive Intestinal Peptide (VIP) is a key neuroimmune regulator that maintains gut homeostasis by regulating epithelial integrity and immune cell balance. VIP's anti-inflammatory effects are thought to be mediated by one of two G-protein coupled receptors (GPCR), termed VPAC1. Disruptions in VIP signaling have been linked to inflammatory bowel diseases (IBD) and increased susceptibility to gut inflammation. While VIP's role in modulating immune responses is recognized, its impact on intestinal epithelial cells (IECs) and lamina propria lymphocytes (LPLs) remains unclear. This study will investigate how epithelial VIP VPAC1 signaling alters homeostasis by measuring epithelial and immune cell frequencies. To this end, we will employ gut epithelial conditional knockout mice by crossing VPAC1 floxed mice with Villin-Cre hemizygous mice. At 8 weeks of age, small intestines were harvested and both epithelial and lamina propria immune cells were analyzed by flow cytometry. Viable epithelial cell lineages, intestinal epithelial lymphocytes, innate lymphocyte cells (ILC), regulatory T cells (Tregs), and eosinophils will be assessed for frequencies using fluorescently conjugated antibodies against appropriate cell markers. We anticipate that VIP deficiency will impair epithelial integrity by disrupting cell epithelial lineages, like Goblet cells while dysregulating mucosal immunity by lowering the frequencies of ILCs, Tregs, and eosinophils. By clarifying VIP's role in epithelial and immune cell regulation, this study may identify novel VPAC-1 signaling contributions to gut inflammation, offering potential therapeutic targets for IBD and related disorders.

Evaluating cultivar and planting date effect on garlic growth and yield

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Horticulture and Urban Agriculture

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Garlic (*Allium sativum*) is a widely cultivated and consumed crop globally. While the U.S. is among the leading garlic producers, it remains the world's largest importer, indicating that domestic production does not meet the growing demand. Planting date (PD) and cultivar selection are critical factors influencing garlic growth

and yield. This study was conducted at two locations, Abby and Fargo, to evaluate the effects of planting date and cultivar on garlic growth and yield and to determine the most adaptable cultivar for both locations. The experiment followed a randomized complete block design (RCBD) with four replications. Data were collected on leaf number, scape length (SL), bulb weight (BW), bulb diameter (BD), scape weight (SW), fresh plant weight (FW), dry plant weight (DW), and clove number (CN). Results showed that the interaction between cultivar and planting date significantly influenced FW, DW, and SL but not SW. 'German White'(GW) planted 9/28 had the highest FW and DW, while 'German Extra Hardy'(GEH) planted 10/25 had 87% less FW and 84% less DW. 'Music' planted 9/28 and 'GW' 10/12 had the longest scapes. Cultivar by PD interaction also affected BD, with 'GW' on 9/28 having 99% greater BD than 'GEH' on 10/25. Cultivar by PD interaction also affected plant height and leaf number. Location by cultivar interaction affected FW, DW, Scape Weight(SW), and SL, with 'GW' (Abby) performing best. Location by PD influenced DW, SL, and SW, with the highest values at (Abby) on 9/28 and the lowest values at (Fargo) on 10/25. Cultivar by Loc interaction also affected leaf number and plant height, with 'GW' at (Abby) producing the highest values. The correlation analysis revealed strong positive relationships between BW and FW, DW, BD, and SW, indicating that these traits are strong selection criteria for improving garlic bulb yield. However, leaf number, CN, and SL exhibited moderate to low correlations with BW. In conclusion, 'GW' was the most adaptable cultivar under North Dakota conditions. Early planting, particularly around Sept 28, significantly enhanced garlic yield, making it a recommended practice for optimizing production.

Marketing to the Long Tail: Evidence from ETSY

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Business Administration
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Long tail phenomenon in online retailing is the strategy of selling many unique items with relatively smaller quantities sold for each, i.e., towards the long tail of sales distribution, usually in additional to selling fewer more popular items sold in larger quantities, which are towards the head of the distribution. In certain product categories, such as jewelry, home decoration, art and collectibles, customer needs are such that there is a need for long tail type of products. In this research, we explore a platform, ETSY, which is known for selling such items and explore its' seller's success in marketing to the long tail. In particular, we focus on two factors, Customization and Shipping policy. Customization in form of offering of custom-made products to fit with specific needs of users is a key strategy that entrepreneurs use on ETSY, thereby, benefiting from the trend towards long tail products and offering greater value to users. Free shipping is another such alternative that reduces up front cost and inconvenience for buyers as they shop online. To conduct the study, we consider a large data set of about 10,000 sellers on ETSY and consider the effect of their customization and shipping policies on their ratings and sales using regression analysis. On examination of distribution of sales of products on the platform, we find a long tail distribution pattern in sales. Our analysis suggests that both customization and free shipping help receive better rating on the platform. However, the effect of customization is larger and statistically significant. Further, we find that while total rating, number of favorites, average ratings, customization and free shipping, all affect sales revenue, the effect is stronger for total rating, favorites, average ratings, and customization. Together, the results suggest the benefits of customization, getting high number of total ratings and number of favorites for entrepreneurs on the platform. Entrepreneurs, using this information can better focus their efforts to increase sales using the variables discussed.

Phylogenetic Relationships and Subspecies Boundaries of Myotis Bats in the Northern Great Plains

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Advisor: Erin Gillam, Ph.D., Biological Sciences

Bats (Order *Chiroptera*) are the only mammals capable of flight, with over 1,400 species spanning the globe. Since 2006, millions of bats in North America have died due to a fungal pathogen that attacks bats during hibernation, causing the disease known as White Nose Syndrome (WNS). This disease causes too-frequent arousal from hibernation throughout the winter, resulting in premature depletion of fat reserves and mortality in 90-100% of infected bats. To document the host-pathogen interactions of WNS, as well as the genetic implications of population decline, our project focuses on understanding patterns of genetic variation in susceptible bat populations of the Northern Great Plains (NGP). We collected tissue samples from bats in multiple states (ND, MT, NE, KS, WY, NY, PA, IA, MN, and NM) and used two techniques, mitochondrial analysis and Genotype-by-Sequencing (GBS), to assess genetic diversity at multiple loci across the genome. The results of this project will allow us to reconstruct a shallow evolutionary history and delimit species boundaries in the Great Plains Region. Of particular interest is the little brown bat (*Myotis lucifugus*), which is assumed to have a subspecies boundary in North Dakota. Our results will help us better understand the phylogenetic structure of multiple bat species in the NGP, as well as assess any genome-wide responses to WNS in *M. lucifugus*.

Junctophilin-2 is a double-stranded RNA-binding protein that regulates cardiomyocyte-autonomous innate immune response

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Pharmaceutical Sciences
Advisor: Ang Guo, Ph.D., School of Pharmacy

Junctophilin-2 (JPH2) is traditionally recognized as a cardiomyocyte-enriched structural protein that anchors the junction between the plasma membrane and the endo/sarcoplasmic reticulum, facilitating excitation-induced cardiac contraction. In this study, we uncover a novel function of JPH2 as a double-stranded RNA (dsRNA)-binding protein, which forms complexes with dsRNA both in vitro and in cells. Stimulation by cytosolic dsRNA enhances the interaction of JPH2 with the dsRNA sensor MDA5. Notably, JPH2 inhibits MDA5's binding to its dsRNA ligand, likely by sequestering the dsRNA. Silencing JPH2 in cardiomyocytes increased the interaction between MDA5 and its dsRNA ligands, activated the MAVS/TBK1 signaling, and triggered spontaneous interferon-beta (IFNb1) production in the absence of foreign pathogen. Mouse hearts deficient in JPH2 exhibited upregulation of innate immune signaling cascade. Collectively, these findings identify JPH2 as a regulator of dsRNA sensing and highlight its role in suppressing the automatic activation of innate immune responses in cardiomyocytes, suggesting the cytosolic surface of the endo/sarcoplasmic reticulum as a hub for dsRNA sequestration.

The NATS Singing Competition as a Valuable Context for Collaborative Pianists: A Report on Challenges and Improvements of Piano Skills to Coach Singers

GUILHERME MONTENEGRO
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This abstract describes a graduate student piano preparation of vocal repertoire to be performed at the 2024 National Association Teachers of Singing (NATS) Chapter Competition, highlighting the improvements in collaborative skills. During their second school year, the pianist was assigned to accompany 6 singers who, in total, performed 28 songs. Their vocal repertoire choices related to both classical and musical theater genres, including a variety of languages such as English, French, German, Italian, Spanish and Brazilian Portuguese. Due to the brief time to learn the repertoire, deliberate practice was required. According to the literature, this concept is a focused, self-regulated learning environment where the musical results are achieved in a relatively shortened amount of practice time. Given that context, the pianist identified some procedures regarding their individual practice: active listening of recordings; fingering of difficult passages already considering final tempo markings; identification of contrasting moods and character on each song; notation of anticipated chord symbols and dynamics, especially at page turns; basic text pronunciation to refine the ability of following the vocal line; and further record listening to either sharpen the understanding of the songs or clarify challenging passages. Particular attention was given to piano introductions, interludes, and postludes. When the ensemble rehearsals took place, especially at the beginning of each session, the pianist started valuable discussions with the singers about their musical interpretation. As advocated by some scholars, these strategies enriched the deliberate practice, assuring the best piano-voice collaboration with confidence and high levels of motivation. The following improvements were identified: brisk learning of songs; larger confidence on the piano playing; and positive influence on the singer's performance on stage. As a result, the pianist's performance at the contest resulted in some prizes being awarded to a few singers, validating the effectiveness of the piano deliberate practice applied to vocal repertoire.

Identifying ligand specific RAGE antagonists based on monoclonal antibodies

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The receptor for advanced glycation end products (RAGE) is a 404 amino acid long cell surface receptor belonging to the immunoglobulin superfamily and is capable of binding multiple ligands. It is expressed at low levels across various cell types, including epithelial and endothelial cells, neurons, hepatocytes, vascular smooth muscle cells, and immune cells. The full-length RAGE protein comprises a variable-like (V) domain, constant type 1 (C1) and constant type 2 (C2) domains, a short transmembrane segment, and a cytoplasmic tail. The V domain serves as the primary ligand-binding site, although certain ligands can also interact with the C1 and C2 domains. Originally named for its first identified ligand, advanced glycation end products (AGEs), RAGE has since been recognized to bind a diverse array of ligands, including HMGB1, S100 proteins, amyloid β peptides, transmembrane proteins such as MAC-1, C1q, phosphatidylserine, lysophosphatidic acid, and nucleic acids. Beyond its role as a cell surface receptor, RAGE's ability to engage multiple ligands positions it as a key regulator in numerous pathological conditions, including Alzheimer's disease, neurodegeneration, cardiovascular disease, cancer, and diabetes. Targeting RAGE to block specific ligand interactions holds therapeutic potential across multiple diseases. This study aims to identify ligand-specific RAGE antagonists using a live-cell NanoLuciferase system. The NanoLuciferase complementation system, NanoBiT, was utilized to investigate RAGE-ligand interactions. For this purpose, HEK293 cells were stably transfected with an LgBiT-tagged human RAGE (hRAGE) receptor. To complement the LgBiT, SmBiT-tagged S100B and HMGB1 were employed, as both ligands are known to bind RAGE. Following complementation of LgBiT and SmBiT, luciferase activity was measured upon the addition of furimazine substrate. Changes in luminescence signals were assessed to identify ligand displacement by anti-RAGE antibody binding. The nLuc/LgBiT_hRAGE plasmid was successfully designed, expressed, and used to generate stable HEK293 cell lines. These stable cell lines expressed the target receptor and exhibited luciferase activity. Additionally, SmBiT-tagged S100B and HMGB1 proteins were successfully constructed, expressed, and purified. The interaction between LgBiT_hRAGE and SmBiT-tagged proteins effectively reconstituted the NanoLuciferase enzyme. Furthermore, the NanoBiT system demonstrated the ability to detect competition with untagged S100B, confirming its utility in studying RAGE-ligand interactions.

Building Stronger Families: A Comparison of Early Childhood Parenting Programs in North Dakota

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Parent education programs are designed to strengthen parent-child bonds and improve the overall well-being of both family members and children. A significant goal of these programs is to prevent and reduce child abuse and neglect, which is important for promoting family stability and ensuring children's safety (Centers for Disease Control and Prevention, 2013). The purpose of this study was to evaluate and compare the effectiveness of five early childhood parent education programs offered by the North Dakota Parent Education Network on seven child-focused outcomes, including positive reinforcement, emotional regulation, parent-child bonding, and misbehavior. The programs examined were Active Parenting, Circle of Security, Gearing Up for Kindergarten, Incredible Years, and Love and Logic – Early Childhood. A repeated measures ANOVA was performed to examine the effect of time (pre-test, post-test). Circle of Security showed the highest improvement in praise ($F = 90.29$, $p < .01$), emotional closeness ($F = 29.53$, $p < .01$), soothing ability ($F = 45.48$, $p < .01$), and engaging in the child's favorite activities ($F = 45.33$, $p < .01$). Love and Logic had the greatest reduction in losing control during discipline ($F = 79.68$, $p < .01$) and misbehavior aimed at upsetting the parent ($F = 65.85$, $p < .01$). Active Parenting showed improvements in praise ($F = 46.50$, $p < .01$), emotional regulation ($F = 23.76$, $p < .01$), and soothing ability ($F = 21.36$, $p < .01$). Incredible Years showed improvement in emotional regulation (2.00 to 1.70, $F = 27.11$, $p < .01$) and soothing ability (2.93 to 3.04, $F = 15.51$, $p < .01$). Gearing Up for Kindergarten showed the least improvement, with no significant changes in

emotional closeness (F = 3.33) and a moderate increase in doing the child's favorite activities (F = 10.43, p < .01). The findings suggest that different parenting programs have varying levels of effectiveness in promoting positive child-focused outcomes. These results highlight the importance of tailoring parenting interventions to specific family needs, since some programs are more effective for improving specific aspects of parent-child relationships.

Deployable Rigid Polyurethane Foam

RYLEY OTTO
Mechanical Engineering
Advisor: Chad Ulven, Ph.D., Mechanical Engineering

The development of a rapidly deployable rigid foam structure has become a topic of interest for its humanitarian, emergency, and industry purposes. The applicable industries to this research include the military, emergency response, and construction. This could be used in many applications and solve challenges around the world. Foam core has proven useful in these applications for its strength to weight ratio. While foam core has proved its usefulness, it has limitations in the cost of distribution which can be large due to its size. A potential solution to this is the development of a deployable rigid foam that can be shipped relatively small to reduce overall cost while still maintaining the material properties of a non-deployed core. An alternative method to reduce the cost of distribution has been developed termed as spray foam. This method can be convenient for distribution through barrels filled with the liquid components. However, equipment costs and multiple installment locations can be expensive. While there are not many methods for the distribution, there is a previous military application of a deployable raft that shows some insight into one method of deployment using a nozzle that mixes the two parts using pressure. The objective of this research is to develop a deployable foam which would enable bulk distribution and reduce the overall cost of the process currently used. The deployment designs could be using a static mixer, roller, or slider which allow for varying analyses to be seen. Using these various deployment methods and material testing, the best overall concept will be selected and tested across multiple deployments to ensure that the deployment process is repeatable.

What happens when plants get rare: A study of constraints on the reproductive success of the threatened Western Prairie Fringed Orchid, *Platanthera praeclara*

JOSEPHINE PICKAR
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Rare plants can experience reduced reproductive success and outcrossing rates due to the increased distances between populations and decreased potential mates associated with small, fragmented populations. These conditions can influence pollinator interactions and lead to pollen limitation, thereby affecting seed production. The federally threatened orchid *Platanthera praeclara* is a species that requires specific pollinators (hawkmoths) to successfully reproduce. We wanted to explore if its rarity may, in part, be due to low recruitment stemming from a lack of sufficient pollination and thus inform conservation strategies for this species. We first hypothesized that fruit set (# fruits per flower per plant) in this species is relatively low due to limited pollinator visitation and outcrossing. Second, we hypothesized that fruit set would be positively related to environmental and plant characteristics associated with signals or cues to pollinators. In order to measure natural levels of fruit set and test hypotheses about fruit set correlates, we: 1) surveyed flower and fruit production in natural populations in North Dakota, Minnesota and Manitoba; 2) correlated climate variables, soil properties, population density, and size with fruit production; 3) estimated the potential impact of surrounding land use on fruit production; and 4) measured plant mortality due to herbivory over a growing season. We surveyed 16 populations of *Platanthera praeclara* across North Dakota, Minnesota, and Manitoba during the summer of 2024. In July, at each population, we counted the flower number and plant height of up to 30 plants and georeferenced their location. These plants were then revisited two months later and surveyed for fruit set and fate. We found that fruit set across sites was relatively low ($\bar{x}$ = 0.10, SE = 0.008, n= 348), and significantly different between two populations (Chi-square = 36.377, p = .0016, df = 15) in Minnesota and Manitoba. We also found statistically significant differences among populations in plant height ($p = 8.41 \times 10^{-9}$), but not in flower number (p = 0.425). Our results strongly suggest that *Platanthera praeclara* is pollen limited and have important implications for the consequences of rarity and potential management strategies associated with conservation of rare species.

Altered function and expression of transient receptor potential vanilloid type 4 in the hypothalamic neurons in salt-sensitive hypertension

ARYA POUDEL
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Advisor: Chengwen Sun, Ph.D., School of Pharmacy

Hypertension is a major risk factor for cardiovascular diseases, with over two-thirds of the population affected. A high-salt diet contributes to hypertension and often leads to drug-resistant forms of the condition. However, the mechanisms underlying salt-sensitive hypertension remain poorly understood. Transient Receptor Potential Vanilloid 4 (TRPV4), a nonselective cation channel primarily permeable to Ca^{2+}, is activated by physical stimuli such as osmolality and hypotonic solutions. TRPV4 is expressed in the brain, including the hypothalamus, which plays a critical role in regulating osmolality, the autonomic nervous system, and endocrine functions related to blood pressure regulation. Therefore, this study investigates the role of TRPV4 channels in hypothalamic neurons in the development of salt-sensitive hypertension. The expression of TRPV4 in neurons and glial cells was examined in cultured hypothalamic cells from neonatal rats using immunocytochemistry. Neuronal and glial cell markers were used to localize TRPV4. Additionally, the effect of TRPV4 activation on blood pressure was assessed by microinjecting the TRPV4 agonist GSK1016790A into the paraventricular nucleus (PVN) of both control Sprague Dawley (SD) and Dahl salt-sensitive (DS) rats after 4 weeks of a high-salt diet. Blood pressure and heart rate were measured using femoral artery catheterization. TRPV4 was predominantly localized in neurons compared to glial cells in the hypothalamus. Microinjection of GSK1016790A into the PVN significantly reduced mean arterial pressure and heart rate in both SD and DS rats. Notably, the depressor effect was more pronounced in DS rats, suggesting enhanced TRPV4 function in salt-sensitive hypertension. TRPV4 channels are expressed in hypothalamic neurons, and their activation reduces blood pressure

and heart rate. The enhanced depressor effect in salt-sensitive rats indicates that TRPV4 may contribute to the pathogenesis of salt-sensitive hypertension. Future studies will explore the regulatory effects of TRPV4 on neuronal activity and examine its expression in salt-sensitive rats on varying diets.

Experimental investigation of the performance and durability of duplex metallized polymeric coatings in harsh environments

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This study investigates the use of corrosion, flammability, and high-temperature tests to evaluate the performance and durability of duplex metallized polymeric coatings in extremely harsh environments. Polymers, widely used in various industries, are promising candidates for applications exposed to corrosive agents. However, their inherent susceptibility to degradation under extreme conditions, particularly high temperatures and flame exposure, limits their utilization. Applying a metallic coating can enhance their ability to withstand these challenging environments. To assess the performance of duplex coatings, three key tests were conducted: corrosion, flammability, and high-temperature resistance. Corrosion testing evaluates the coating's resistance to environmental degradation in simulated marine conditions, including exposure to chemicals and moisture. Flammability testing assesses the coating's combustibility, ignition resistance, and fire propagation. High-temperature testing examines the coating's structural integrity, mechanical properties, and thermal stability under elevated temperatures. By integrating these testing methods, this study provides a comprehensive assessment of duplex coating performance under multiple stressors, enabling the selection of coating materials for applications requiring long-term reliability and safety.

Degradation of zinc rich epoxy polyamide coatings under impingement flow in 3.5% NaCl solution.

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Advisor: Yechun Wang, Ph.D., Mechanical Engineering

Zinc-rich epoxy polyamide coatings are commonly used to protect hydraulic steel structures from corrosion. To estimate the service life of such coatings under the influence of fluid flow, studies have been carried out to monitor the change of their barrier properties when submerged in fluids. In this study, steel substrates coated with two layers of zinc rich primer and two layers of epoxy polyamide topcoat were exposed to a 3.5% NaCl solution for different flow rates under impingement flow. The degradation process of coating samples across different flow regimes was evaluated by electrochemical impedance spectroscopy (EIS) with data interpreted by equivalent circuit modeling (ECM). The EIS results showed significant changes in low-frequency impedance across different flow rates, indicating degradation in barrier properties. The ECM analysis exhibited variations in coating capacitance and resistance, which reflects the changes in water uptake and coating durability. Atomic force microscopy (AFM) and nanoindentation were performed before and after exposure to capture changes in surface morphology, surface roughness, and coating modulus due to fluid shear. This study reveals that the flow regimes significantly influences the degradation of zinc-rich epoxy polyamide coatings, impacting their barrier properties and mechanical integrity.

Effect of Extrusion Nozzle Tilt Angle on the Surface Quality and Density of the 3D Printed Continuous Fiber Reinforced Composites

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Mechanical Engineering
Advisor: Chad Ulven, Ph.D., Mechanical Engineering

The additive manufacturing process enables the fabrication of complex geometries with ease using continuous carbon fiber reinforcement. However, due to its layer-by-layer deposition nature, additive manufacturing process often results in high surface roughness. Conducting the printing process in multiple axes alongside optimized nozzle tilt angle can mitigate this issue by refining material deposition and fiber orientation during fabrication process. A key prerequisite for reducing void content in a printed specimen is achieving a smooth surface. As each layer is deposited, rough surfaces with ridges and valleys can trap air pockets, preventing proper adhesion between layers. These voids disrupt material flow, compromising the structural integrity. By ensuring smooth surfaces, the risk of void formation is minimized, resulting in a denser, stronger, and more uniform material. The goal of this study is to investigate how the tilt angle of the nozzle in a 4-axis printing process affects the surface roughness and density of the printed specimens. The specimens are printed using continuous carbon fiber reinforced and liquid photocurable thermoset resin. UV light was used to cure the resin on the print bed. In this setup, the custom-built printer operates by rotating the print bed while also allowing movement along the X, Y, and Z axes. The nozzle can adjust its tilt angle relative to the horizontal print bed.

Square-shaped rings were 3D printed using both axial and rotary movement of the print bed. After each linear motion, the bed rotated by a set angle (90° for a square) to adjust the nozzle's direction. The ring thickness, measured between its inner and outer edges, was 10 mm, with 10 lines per layer. The raster gap was 1 mm. Each specimen was printed with a 0.9 mm layer height at 690 mm/min. The nozzle tilt angle, the angle between its axis and the X-axis, ranged from 20° to 50° in 5° increments. Average surface roughness was analyzed for each arm.

Surface roughness dropped from 70 μm to 39 μm as the tilt angle increased. Specimens printed at higher angles had smoother surfaces with fewer indents. The reduction in roughness also minimized voids, improving density. A higher tilt refined the extrusion path, aligning fibers properly for better surface quality.

MXene-reinforced UV-curable Acrylated epoxidized soybean oil coating for improved corrosion resistance

IRAM RIAZ
Coatings and Polymeric Materials
Advisor: Xiaoning Qi, Ph.D., Coatings and Polymeric Materials

This study investigates eco-friendly UV-curable coatings for improved corrosion resistance by incorporating 2D nanomaterial MXene into an acrylated epoxidized soybean oil (AESO) resin. The concentration of MXene nanoparticles was between 0.1 to 0.4 wt%, and they were dispersed in the AESO resin using three methods: ultrasonication

dispersion (80 amplitude for 30 minutes), high-speed Cowle-blade dispersion (2000 rpm for 30 minutes), and DAC (200 rpm for 30 minutes). TMPTA (trimethylolpropane triacrylate) was used as a crosslinker, and Ricon 134 was the plasticizer. A photoinitiator, ethyl phenyl (2,4,6-trimethyl benzoyl) phosphinate, was then introduced and homogenized to trigger free radical polymerization, ensuring efficient UV curing. The coatings were applied on the steel substrates using a drawdown bar at 8-mil thickness and cured under UV light (380nm, 2 minutes) exposure. The resulting coatings were evaluated for their adhesion, mechanical, and anti-corrosion properties. The results showed good abrasion and corrosion resistance, particularly with samples at 0.3% MXene with the ultrasonication dispersion. The anti-corrosive performance of the coating was evaluated using electrochemical impedance spectroscopy (EIS) and a salt spray test in a 5% NaCl solution. The results of the 14-day salt spray test show that samples with the ultrasonication dispersion method have better corrosion performance. The results indicate that the ultrasonication method effectively disperses MXene nanoparticles in the AESO resin, improving corrosion resistance. This coating design presents a promising approach to sustainable, high-performance protective coatings as an environmentally friendly alternative to traditional anti-corrosion technologies.

Safeguarding the Smart Home: Heterogeneous Federated Deep Learning for Intrusion Defense

MOHAMMED SHALAN
Computer Science
Advisor: Juan Li, Ph.D., Computer Science

The study introduces an advanced federated learning framework tailored for smart home intrusion detection, incorporating knowledge distillation and transfer learning to tackle escalating threats to IoT devices. In light of the rapid expansion of IoT devices and their vulnerability to botnet incursions, our approach specifically addresses the challenges related to the privacy concerns of home device data, heterogeneity of devices, sparse intrusion data, and the dynamic nature of smart home settings. We adaptively select model architectures tailored to the computational capabilities of each device, ranging from simple Neural Networks (NNs) to more complex Convolutional Neural Networks (CNNs) and hybrid CNN-LSTM models, ensuring efficient local training without overburdening the devices. However, it can achieve good performance through collaborative learning, even for devices with lower capacity and sparse data. Our evaluation, conducted using the N-BaIoT dataset, demonstrates the effectiveness of our approach in detecting anomalies across a diverse set of IoT devices infected with real-world botnets such as Mirai and BASHLITE. The results highlight the potential of our framework to provide a robust, privacy-preserving, and adaptable solution for securing smart homes against emerging threats.

Influence of Grazing Management on Degraded Riparian Ecosystems in Southeastern North Dakota

JOHN STABLES
Natural Resource Sciences
Advisor: Miranda Meehan, Ph.D., Animal Sciences

For well over a century, livestock managers have used riparian areas for their goods and services. Due to overuse, many riparian systems began to degrade, leading to the exclusion of cattle from riparian areas. However, studies have shown that livestock can utilize riparian areas under certain grazing conditions without exasperating degraded conditions. The goal of this study was to evaluate the influence of grazing management on the stability of intermittent streams. Three grazing treatments: Rest Rotational Grazing (RR), High Intensity-Short Duration Grazing (HISD), and Grazing Exclusion (GE), were implemented to identify the impact of management practices on riparian areas. Treatments were implemented along 13 stream reaches in southeastern North Dakota: Iron Spring Creek, Evanson Creek, and Bird Creek. Stream stability was assessed using the Rosgen Stream Classification System. Additionally, the extent of riparian features, including stream edge, floodplain, and flood-prone area, were mapped using a global positioning system. The line point intercept method was used to evaluate the greenline plant community. These assessments have been conducted annually since 2020 to assess the long-term effects of grazing treatments on geomorphic characteristics and the riparian plant community. Initial comparisons of the 2020 and 2024 stream morphology data have not revealed a significant difference between treatments over time. However, the data shows a trend related to an increase in flood prone areas and a widening of the width/depth ratio, as well as a decreasing trend in the entrenchment ratio across all treatments. An Indicator Species Analysis (ISA) of the plant community data identified significant indicators for each treatment. With *Calamagrostis stricta* and *Schoenoplectus pungens* serving as indicators of the GE, *Carex pellita* for the RR, and *Trifolium pratense* as an indicator of the HISD. The lack of significant differences in stream morphology between treatments, combined with the general trend of widening in the riparian area, along with the presence of a riparian obligate indicator (I) in the rest rotational treatment, indicate that grazing livestock in riparian areas in accordance with the treatments tested may have no significant impact on the stability of the stream channel or riparian plant communities.

Effects of tempering on functionality and pasta quality – Stone Milling vs Roller Milling

AISHWARYA SURESH
Cereal Science
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Durum flour is primarily used in pasta production. Stone milling is a traditional method of grinding wheat that preserves the grain's nutrients and flavors by maintaining the proportions of the bran, germ, and endosperm. In contrast, the modern roller milling removes the bran and germ and grinds the endosperm into a refined flour. Whole wheat flour (WWF) particles can vary in size. Large particles containing bran and germ are known to adversely affect the texture, color, cooking behavior, and overall quality of pasta. WWF can be sieved to remove large particles of bran, germ, and endosperm resulting in a semi-refined wheat flour (SRF). This study aimed to evaluate the effects of grain tempering (12, 14, and 16% moisture) on the functionality, and pasta quality of SRF and WWF produced via stone milling, compared to roller-milled refined flour. Durum wheat was tempered for 24 hours. The resulting flours were analyzed for protein, starch damage, solvent retention capacity (SRC), pasta color, density, and cooking loss. Protein content was higher in stone-milled flours compared to roller-milled semolina, with minimal variation across tempering levels. Starch damage and water SRC decreased with higher tempering moisture. Pasta made from SRF exhibited reduced cooking loss with increased tempering, whereas WWF pasta showed

the opposite trend. Pasta color varied significantly by milling type and flour composition. Roller-milled semolina yielded the brightest and most yellow pasta, characteristic of high-quality products. SRF pasta had lower brightness and yellowness, though increasing hydration improved brightness significantly. Higher tempering moisture improved pasta density and mechanical strength in SRF pasta. However, WWF pasta had significantly lower mechanical strength, with WWF with 16% moisture showing the lowest density and strength. These findings indicate that grain tempering and stone milling can be used to modify the quality, and functionality of durum wheat flour. Compared to roller milling, stone milling with optimized tempering conditions presents advantages in producing high-quality semi-refined durum flour for pasta applications.

Home Environment and Digital Technology Adoption Among Older Adults: A Qualitative Study

YUFANG TU
Developmental Science
Advisor: Melissa O'Connor, Ph.D., Human Development and Family Science

Digital technology (DT) is crucial for connecting people across age groups, including older adults, enhancing their quality of life, independence, and ability to age in place. While previous research has explored factors influencing older adults' adoption of DT, limited attention has been given to how the home environment impacts DT use. The current qualitative study examines the role of the home environment in supporting or limiting DT use, specifically focusing on computers and/or cellphones, among community-dwelling older adults. Through semi-structured interviews with eight participants (primarily from North Dakota), this study explored perceptions of home environments and their impact on DT use. Using a non-probability snowball sampling method and qualitative thematic analysis, the study identified key environmental factors facilitating and hindering DT adoption. Findings reveal that comfortable workspaces, convenient outlet setups, and quiet, distraction-free areas contribute to cognitive and psychological benefits for focused productivity. Communal spaces and reliable support systems also facilitate DT adoption, while assistive tools and adaptations (e.g., functional glasses, larger screens, reminders) help address age-related vision and cognitive challenges. Cord organization and accessible workspaces help prevent falls and injuries. While some participants discussed generational differences and technology fears, others showed shifts toward embracing DT in daily life. Most expressed satisfaction with their current home setups and recommended improvements like ergonomic furniture and workspace design. Many also demonstrated autonomy in adapting their homes to meet their needs, showing openness to technology-integrated smart homes. These results highlight the importance of universal design in promoting DT usage among older adults, offering insights for future research, policy, and practice in aging, environmental design, and DT adoption. Prioritizing accessibility and usability in home environments can help older adults integrate DT into their daily lives, enhance well-being, and support healthy aging.

Correctional Workers and PTSD The Impact of Trauma, Organizational Stress, and Role Differences

SHANNA URBAN
Criminal Justice
Advisor: Amy Stichman, Ph.D., Criminal Justice

Correctional staff, particularly uniformed personnel, face heightened PTSD risks due to trauma exposure and chronic stress. This study examines PTSD prevalence and symptom severity among uniformed and non-uniformed correctional workers, analyzing the impact of lifetime trauma exposure, correction-specific traumatic events, organizational cynicism, and commitment. Survey data from a medium-security male prison indicate that PTSD is more prevalent among uniformed staff, but lifetime trauma exposure is the strongest predictor of symptom severity for both groups. Organizational cynicism appears to buffer against PTSD symptoms, while strong organizational commitment may increase vulnerability among uniformed staff. These findings highlight the need for trauma-informed workplace policies, targeted mental health interventions, and role-specific support systems to enhance correctional staff well-being.

AI-Driven Analysis of NADES to Predict Glass Transition Temperatures

DURBEK USMANOV
Materials and Nanotechnology
Advisor: Bakhtiyor Rasulev, Ph.D., Coatings and Polymeric Materials

The glass transition temperature (Tg) of NADES is a critical thermo-physical property, but its experimental determination can sometimes be challenging. In this study, a dataset comprising 263 NADES with Tg values was compiled from experimental research. Various machine learning (ML) models were developed, with the Random Forest model demonstrating the best performance, achieving R^2 values of 0.95 and 0.86 for the training and test sets, respectively. Analysis of feature importance revealed that distance matrix-based polarizability effect indices play a significant role in positively influencing Tg values. In this study, we aimed to expand the chemical space by assembling a medium-sized dataset of 263 NADES with glass transition temperature (Tg) values, compiled from experimental research. We explored the structure-property relationships within the dataset by applying various QSAR/QSPR approaches to develop computational tools for accurately predicting Tg from molecular structures. Several machine learning (ML) models were trained, including Random Forest, Gradient Boosting, k-Nearest Neighbors, XGBoost, LightGBM and CatBoost, all of which demonstrated adequate performance with R^2 values above 0.65 and RMSE below 0.09 in the training set. Among them, the Random Forest (RF) model exhibited the best performance, achieving R^2 values of 0.95 and 0.86 for the training and test sets, respectively. SHAP analysis identified distance matrix-based polarizability effect indices as key descriptors that positively contribute to Tg values. Further insights from the SHAP method confirmed that molecular descriptors related to polarizability effect play a significant role in predicting Tg, aligning with the model's interpretability analysis. This research was supported by the Defense Advanced Research Projects Agency (DARPA) Award "Ice Control Enhancement with Closed Loop Molecular Design (ICECycle)" No.HR001122S0047-ICE-FP-004 and by the NSF-MRI award No. OAC-2019077. Authors thank the Materials and Nanotechnology (MNT) program (NDSU) for the financial support of the D.U. in the form of the graduate research assistantship. Supercomputing support (HPC system Thunder Prime) from the CCAST at NDSU is acknowledged.

BPD: Borderline or Bipolar? An evaluation of the similarities and differences.

EMILY VIEWEG
Sociology
Advisor: Christina Weber, Ph.D., Sociology

Even though Bipolar Disorders and Borderline Personality Disorder (BPD) are in completely separate classifications in the Diagnostic and Statistical Manual of Mental Disorders (DSM), researchers have sought to understand the similarities between these disorders and comorbid disorders (Paris). If these two disorders share multiple comorbid characteristics, could BPD be closely related to Bipolar? What about treatment and management strategies? Could similar treatment plans help both disorders? (MacDonald). "Bipolar and Related Disorders" is a complete section in the DSM-V. This paper will focus on comparing Bipolar I with BPD.

A Patient-Centered Approach to 3D In Vitro ECM Modeling of Pancreatic Ductal Adenocarcinoma

JADE VIPOND COTTER
Biological Sciences
Advisor: Katie Reindl, Ph.D., Biological Sciences

Matrigel® is the most commonly used commercial hydrogel product for developing and testing 3-D in vitro pancreatic ductal adenocarcinoma (PDAC) models; however, its composition is not reflective of the extracellular matrix (ECM) content of most PDAC tumors. To remedy this pitfall, we have developed a novel approach for generating 3D tumor organoids grown in customized hydrogels that better reflect their original tumor tissue. Using surgically resected original patient tissue, we measured the relative area covered by the major ECM constituents in PDAC: collagens I, III, IV, and laminin via immunohistochemistry. The average expression of these ECM components across patient tissue was then used to generate a broadly representative hydrogel for in vitro organoid proliferation experiments. Custom hydrogel organoids were monitored for size and rate of proliferation in comparison to Matrigel® and cells cultured without use of any hydrogel. We anticipate organoids grown in these custom hydrogels will demonstrate a greater likelihood of successful model development and exhibit a rate of growth and size substantially different than those grown in Matrigel®. These results provide preliminary evidence that the composition of the hydrogel used to generate 3D in vitro models may have an impact on their phenotypic expression. Further development and characterization of these models could result in better reflection of in vivo conditions critical to evaluation of new therapies.

Sex-dependent Protective Effects of Alamandine in Cardiac Aging.

REDEMPTOR ZHOU
Pharmaceutical Sciences
Advisor: Natasha Fillmore, Ph.D., School of Pharmacy

Introduction: The renin-angiotensin system (RAS) is critical in regulating cardiac function and also in the pathogenesis of cardiac disease. Alamandine (Ala), a member of the non-classical RAS is produced from the catalytic hydrolysis of Angiotensin A by ACE2 or by the decarboxylation of Angiotensin 1-7. Previous studies showed that Alamandine, a ligand of the Mas-related G-protein coupled receptors member D (MrgD), is cardioprotective. D-pro-(Angiotensin 1-7) [D-Pro] is a Mas receptor and MrgD antagonist. In this study we investigated whether Alamandine is protective in the aging heart. Method: Mice aged 2-3 months (Young) or 22–23 months (Old) were treated with a vehicle (saline), Alamandine (1 ug/Kg/min, s.c), or D-pro (1 g/Kg/min, s.c) for 4 weeks. At the end of treatment, echocardiography was performed before cardiac tissue was collected and probed for protein expression. Results: MrgD had a higher expression in young vs. old females, and no difference was noted in MrgD expression in young vs. old males. Interestingly, Alamandine increased MrgD expression in males while no significant change in females. An age-dependent decline in systolic function and worsened cardiac hypertrophy was observed in the females, and this was attenuated by Alamandine. However, while there was an age-dependent increase in cardiac hypertrophy, systolic function did not differ between young and old male mice. Interestingly, Alamandine exacerbated age-dependent cardiac hypertrophy in males. Conclusion: Our data suggests that in aging, the beneficial effects of Alamandine are sex-dependent. Additionally, if MrgD activity is not tightly regulated, cardiac function in the aged is impaired.

ORAL PRESENTATIONS

Energy Transfer Dynamics and Coupling Effects in Vibrational Polaritons

PATRICIA ADEOYE
Chemistry
Advisor: Dmitri KIlin, Ph.D., Chemistry and Biochemistry

Our research focuses on how coupling strength governs energy transfer dynamics in vibrational polaritons, a hybrid quasiparticle emerging from the strong interaction between molecular vibrations and the electromagnetic field inside an optical cavity. By comparing a semiclassical model implemented via VASP simulations with a fully quantized treatment performed in Python, we confirm that both approaches yield analogous trends in polariton resonance frequencies, the increase in the number of beats as coupling intensifies, and Rabi splitting. Such a dual-perspective analysis is pivotal: it ensures that our observations stem from genuine physical phenomena rather than artifacts of a single computational strategy, thereby enhancing the credibility and robustness of our conclusions. Using hydrogen fluoride (H–F) as a model system, we demonstrate that increasing the coupling strength intensifies energy transfer rates by directly altering the molecular geometry through photon-driven modifications. This mechanism offers an avenue for manipulating reaction pathways, accelerating energy flow, and finely tuning molecular behaviors at the quantum scale. Furthermore, our results show that heightened coupling strength lifts degeneracies in the molecular energy landscape, enabling precise control over photon–matter interactions and opening pathways toward the rational design of quantum systems with engineered characteristics. Despite their differing assumptions and computational complexities, both the semiclassical and fully quantized models display qualitative alignment: they predict similar resonance frequencies, show a consistent increase in Rabi splitting as coupling strengthens. However, the fully quantized model is more sensitive to subtle quantum effects, including the nuanced breaking of degeneracies, showcasing the value of a complementary modeling

approach that provides thorough validation and deeper insight into the underlying physics. These findings provide a framework for understanding how coupling strength shapes vibrational polariton dynamics, guiding the deliberate engineering of advanced quantum architectures, informing molecular design, and propelling progress in cavity-modified chemistry and next generation photonic devices.

Examining Access and Gaps in Folic Acid Usage Among Pregnant Women in North Dakota

EDWIN AKOMANING
Public Health
Advisor: Pamela Jo Johnson, Ph.D., Public Health

Background: Neural Tube Defects (NTDs) occur in about 3,000 pregnancies yearly in the United States, contributing to infant mortality in the first year of life. In early pregnancy, 400mcg of folic acid reduces the risk of NTDs by 50–70%. North Dakota (ND) has limited data on factors associated with folic acid consumption among pregnant women. This study aims to fill this gap by examining the factors associated with folic acid use among pregnant women in North Dakota. Methods: We analyzed data from the ND PRAMS from 2017 to 2022. We computed factor-specific prevalence and confidence intervals (95% CI) of potential predictors. Logistic models were used to investigate and identify predictors of folic acid non-utilization. Results: About 53.9% of the mothers did not report using folic acid. The majority of these women were ≤30 years (61.10%), American Indian/Alaska Native (AI/AN)(75.80%), ≤ 12-grade education (70.60%), Medicaid eligible (73%), from the rural residential areas (57.10%), unmarried (73.80%), had unintended pregnancies (69.10%) and had no pre-pregnancy talk on folic acid use (59.50%). Four significant (p-value: 0.05) risk factors were identified for folic acid utilization among women in ND. Individuals who had pre-pregnancy talks on folic acid had almost four times increased usage of folic acid (aOR = 3.9; $p < 0.001$) compared to those who did not have pre-pregnancy talks. Women who had intended pregnancy were twice as likely to use folic acid compared to those who had an unintended pregnancy. (aOR= 2.4; p =0.009). Women who had diabetes three months before pregnancy had a 70% reduction in folic acid intake compared to those who did not (aOR=0.3; p =0.015). Women who smoked three months before pregnancy were half as likely not to take folic acid (aOR=0.5; p =0.007). Conclusion: Targeted interventions to populations at high risk of folic acid non-use to reduce inequalities in folic acid utilization remain important in increasing folic acid utilization.

Development and validation of Physical and Simulink Model of a Car Inertia Engine Dyno Testbed

FATEMA AKTER
Agricultural and Biosystems Engineering
Advisor: Sulaymon Eshkabilov, Ph.D., Agricultural and Biosystems Engineering

It is critically important to evaluate and optimize the performance of vehicle engines to enhance the fuel efficiency, reduce the emission, improve reliability and upgrade overall vehicle dynamics according to different types of requirements. In automotive engineering, some major challenges are identifying problems like power loss or inefficient fuel consumption, emission testing, durability testing, troubleshooting and fine tuning of engine setup. This research addresses an inertia engine dynamometer(dyno) testbed which helps to solve these issues for remote control car engines. The objective is to develop a physical testbed which involves designing and constructing an inertia engine dyno testbed which is used to gather data of a Nitro engine performance and also model the testbed in Simulink under similar parameters. As the model mimics the physical testbed's behavior, it allows to assess the accuracy and validity by directly comparing between simulated and measured results. The final outcome is a fully operational testbed and a simulation tool that can be used for the future performance analysis and optimization of .21 to .28 cc nitro engines. The significance of this research is the integration of physical testing with simulation techniques, which provides a cost effective and scalable method for engine performance analysis.

Modeling Crystallization in Concentrated Suspensions of Compressible Microgels

OREOLUWA ALADE
Physics
Advisor: Alan Denton, Ph.D., Physics

Microgels are soft colloidal particles, made of crosslinked polymer gels. Their ability to swell by absorbing solvent makes them responsive to changes in temperature and concentration, enabling applications, e.g., to drug delivery and photonic crystals. In concentrated suspensions, mutual crowding can cause microgels to deswell, facet, and interpenetrate [1], which can influence thermodynamic properties. To explore the influence of particle softness on phase behavior, we adapt a coarse-grained model, based on the Hertz elastic pair potential and the Flory-Rehner theory of polymer networks [2]. In our model, faceting reduces the swelling volume, while interpenetration costs polymer-solvent mixing entropy. By performing Monte Carlo simulations with trial changes in particle size [2], we compute liquid-solid and solid-solid phase boundaries over a range of microgel crosslink fractions. In contrast to the phase behavior of incompressible Hertzian spheres [3], we find that compressible microgels crystallize at significantly lower volume fractions, when accounting for deswelling, faceting, and interpenetration. Our results may help to interpret experiments on microgel phase behavior [4]. [1] F. Scheffold, Nat. Commun. 11, 4315 (2020). [2] M. Urich and A. R. Denton, Soft Matter 12, 9086 (2016). [3] J. C. Pàmies et al., J. Chem. Phys. 131, 044514 (2009). [4] M. Pelaez-Fernandez et al., PRL 114, 098303 (2015). Supported by National Science Foundation (DMR-1928073).

Reinterpreting Fanny Kelly's Live

NASIH ALAM
History
Advisor: Donald Johnson, Ph.D., History

The presenter will reinterpret Fanny Kelly's life with the theme of "Captivity Narrative." Historians have not analyzed her life that much. Fanny Kelly, born in Canada but raised in Kansas, sold her home in Kansas and sought greener pastures in Idaho in October 1864. As Fanny, her Black servants, Andy and Franklin, her husband, Mr. Josiah Kelly, and their friends, Mr. Larimer and Sarah Larimer, traveled past the Oglala Trail near Converse County, Wyoming, they did not expect any hostility from the Sioux Indians there. The noncombatant settlers felt so relaxed that one of them sang "Ho! Ho! Idaho," hoping to secure better living conditions in Idaho. Although Mary, Fanny's stepdaughter, Mary secretly feared Native tomahawks and knives,

they had maintained friendly relations. But their hopes soon shattered when they encountered "two hundred and fifty Indians, painted and equipped for war, who uttered a wild war whoop and fired a signal volley of guns and revolvers into the air." Fanny's husband wanted to retaliate, but she urged him not to, fearing for her family's safety and doubting their chances against the Indians. Instead, Mr. Kelly met with Ottawa, a war chief of the Oglala band of the Sioux nation, to discuss options. The Indians took Mr. Kelly's good horse and exchanged it for a weaker one. Fanny accepted "a nice pair, richly embroidered with different color beads" moccasins from "a very pleasant young Indian." However, the peace did not last long. Before her capture, Fanny hid Mary but the Indigenous Peoples killed her. This paper wants to investigate her life as a captive woman to understand her challenges in captivity and perspectives on the Sioux People. The presenter plans to write a PhD dissertation focusing on the marginalized people of the U.S.-Indian Wars from 1862–1865. He will use primary and secondary sources to refurbish the paper and make it one of the chapters of his dissertation that he would begin writing in 2027.

Inducing Biopolymer Folding via Responsive Nanoconfinement

MAHESH ARYAL
Physics
Advisor: Alan Denton, Ph.D., Physics

Controlling the folding of biopolymers in crowded and confined environments (e.g., biological cells) remains a significant challenge. For example, crowding or confinement of proteins can influence transition pathways between folded and unfolded states. In experiments, polymers can be immersed in a solution of crowding agents or in a confined environment. One adaptive, stimuli-responsive medium for confinement can be offered by microgels – microscopic crosslinked polymer networks that swell by absorbing solvent and whose swelling behavior responds to changes in temperature [1]. To explore the influence of confinement on the structure of polymers and the surrounding medium, we model fluctuating conformations by probability distributions of gyration tensor eigenvalues [2] and microgels via the Flory-Rehner theory of polymer networks. Within this coarse-grained model, we perform molecular simulations of polymers in solutions of crowders and microgels and analyze polymer response (size, shape, and folding) to changes in crowder concentration and microgel swelling. Our results can elucidate protein behavior in crowded cellular environments. [1] Routh et al., J. Phys. Chem. B 110, 12721 (2006). [2] W. K. Lim and A. R. Denton, J. Chem. Phys. 141, 114909 (2014); 144, 024904 (2016).

Laying the Groundwork for Restoration: Managing Kentucky Bluegrass and Smooth Brome with Herbicides

ANNIE BAHE
Natural Resource Sciences
Advisor: Shawn DeKeyser, Ph.D., School of Natural Resource Sciences

The introduction of invasive species is a primary driver of grassland ecosystem degradation in the United States, increasing the need for grassland restorations. By displacing native species and decreasing diversity, invasive species pose a serious threat to rangeland restorations and long-term rangeland health. In the northern Great Plains, two of the most prominent invaders in rangelands are Kentucky bluegrass and smooth brome due to their ability to rapidly reproduce and spread. Herbicide may be an effective option to manage these invasive grasses. This study was designed to test whether different herbicide mixes and concentrations control Kentucky bluegrass and smooth brome, while limiting harm to native plants. Six different herbicide treatments were used to treat Kentucky bluegrass and smooth brome within an invaded rangeland in southeastern North Dakota, using a randomized complete block design. Herbicide treatments were applied once in June of 2023 (in spring only plots) and once in September of 2023 (in fall only plots) with an additional pre-emergent herbicide applied at one of three application rates to each treatment. One year after treatment, our results show a decrease in Kentucky bluegrass for three of our treatments where the highest rate of pre-emergent herbicide was added. However, none of our herbicide treatments significantly reduced smooth brome cover for one year after treatment. Further analysis will evaluate the effect these herbicides have on native species cover. Pending further analysis, these herbicides may provide new guidelines for herbicide use in invaded rangelands in the northern Great Plains.

The Characterization of a Riparian Forest on the Missouri River Floodplain

ELISE BAKKE
Natural Resource Sciences
Advisor: Shawn DeKeyser, Ph.D., School of Natural Resource Sciences

Riparian woodlands are some of the most diverse ecosystems on our planet. This diversity stems from their dynamic environment and intimate relationship with rivers and streams. The surrounding fluvial systems deposit nutrients and disperse seeds, while facilitating a wide range of vegetation, from wetland to upland species, creating a mosaic of high biodiversity. Riparian forests provide a multitude of ecosystem services as well, like flood mitigation, water filtration, and bank stability. These areas are becoming increasingly more degraded and fragmented due to altered hydrological systems that affect natural disturbance regimes. This has shifted vegetation composition and allowed invasion of exotic species to take over, preventing tree and understory regeneration. Management needs to be executed so that we can prevent further degradation and loss of riparian forests moving forward. To begin the restoration process, a baseline characterization of the understory plant community is necessary. This allows us to assess the health of the plant communities and dictate what management strategies will be employed moving forward. This characterization will also provide a database to compare back to as management practices take place. To accomplish this, transect surveys were conducted across the entirety of a green ash woodland on the Missouri river floodplain. Along with those, we collected seed bank samples, recorded the amount of dead and downed woody debris, and recorded light readings.

Mesenchymal Stem Cell (MSC) Derived Exosomes Loaded with Antineoplastic Drugs for the Management of Pancreatic Ductal Adenocarcinoma (PDAC).

ANURAG BANERJEE
Pharmaceutical Sciences
Advisor: Buddhadev Layek, Ph.D., School of Pharmacy

Exosomes are a type of extracellular vesicles ranging from 50-200nm in size. Exosomes derived from MSCs are an appealing option for use

as a drug delivery system to transport therapeutic molecules, like proteins, drugs, or nucleic acids; to tumor sites, which could improve the effectiveness and lessen the adverse reactions. PDAC is one of the deadliest diseases affecting the human population, with a 5-year survival rate of around 13%. Our research group used a tangential flow filtration (TFF) system to isolate exosomes from the conditioned cell culture media of MSCs. The yield of the isolated exosomes is significantly higher than the yield of traditional methods involving ultracentrifugation. The characterization of the exosomes was done using TEM imaging, nanoparticle tracking analysis (NTA) analysis and zeta potential. Additionally flow cytometric analysis was done to verify the identity exosomes using markers CD63 and CD81, while CD90 confirmed the isolated exosomes were from MSCs. The protein quantification of the exosome samples was done using BCA assay. The isolated exosomes were loaded with the antineoplastic drug paclitaxel (PTX) by ultrasonication method. The blank exosomes were checked for in-vitro cytocompatibility in different pancreatic cell lines. The IC50 values of free PTX solution and PTX-loaded exosomes were compared using pancreatic cancer cell lines (Panc-1 & BXPC-3). In all cases the IC50 values of PTX-loaded exosomes were found to be lower than free PTX solutions, suggesting the uptake of the exosomes in the pancreatic cancer cells and the subsequent release of the loaded drug. Thus, MSC derived drug loaded exosomes shows immense potential as a drug delivery system and mandates further probing into the research topic.

Resisting Norms Through Blogging: Life Writing and Disability

JAINAB BANU
Rhetoric, Writing and Culture
Advisor: Anastassiya Andrianova, Ph.D., English

My paper explores how blogging serves as a potent form of life writing which challenges societal norms surrounding disability and body image. Drawing from feminist disability theory, I examine personal narratives shared on platforms like The Mighty, focusing on how this digital space enables individuals to articulate embodied experiences of illness and disability. My research highlights the intersection of personal storytelling and activism, illustrating how life writing in the digital age can foster community, reshape identities, and promote social change. Through a close analysis of selected blogs of The Mighty, I argue that blogging not only provides a platform for self-expression but also acts as a form of resistance against ableist ideologies, contributing to a broader understanding of disability and identity.

From Waste to Remedy: Bergamot Byproduct Prevents Obesity-Related Cardiovascular Diseases

MATHEUS BELIN
Pharmaceutical Sciences
Advisor: Jagdish Singh, Ph.D., School of Pharmacy

The hydrophilic portion of bergamot (*Citrus bergamia*) is often discarded but may serve as a valuable byproduct (BB) due to its bioactive compounds, which have potential applications in mitigating oxidative stress and inflammation-related diseases, such as obesity-related cardiovascular diseases (CVD), the leading cause of mortality worldwide. This study aims to evaluate the effects of bergamot byproduct on obesity-related cardiovascular diseases. Wistar rats (n=30) were randomly divided into three groups: control, obese, and obese + BB. A Western diet induced obesity and, subsequently, CVD. BB, diluted in water, was administered daily by gavage (250 mg/kg) for 20 weeks. Body weight and adiposity index were measured. Doppler echocardiography and systolic blood pressure assessments were performed. After euthanasia, the heart tissue was collected for the following analyses: high-performance liquid chromatography to determine the biogenic amine (BA) profile; gas chromatography for the fatty acid (FA) profile; nuclear magnetic resonance (^{1}H-NMR) for metabolomics; inflammatory markers, including interleukin-10 and tumor necrosis factor-alpha; and oxidative stress markers, including malondialdehyde, protein carbonylation, and ferric reducing antioxidant power by spectrophotometry. Data were compared using one-way ANOVA, followed by Tukey's post hoc test or Dunn's method (significance = 5%). Principal component analysis (PCA) was performed. The Western diet led to obesity ($p<0.001$), elevated inflammatory ($p=0.009$) and oxidative markers ($p<0.001$), and the development of CVD ($p<0.001$) in the obese group. BB prevented CVD development in obese animals by inhibiting the increase in inflammatory cytokines ($p=0.008$) and oxidative stress markers ($p<0.001$), as well as modulating heart BA (spermine, spermidine, and putrescine) and FA profiles (decreasing C18:0 while increasing C17:1, C18:3n6, and C20:4n6). Additionally, BB influenced metabolite levels by enhancing carbohydrate and amino acid influx (sucrose, glucose, glucose-6-phosphate, total glucose, isoleucine, leucine, threonine, and histidine) and increasing cardioprotective metabolite concentrations (uridine, glycerol, inosine, hypoxanthine, malate, and malonate). PCA effectively distinguished the three groups. We conclude that bergamot byproduct prevents obesity-related cardiovascular disease by inhibiting cardiac inflammation and oxidative stress and by modulating the cardiac biogenic amine profile, fatty acid profile, and metabolite levels. These findings suggest that BB could be a promising natural strategy for preventing obesity-associated CVD, warranting further clinical investigation.

How Agricultural Education Teachers Utilize Artificial Intelligence to Improve Student Learning

TY CASEY
Education
Advisor: Adam Marx, Ph.D., School of Education

In recent years artificial intelligence (AI) has rapidly advanced in its abilities and provided tools for a wide variety of sectors. AI is an ever-evolving tool transforming different industries including agriculture and education. Agricultural Education teachers have their time pulled from the many facets of the job, so we are aiming to provide relief and time back to these teachers. The intent of this phenomenological study was to explore school based agricultural education (SBAE) teachers' uses of and experiences with AI tools in their teaching. We sought to understand how SBAE teachers are incorporating this new technology in their teaching. Through analyzing our two sets of data, one being a qualitative questionnaire distributed nationwide with open-response questions about how SBAE teachers utilize AI. And second, being 15-minute semi-structured one-on-one interviews with a sample of teachers. Four themes emerged from each data set. The open-ended questionnaire items included four items' teachers could respond to offer description on their uses of and viewpoints on AI use in agricultural education. The semi-structured interviews revealed the thought processes behind teacher's adoption of AI technologies and why they have chosen to utilize them. From

the questionnaire we identified the following themes, efficiency, curriculum development, individualization, and barriers to usage. From the interviews the following themes emerged, curriculum development, individualization, ethical use, and need for professional development. A majority of questionnaire respondents indicated they use AI in their classroom and found many benefits. Further, SBAE teachers need support to be fully able to incorporate how to use AI in their classrooms and are willing to learn more. In the interviews it became clear, curriculum development can be far more streamlined. The process of individualizing student learning to quickly meet IEP needs with high quality materials was a widely expressed use of AI in SBAE classrooms. Teachers should find ways to learn about how AI can support their teaching. Whether in their own research of the technology or by finding a training to attend. Schools need to provide opportunities for professional development about how to teach with AI tools. In addition to developing user ethics, including students.

Helical Blood Flow Dynamics: Transition to Turbulence and Implications for Vascular Health

SIFAT KARIM CHOWDHURY
Mechanical Engineering
Advisor: Yan Zhang, Ph.D., Mechanical Engineering

Helical blood flow, a natural swirling motion of blood, plays a crucial role in circulation. It occurs in the heart, major arteries, vessel branches, the umbilical cord, and the respiratory system. This spiral movement helps to improve blood flow, enhances oxygen delivery to tissues, reduces harmful stress on vessel walls, and conserves energy. Despite its importance, the mechanics of helical blood flow are not fully understood. To explore this, an experimental setup was developed to study how laminar, helical blood flow transitions to turbulence under various conditions. A closed-loop system, equipped with a pulsatile flow generator and a steady pump, generated sinusoidal waveforms with adjustable frequencies and amplitudes. Five different helical tube models, designed with varying curvature radius and torsion but maintaining a consistent inner diameter, were used to simulate physiological conditions. High-frequency pressure transducers, ultrasonic flow sensors, and advanced flow diagnosis methods like digital imaging and Laser Doppler Velocimetry (LDV) were used to visualize flow fields and measure turbulence kinetic energy. The results demonstrated that helical tube geometry plays a crucial role in determining when blood flow transitions from laminar to chaotic. Specifically, increasing the curvature of the tube delayed the onset of turbulence, allowing blood to flow more smoothly at higher speeds. In contrast, greater torsion led to earlier turbulence, increasing fluctuations in blood velocity. Additionally, measurements of turbulence kinetic energy showed that specific helical configurations help distribute energy more efficiently, reducing potentially harmful stress on blood vessels. These insights provide a deeper understanding of helical blood flow and could guide the development of medical devices such as vascular grafts and stents, improve diagnostic imaging techniques, and inform treatments for circulatory disorders.

Achieving Diverse Avian Nesting Requirements with Heterogeneity-based Grazing

JUSTIN CLARKE
Natural Resource Sciences
Advisor: Torre Hovick, Ph.D., School of Natural Resource Sciences

Traditional grazing management uniformly utilizes forage, reducing variation in vegetation structure and composition. This decreases niche diversity and contributes to grassland bird declines. Patch-burn grazing restores heterogeneity but remains logically challenging to implement, warranting investigation into alternative methods to promote heterogeneity. In 2018, we established a modified twice-over rest-rotation grazing system to create heterogeneity using variable grazing periods based on percent utilization: heavy (60+%), full (40-60%), moderate (20-40%) and rested (0%). Our objectives included quantifying vegetation structure, nest survival, and nest densities among grazing intensities. We sampled vegetation structure within each paddock and used rope dragging and nest monitoring to determine nest fate. Nest site vegetation surveys were conducted on the fledge date or expected fledge date for successful and failed nests, respectively. We found that modifying grazing intensity within a pasture created heterogeneous litter depth, but changes in vegetation density were less consistent. Gadwall was the only species where nest survival was impacted by grazing practice. Litter cover reduced nest survival for Brewer's Blackbird, Northern Pintail, and Mallard. Blue-winged Teal and Northern Pintail showed increased nest survival with taller and denser vegetation, respectively. Finally, Clay-colored Sparrow nest survival was lower with higher bare ground cover and higher with deeper litter. Clay-colored Sparrow, Northern Pintail, and Gadwall nesting densities were lowest in the rested and heavy paddocks. Responses to grazing-induced changes in vegetation structure were species-specific, underlining the importance of heterogeneity to achieve diverse avian communities. The modified twice-over rest-rotation grazing practice offers a promising solution to incorporating conservation into working landscapes.

Water Transport Mechanisms in Commercially Available Bio-Based Polymer Films

AYDA DADRAS
Coatings and Polymeric Materials
Advisor: Andriy Voronov, Ph.D., Coatings and Polymeric Materials

Polymer materials, widely used in various applications such as food packaging, have seen a rise in usage due to their versatility, lightweight nature, and cost-effectiveness. Bio-based and biodegradable polymers, such as poly (lactic acid) (PLA), poly (butylene succinate) (PBS), and poly (3-hydroxybutyric acid-co-3-hydroxyvaleric acid) (PHBV) are derived from renewable resources. They are thought to degrade more quickly than conventional plastics. The independence of these polymers from petroleum resources positions them as excellent alternatives to petroleum-based polymers. However, bio-based and biodegradable materials generally exhibit inferior water barrier properties, mechanical strength, and processability compared to conventional fossil-based plastics. Nevertheless, despite the significant focus on their mechanical performance, research on water barrier properties and its relationship with chemical composition, structure, and morphology is still limited. Water transmission in packaging can lead to food spoilage by affecting its appearance and flavor, making it essential to understand water transport mechanisms in bio-based polymers. The primary objective of this research is to understand the

mechanism of water transport in films made of selected commercial biobased polymer films by relating the moisture adsorption and diffusion, determined via Dynamic Vapor Sorption (DVS) to water vapor permeability assessed by standard desiccant method (ASTM E96) within a controlled humidity chamber. By exploring these parameters, we aim to find a relationship between biobased polymers' water vapor barrier performance and their chemical compositions and physical properties, such as Hansen solubility parameters, crystallinity, and water clustering effect. The latter is caused by hydrogen bonding between water molecules and various polar functionalities in macromolecules. Resulted water clusters diminish the free volume, thus, impacting permeability. Moreover, cluster-promoting additives, such as fatty alcohols, are used to study their impact on the water barrier properties of biopolymers.

Automated SDS-PAGE Band Detection and Protein Classification in Tofu Samples Using Machine Learning

BASANTA DHUNGANA
Genomics, Phenomics & Bioinformatics
Advisor: Changhui Yan, Ph.D., Computer Science

Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) is widely used for protein separation and analysis. However, traditional methods for detecting protein bands rely on manual interpretation, which can be subjective and time-consuming. In this study, we propose an automated approach for band detection and classification in SDS-PAGE images of tofu protein samples. We analyzed 16 SDS-PAGE images, each containing a molecular weight marker at the leftmost and rightmost lanes. Four reference points were marked on each image, followed by segmenting the gel into 100 equal pieces along the vertical axis. Multiple lines were drawn at the top and bottom of the gel for precise alignment, and the intensity of each segment was extracted. To enhance band detection, we applied a smoothing window and utilized key parameters such as height threshold, prominence threshold, and distance constraints to identify protein bands automatically. From the detected bands, we calculated the ratio of 7S and 11S protein fractions, which are critical in determining tofu protein quality. Furthermore, we incorporated machine learning techniques by training a Support Vector Machine (SVM) model on the extracted intensity features with associated class labels. The model achieved an 88% accuracy in predicting the class on the validation set. Our approach eliminates the subjectivity of manual band detection, providing a more reliable and automated method for protein analysis. To our knowledge, previous studies have not focused on automatic band detection from SDS-PAGE images. This study not only introduces a robust image-processing pipeline for protein band detection but also integrates machine learning for accurate classification, demonstrating its potential for broader applications in food science and protein analysis.

Human Pose Estimation using Automated Multi-Camera Calibration

ISRAT SHARMIN DOLA
Mechanical Engineering
Advisor: Inbae Jeong, Ph.D., Mechanical Engineering

3D human joint estimation is essential for enabling effective human-robot interaction in construction automation, facilitating precise monitoring of worker movements to enhance safety, ergonomics, and operational efficiency. Vision-based systems utilizing multi-camera setups offer diverse perspectives to address challenges such as occlusions, projection ambiguities, and sensor noise. However, these systems depend heavily on accurate camera calibration to align views and synchronize measurements. Traditional manual calibration methods are time-consuming, labor-intensive, and prone to human error, making them unsuitable for dynamic construction sites where frequent camera repositioning is required due to shifting conditions and tasks. This study proposes a novel framework that leverages external marker detection for real-time, automated camera calibration, eliminating the need for manual intervention. This approach significantly reduces setup time, minimizes errors, and ensures reliable performance in rapidly changing environments. Furthermore, the framework integrates an Extended Kalman Filter (EKF) to fuse 2D joint locations from multiple cameras, effectively handling sensor noise and the nonlinear nature of human motion. By combining marker-based calibration with EKF-based fusion, the proposed framework delivers a robust and automated solution for 3D human joint estimation, enhancing safety, efficiency, and adaptability in construction automation applications.

Interfacially adhesive corrosion protective fluoropolymer coatings modified by soybean extract

MARCEL ROY DOMALANTA
Coatings and Polymeric Materials
Advisor: Eugene Caldona, Ph.D., Coatings and Polymeric Materials

Fluoropolymers are gaining interest from the coating industry thanks to their mechanical integrity, thermal stability, hydrophobicity, and chemical inertness. However, their nonstick nature limits their applications as it often leads to poor film adhesion to various surfaces. While various approaches have been explored to improve fluoropolymer adhesion, their practical application remains restricted due to their complexity, cost, and environmental impact. In recent years, extracts from fruits, leaves, and plants have been used as eco-friendly additives for polymer coatings due to their ready availability, sustainability, low toxicity, and compatibility. Herein, soybean extracts (SEs) were employed as a green additive to enhance both the surface adhesion and corrosion protection of poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) coatings on carbon steel. Results showed that the inclusion of SEs increased the affinity between the fluoropolymer coating and metal surface. This improvement is attributable to the presence of abundant heteroatoms and pi-electrons from isoflavones in SEs and their capability to facilitate interactions at the coating-metal interface. Moreover, the coatings were able to suppress corrosion in 3.5 wt% NaCl solution, peaking an impedance modulus of ~10^8 Ω cm^2 after 7 d of continuous immersion, even at low SE doses. This result was supported by microscopic, spectroscopic, wettability, surface mechanical, thermal stability, cyclic corrosion, and simulation studies. Overall, our strategic approach highlights the beneficial use of SE additives toward formulating cost-effective, sustainable, and high-performance fluoropolymer coatings for a wide range of surface protection applications.

Dendrochronology Applications of Disturbance Ecology in Central North Dakota

MADISON ENGLER
Natural Resource Sciences
Advisor: Joseph Zeleznik, Ph.D., School of Natural Resource Sciences

Dendrochronology, or tree ring analysis, has many applications and can be used to create tree ring chronologies as well as date past ecological events. Specifically, green ash trees can record ecological disturbances in their rings. Knowing when and why these disturbances occur can help resource managers make stewardship decisions on the environment. We sought to create a green ash tree ring width chronology of a forest stand in central North Dakota to determine ring width correlations with environmental factors, as well as determine what ecological disturbances are recorded in the rings. Green ash samples were collected from live and dead trees throughout the stand, and samples were finely sanded and analyzed under a microscope. Samples were then measured and dated visually and/or statistically using the computer program COFECHA. A ring width chronology was constructed dating from 1910 to 2023, which will be compared to other environmental factors such as moisture levels. Ring anomalies indicating disturbance were observed visually, and the ring 1966 appears white in 21 out of the 27 samples collected and serves as a marker year for crossdating samples. Additionally, 21 out of the 27 samples show larger vessels within the latewood of the 1966 ring, suggesting a flood event. Not all samples that displayed a white ring also displayed larger latewood vessels, and vice versa, although most samples showed both. In contrast, green ash trees sampled at a nearby state park outside of the stand did not show either abnormality within the 1966 ring. We hypothesize that the reason for the 1966 ring's white appearance and increases in latewood vessel sizes to be the result of a severe thunderstorm that went through the area in June of that year, with reports of as much as 13 inches of rain accompanied by excessive flooding. This study enhances our understanding of tree responses to ecological disturbances. Further research on this topic will encompass expanding the reach of sample collection to determine if there is other evidence of this white ring phenomenon.

Effects of Safeners on Photodegradation of Herbicide Leftovers Using Simulated Sunlight on Solid Surface

MD ATIK FAYSHAL
Civil Engineering
Advisor: Jiale Xu, Ph.D., Civil, Construction and Environmental Engineering

Herbicide residues in agricultural soils raise concerns for environmental sustainability, crop productivity, and safety. While previous studies have demonstrated that certain safeners, such as benoxacor, enhance the photodegradation of herbicides, the effects of a wide range of safeners on herbicides with residue issues, the mechanisms underlying these interactions, and their behavior under different environmental conditions remain unclear. To address these gaps, we investigated the degradation of nine herbicides and eleven safeners, individually and in mixtures, on quartz surfaces under simulated light and dark conditions. Photodegradation experiments revealed that, except for metolachlor and mesotrione, seven herbicides exhibited slower decay rates ranging from 9×10^{-4} to 1.4×10^{-2} h^{-1} under sunlight and 1×10^{-3} to 2.7×10^{-3} h^{-1} in the dark. Subsequently, clopyralid, one of the most inert herbicides, was selected to assess the effects of 11 different safeners as a 1:0.5 mixture of clopyralid to safeners. Among the tested safeners, all 11 compounds showed positive synergistic effects by enhancing clopyralid degradation by up to approximately five times. Notably, 3.25-, 4.54-, and 4.68-fold increases in the decay rate of clopyralid were observed when mixed with benoxacor, cloquintocet-mexyl, and isoxadifen-ethyl under light conditions. As expected, dark experiments revealed negligible degradation of clopyralid (1×10^{-3} to 2×10^{-3} h^{-1}) in mixtures, although safeners exhibited dominating degradation patterns when tested as mixtures rather than individually. This phenomenon is likely due to synergistic interactions with clopyralid or the production of reactive intermediates. Furthermore, structural correlations indicated that the chemical properties of safeners play a critical role in facilitating indirect photolysis and enhancing mixture stability. These findings underscore the potential for safeners to mitigate herbicide residues in agricultural environments and emphasize the importance of considering safener-herbicide interactions under diverse environmental conditions.

Identifying the Lower Threshold of Efficacy for Hercon® Disrupt® Bio-Beads™ MCH (Patent pending No. 18/521,155), a New Formulation Made with Biodegradable Ingredients, for Protecting Live Trees from the Douglas-fir Beetle

LEWIS GOEHRING
Natural Resource Sciences
Advisor: Darrell Ross, Ph.D., School of Natural Resource Sciences

This study is focused on identifying the lower threshold of efficacy for the new Hercon® Disrupt® Bio-Beads™ formulation of MCH (3-methylcyclohex-2-en-1-one) manufactured by Hercon® and finding the optimal application rate. Optimal application rates are crucial for landowners and resource managers to apply levels that are both economically efficient and efficacious. Prior research demonstrated that MCH, the anti-aggregation pheromone of the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins), is effective in protecting live Douglas-fir trees (*Pseudotsuga menziesii* Mirb. Franco) from infestation by the Douglas-fir beetle. During the first 25 years of operational use, the most common formulation of MCH has been the bubble capsule which is constructed from two small pieces of plastic (about 50 x 75 mm) fused together with a bubble that contains the pheromone. There has been increasing concern about putting plastic into the environment and some resource managers have been retrieving the bubble capsules after the beetle flight period has ended, adding significantly to treatment costs. Disrupt® Bio-Beads™ MCH is the first formulation derived from 100% biodegradable materials. A study conducted in 2024 on the Nez Perce National Forest in southwestern Idaho used a randomized complete block design including four blocks and three treatments. The treatments included:1/3 of the manufacturers recommended application rate, 2/3 of the recommended application rate, and a control. Both lower application rates resulted in statistically lower infestation rates of Douglas-fir host trees compared to the control. These results will allow landowners and resource managers in western North America to protect high-valued trees during Douglas-fir beetle outbreaks using a formulation that is more environmentally sensitive than bubble capsules.

From Polluted Lakes to Fertile Fields: Creating Sustainable Phosphorous Fertilizers

ADITYA GOYAL
Materials and Nanotechnology
Advisor: Achintya Bezbaruah, Ph.D., Civil, Construction and Environmental Engineering

Phosphorus is a critical nutrient for agriculture, yet its mismanagement has led to a global paradox—while excess phosphorus runoff pollutes water bodies, natural phosphorus reserves for farming are rapidly depleting. 34% of U.S. lakes suffer from eutrophication, where excessive phosphorus triggers harmful algal blooms, depleting oxygen and devastating aquatic life. Current phosphorus removal methods are often costly, inefficient, or generate secondary waste. My research provides a sustainable and scalable solution using calcium peroxide nanoparticles to rapidly capture phosphorus from polluted water and repurpose it as fertilizer. These nanoparticles, engineered with high adsorption capacity, act like tiny sponges, binding phosphorus within five minutes. Packaged in reusable mesh bags, they can be deployed in lakes, retrieved easily, and processed for agricultural use. Laboratory experiments confirm that these nanoparticles remove phosphorus faster and more efficiently than conventional treatment methods, offering a cost-effective, non-toxic alternative. The recovered phosphorus can be directly reintegrated into farming, creating a circular economy that links water purification with sustainable agriculture. By transforming a pollutant into a resource, this research not only improves water quality and ecosystem health but also addresses the looming phosphorus shortage. This work paves the way for an innovative, dual-benefit approach to environmental and agricultural sustainability.

The Dynamics of photoexcited Janus semiconductor nanocrystals: a DFT-based calculation

HADASSAH GRIFFIN
Physics
Advisor: Andrei Kryjevski, Ph.D., Physics

Applications of heterostructured nanomaterials, such as Janus semiconductor nanocrystals (NCs), require a quantitative understanding of their photoexcited properties. Here, we study photoexcited state time evolution of a reference PbSe NC and several 1.9 nm Janus NCs made of Cd, Pb, and Se by employing the Boltzmann transport equation (BE), which allows for competition between different relaxation channels such as phonon-mediated carrier thermalization, exciton transfer, and exciton multiplication and recombination. BE collision integrals (CI) are computed using finite-temperature many-body perturbation theory (sometimes called Kadanoff-Baym-Keldysh (KBK) technique) based on density functional theory (DFT) simulations. Exciton effects are included by solving the Bethe-Salpeter equation, with additional simplifying approximations, and incorporating exciton energies and states into the CI. Phonon-mediated relaxation is included by utilizing on-the-fly nonadiabatic coupling data from DFT-based finite-temperature molecular dynamics simulations in the KBK technique. In particular, we calculate internal quantum efficiency (the number of excitons generated from a single absorbed energetic photon) and discuss the formation of charge transfer states in the Janus and uniform systems.

Is it all fixed? Genetic Essentialism and mindset

EMILY HACKERSON
Biological Sciences
Advisor: Jennifer Momsen, Ph.D., Biological Sciences

This study explored undergraduate biology students' beliefs about genetic essentialism, particularly concerning race and gender, and its relationship with mindset. Genetic essentialism is the belief that genes primarily determine traits, sometimes leading to the misconception that social constructs like race and gender are biologically fixed. Prior research often examined these beliefs in isolation, but this study investigated their intersection. Nineteen students at a Midwestern university participated in a Q-sort interview. They sorted 48 statements about genetic essentialism, some adapted to reflect gender rather than race, into a grid reflecting their level of agreement. The statements covered various traits, including physical appearance, mental and physical health, personality, gender, and race. Students also defined "gene" and completed a mindset survey. Analysis revealed three distinct thought profiles. The first profile (5 students) prioritized the role of genes in trait development, though with some reservations regarding personality. The second profile (5 students) demonstrated key aspects of essentialism in the context of both race and gender. The third profile (5 students), composed entirely of first-year students, endorsed essentialism, especially concerning parentage, potentially indicating less biology coursework experience. Surprisingly, no significant link emerged between mindset (fixed or growth) and profile membership. However, further analysis revealed nine statements positively correlated with a growth mindset. Intriguingly, four of these statements endorsed essentialism in race or gender contexts, while the other five related to essentialist beliefs about other traits like ADHD, personality, and disease. This suggests that while a growth mindset might influence views on intelligence, it may not extend to how students perceive other traits, including those tied to social constructs. This research contributes by examining the interconnectedness of essentialist beliefs about race and gender, an area understudied compared to research focusing on these beliefs in isolation. The findings indicate students may essentialize race and gender similarly, distinct from other traits. As the conflation of biological sex and gender becomes increasingly politicized, understanding how students perceive the role of genetics in social constructs becomes crucial for biology education.

Collision-mediated Transfer Kinetics of Cargo among Mobile Nanocarriers

MD FARUK HOSSAIN
Physics
Advisor: Sylvio May, Ph.D., Physics

Micelles, liposomes, microgels, dendrimers, and nanoparticles represent nanocarriers that deliver cargo items–often drug molecules to a target. We calculate the kinetics of collision-mediated transfer of cargo items within ensembles of chemically distinct mobile nanocarriers in the Gaussian regime. To this end, the relevant rate equations for collision-mediated transfer of cargo items are expressed in the continuum limit as a set of Fokker-Planck equations and solved analytically. The solutions fully describe the time evolution of an arbitrary initial distribution of the cargo items among the nanocarriers toward equilibrium. The model analyzes the eigenvalues of a rate matrix, explaining their transition from real values to complex

conjugate pairs. This helps to achieve a complete understanding of the associated physical meaning of these eigenvalues, particularly in cases such as a three-component system (L=3). This model can be generalized to address related problems, including transfer kinetics in a two state reservoir system, spatial variations analogous to diffusion-reaction phenomena, the transport involving the diffusion of cargo directly into the solution, and aggregation of cargo inside carriers.

Nano-Plastics Release from Plastic Food Containers During Microwave Heating

PRATIBHA JHA
Civil Engineering
Advisor: Syeed Iskander, Ph.D., Civil, Construction and Environmental Engineering

The consumption of cooked food sealed in plastic containers is increasing due to the convenience they offer. This study investigates the release of nano-plastics from plastic food containers when exposed to microwave radiation. Ready-to-eat food, commonly microwaved in plastic containers by consumers, was used to analyze contamination by nano-plastics. Containers holding frozen, refrigerated, and room-temperature foods were microwaved at different power settings (100%, 80%, 50%, and 30%) for varying time intervals (5, 6, 7, and 8 minutes) to examine the effects of power and duration on nano-plastic release. Extracting nano-plastics from the food matrix is a complex process, which involved rinsing both the films and the top layer of food with distilled water after microwaving to collect samples for further analysis. The collected samples from both the films and food were first filtered through 1-micrometer filter paper, as the particles of interest were smaller than 1 micrometer. Then, 10 mL of hydrogen peroxide (H_2O_2) was added to all samples for digestion, and the samples were kept in an oven at 50 °C for 12 hours. Once digestion was complete, the samples were transferred into centrifugal tubes for ultracentrifugation, which was carried out at 10,000 rpm and 20 °C. The membrane portion of the tubes was flushed with methanol, and the samples were then transferred to pyrolysis cups, which were kept in an oven at 50°C until evaporation was complete. The cups were subsequently analyzed for the presence of nano-plastics using Pyrolysis-Gas Chromatography-Mass Spectrometry. This study also provides insights into the polymers involved and their potential impact on human health from consuming microwaved food packed in plastic containers.

Characterization of Crack Patterns and Comparative PFAS Sorption in Landfilled Hard and Soft Plastics

MD TANBIR KHAN
Civil Engineering
Advisor: Syeed Md Iskander, Ph.D., Civil, Construction and Environmental Engineering

Plastic waste in landfills undergoes complex degradation processes, leading to changes in surface morphology. This study characterized the crack patterns in 55 hard and 19 soft plastic samples collected from various landfill depths and investigated their comparative sorption of PFAS. Hard plastics, including HDPE, PP, PET, PS, and PVC, exhibited surface cracks classified into line, curve, and network patterns, with crack density increasing with depth. In contrast, soft plastics (LDPE) showed no visible cracks. Two-dimensional spectral analysis further confirmed the absence of cracks in soft plastics. PFAS analysis, following EPA Method 1633, revealed significantly higher PFAS loads in soft plastics (45.9–309.9 μg/kg) than in hard plastics (1.7–16.8 μg/kg). Despite increased roughness and surface area from cracking, hard plastics exhibited lower PFAS sorption due to their rigid, crystalline structure. In contrast, soft plastics absorbed more PFAS due to their amorphous nature, lower crystallinity, and higher free volume. Statistical analysis indicated that crack density had no significant correlation with PFAS sorption, suggesting that additional landfill conditions influence contaminant retention. These findings provide insight into the fate of plastics and PFAS in landfills, emphasizing the role of polymer structure and degradation patterns in environmental contaminant transport.

Detection of Violent Scenes in Cartoon Movies Using a Deep Learning Approach

NOREEN KHAN
Computer Science
Advisor: Changhui Yan, Ph.D., Computer Science

Cartoon movies are a primary source of entertainment for children. However, concerns arise when these movies inadvertently expose children to violent scenes. This paper addresses the challenge of detecting subtle instances of violence within cartoon movies. The main difficulty in this task is the sequential nature of movies, where a sequence of frames must be considered in their given order. Existing methods have not effectively addressed the issue. In this study, we tackled this challenge by employing a sequential model. The research comprises three key steps. Initially, a histogram technique was implemented to select key frames from the video sequences. Subsequently, a Convolutional Neural Network (CNN) was utilized to extract prominent features from these selected key frames. In the third phase, the acquired features were utilized to train a sequential model using sequence-based learning. The model was then refined through transfer learning, using a dataset containing scenes devoid of violence, as well as scenes depicting varying forms of violence, including bloodshed, fights, gunshots, and explosions. A significant contribution of this study is the meticulous categorization of violent scenes into four distinct types, allowing for further investigation into the diverse effects of different violence categories. Furthermore, the study introduces an innovative approach by integrating a dense layer into the sequential model to enhance final classification. The trained model's performance was comprehensively evaluated using metrics such as F1 score, precision, accuracy, and recall. To validate the effectiveness of the proposed model, it was benchmarked against state-of-theart methods. This study presents an innovative deep-learning methodology for the identification of violent scenes in cartoon movies. Its potential applications encompass a wide range, including safeguarding children from inappropriate content.

Floral Frenzy: Reintroducing Wildflowers into North Dakota Grassland Restorations

THEO KNOWLES
Natural Resource Sciences
Advisor: Shawn DeKeyser, Ph.D., School of Natural Resource Sciences

In North Dakota, grassland restoration is an increasingly common strategy to combat the loss of both wildlife habitat and ecosystem services that grasslands historically provided. However, these restorations often lack the plant diversity found in native grasslands they aim to recreate. Native grasslands consist of a balanced mix of

grasses and forbs (wildflowers), yet most restorations are dominated almost entirely by grasses. While grasses provide important ecosystem functions, the scarcity of forbs reduces essential pollinator habitat. Thus, reintroducing forbs into grass-dominated restorations is imperative. However, establishing forbs is challenging, as they are highly susceptible to competition from weedy and invasive species. To address this issue, we are exploring methods of interseeding forb-rich seed mixes in ways that enhance their establishment. This effort has led to the development of a novel approach coined "spike seeding," which incorporates a high density of fast-establishing species within a forb-rich mix to indirectly protect forb establishment by suppressing weed and invasive species competition. Our study tests two spike seeding rates (1X and 2X) across four grassland restoration treatments, all dominated by grasses, to assess how different seeding strategies influence plant community composition. After just one growing season, we observed no significant differences in plant communities across restoration treatments, with similar abundances of seeded forbs, nonsown weeds, and invasive species. Likewise, increasing the spike seeding rate did not impact community composition, forb abundance, or the presence of weeds and invasives. However, doubling the spike seeding rate did lead to a marginal increase in the presence of seeded species. These early results show minimal differences between treatments, however grassland restorations undergo large changes in the plant communities in the first few years. Furthermore, the slight increase in seeded species with the higher spike seeding rate is an encouraging sign, suggesting potential long-term benefits. Understanding how to reintroduce forbs into grassland restorations is crucial, and with more time and monitoring, this study has the potential to provide valuable insights into restoration strategies for improving forb abundance in grass-dominated restorations.

Dual-layered reinforcement: Phytic acid/Polyethylene imine-modified ZnO nanofillers for advanced protective coatings

JAN VINCENT MADAYAG
Coatings and Polymeric Materials
Advisor: Eugene Caldona, Ph.D., Coatings and Polymeric Materials

The corrosion resistance of poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) infused with zinc oxide–phytic acid bilayer (ZnO/PA-BL) was investigated to evaluate its effectiveness in protecting mild steel in a 3.5% NaCl solution. This study explores various concentrations (2%, 4%, and 6%) of ZnO/PA-BL that were incorporated into the PVDF-HFP matrix to assess its structural, mechanical, and electrochemical properties. Corrosion protection performance was evaluated using open circuit potential (OCP), electrochemical impedance spectroscopy (EIS), and potentiodynamic polarization (PDP). To gain deeper insight into the coating morphology and interactions, surface characteristics were analyzed through scanning electron microscopy (SEM), atomic force microscopy (AFM), Kelvin probe force microscopy (KPFM), wettability, surface free energy, and spectroscopic techniques like X-ray photoelectron spectroscopy (XPS). Additionally, a machine learning approach was employed to determine optimized formulation by analyzing datasets and identifying patterns. The results demonstrate improved corrosion resistance with increasing ZnO/PA-BL loading, demonstrating its protective efficiency. Mechanical tests showed that hardness, flexibility, adhesion, and impact strength improved with filler content. While tensile strength increased with ZnO/PA-BL concentration, pristine PVDF-HFP exhibited superior stress performance. Overall, the results suggest that ZnO/PA-BL modified PVDF-HFP coatings offer a promising solution for corrosion protection in marine environments where prolonged exposure demands high-performance protective coatings.

VirusT5: Harnessing Large Language Models to Predicting SARS-CoV-2 Evolution

VISHWAJEET MARATHE
Computer Science
Advisor: Changhui Yan Yan, Ph.D., Computer Science

During a virus's evolution, various regions of the genome are subjected to distinct levels of functional constraints. Combined with factors like codon bias and DNA repair efficiency, these constraints contribute to unique mutation patterns within the genome or a specific gene. In this project, we harnessed the power of Large Language Models (LLMs) to predict the evolution of SARS-CoV-2. By treating the mutation process from one generation to the next as a translation task, we trained a transformer model, called VirusT5, to capture the mutation patterns underlying SARS-CoV-2's evolution. We evaluated the VirusT5's ability to detect these mutation patterns including its ability to identify mutation hotspots and explored the potential of using VirusT5 to predict future virus strains. Our findings demonstrate the feasibility of using a large language model to model viral evolution as a translation process. This study establishes the groundbreaking concept of "mutation-as- translation," paving the way for new methodologies and tools in combating viral threats.

Nitrogen and Plant Competition: Exploring Native-Invasive Species Interactions in a Greenhouse

GOPAL MARWAHA
Natural Resource Sciences
Advisor: Rakhi Palit, Ph.D., School of Natural Resource Sciences

The grasslands of the Northern Great Plains are among the world's most threatened ecosystems, facing degradation due to plant invasions, climate change, and human disturbances. Invasive species like Kentucky bluegrass and smooth brome reduce native prairie biodiversity and disrupt ecosystem functions. Protecting the Great Plains requires conserving and restoring native prairies through effective management strategies, such as reintroducing competitive native species into invaded rangelands. To better understand how native and invasive species interact, especially under changing conditions like increased nitrogen levels, we conducted a greenhouse experiment. We studied five common rangeland species: Kentucky bluegrass (an invasive grass), common yarrow and black-eyed Susan (native forbs), and western wheatgrass and blue grama (native graminoids). The experiment involved testing all possible pairwise combinations of the selected species to assess both intra- and inter-specific competition dynamics under three levels of nitrogen. By measuring parameters such as above-ground biomass, plant height, leaf count, tiller count, branch production, and chlorophyll content, our results showed that while both native and invasive plants grew more with added nitrogen, the invasive Kentucky bluegrass benefited the most. However, common yarrow proved to be a strong competitor, performing better against Kentucky bluegrass than the other native species. This suggests that including yarrow in restoration seed mixes could be a smart strategy for managing Kentucky bluegrass invasions.

Sustaining Soil, Nourishing Crops: Layer-by-Layer Engineered Nano-Sized Rock Phosphate for Enhanced P Release

SHIRSA MAZUMDAR
Materials and Nanotechnology
Advisor: Achintya Bezbaruah, Ph.D., Civil, Construction and Environmental Engineering

Conventional rock phosphate (RP) fertilizers suffer from low water solubility and inefficient phosphorus (P) utilization, posing both agricultural and environmental challenges. This study addresses these issues by sequentially coating nano-sized rock phosphate (NRP) particles with chitosan (CH) and poly(citric acid) (PCA) using layer-by-layer (LbL) technology to regulate P release. Characterization techniques (FTIR, XPS, SEM) confirmed successful polymer deposition, revealing strong interactions between the coatings and the NRP core. The coated formulations exhibited controlled and sustained P release, outperforming uncoated NRPs in water. CH layers provided structural stability and reduced leaching, while PCA enhanced solubilization through acidic interactions. Kinetic modeling indicated a non-Fickian diffusion mechanism, suggesting multiple release pathways influenced by the alternating CH and PCA layers. Among the tested formulations, CH-PCA bilayer-coated NRP demonstrated the most efficient P release, balancing immediate nutrient availability with prolonged release. These findings establish LbL-coated NRP as a sustainable alternative to conventional phosphorus fertilizers, improving P bioavailability while reducing environmental impact, thus contributing to global food security.

AI Assist in the Workplace: Balancing Reliance and Employee Wellbeing

SALOME MBAH
Communication
Advisor: Wan Wang, Ph.D., Communication

Integrating AI assistants in the workplace has revolutionized how tasks are performed, decisions are made, and productivity is enhanced. This paper explores the dynamic interplay between reliance on AI, employee personality traits, trust, and perception, and their collective impact on workplace wellbeing. As AI tools become increasingly embedded in daily operations, understanding how employees interact with these systems is critical to fostering a positive and productive work environment. Personality traits, such as openness to experience and adaptability, significantly influence how employees perceive and rely on AI assistants. Individuals who view AI as a collaborative partner rather than a replacement are more likely to embrace its benefits, leading to increased efficiency and job satisfaction. Trust plays a pivotal role in this relationship; employees who trust AI systems to perform tasks accurately and ethically are more likely to rely on them, reducing cognitive load and stress. However, trust must be cultivated through transparency, explainability, and consistent performance to avoid skepticism or resistance. Perception of AI also shapes reliance. When employees perceive AI as a tool that enhances their capabilities rather than threatens their roles, they are more likely to engage with it positively. This perception can be reinforced through effective communication, training, and demonstrating how AI complements human skills. Over-reliance on AI, however, poses risks, such as diminished critical thinking and reduced human oversight. Striking a balance is essential to maintain employee agency and creativity. Ultimately, the goal is to highlight the positive effects of AI on wellbeing. When implemented thoughtfully, AI assistants can reduce mundane tasks, minimize burnout, and create opportunities for employees to focus on meaningful, high-value work. By fostering trust, aligning AI use with individual personalities, and shaping positive perceptions, organizations can harness AI's potential to enhance both productivity and employee wellbeing, creating a harmonious and future-ready workplace.

Designing Cu(I) Photo-active Catalysts

MARSHALL MCCORD
Chemistry
Advisor: Svetlana Kilina, Ph.D., Chemistry and Biochemistry

Using Copper(I) for photo-catalytic purposes is prudent because of the availability and low toxicity of the metal. Copper(I) prefers to adopt a tetrahedral orientation when it is used in transition metal complexes. This allows two bidentate ligands to bind to the metal which allows for complicated charge transitions when excited with light. These electronic transitions are what allow these complexes to function as photo-active catalysts, and emit light for extended periods of time before relaxing to a lower energy state. The mechanism that allows this to happen is called intersystem crossing, which involves releasing photons as a way of relaxing to lower energy levels, instead of spreading energy out through vibrations, rotations, and translations. This talk will outline what candidates have proven to be the best for intersystem crossing, and what sort of charge transfer they undergo when excited.

Are you Satisfied?

DAYLE MCGRAW
Criminal Justice
Advisor: Andrew Myer, Ph.D., Criminal Justice

Purpose – The purpose of this project is to examine how job stress and the embodiment of the police culture influence levels of job satisfaction for two mid-sized law enforcement agencies in the Southeastern United States. Design/methodology/approach– A survey was conducted of police officers from two mid-sized law enforcement agencies in the Southeastern United States. Ordinary least squares regression models were utilized to assess the impact of job stress and the embodiment of the police culture on job satisfaction. Findings– Results indicated that officers with higher levels of job stress reported being less satisfied with their careers. Contrary to prior research, officers with a greater embodiment of the police culture were significantly less satisfied. Demographic variables were not statistically noteworthy; however, working on a rotating shift and having more years of service significantly decreased job satisfaction. Research limitations/implications– Survey data collected from two mid-sized police agencies in the Southeastern United States may not be generalizable to other areas or regions. Originality/value– These findings provide practical insights for police agencies to address the operational strains of working in law enforcement and the cultural component embedded in this field. Based on these findings, there is a clear need to increase future work on the interplay between job satisfaction, job stress, and occupational culture.

Role of Dissolved Oxygen in the Photolysis of Organic Micropollutants by KrCl* Excimer Lamp (222 nm)

DAUDA MOHAMMED
Civil Engineering
Advisor: Jiale Xu, Ph.D., Civil, Construction and Environmental Engineering

Far-UVC technologies using KrCl* excimer lamps have emerged as a promising technology for removing organic micropollutants (OMP) in water by advanced oxidation process (AOP) and direct photolysis. Recently, preliminary calculation suggested that dissolved oxygen (DO) absorbed UV light at 222 nm similar to or stronger than OMP at environmentally relevant scenarios. However, it is unclear whether DO plays an important role on OMP photolysis at 222 nm. This study investigated the effect of DO on the photodegradation of five selected OMP compounds including 4-nitrophenol, phenol, diethyltoluamide, sulfadiazine, and nitrobenzene under UV 222 nm irradiation, at three DO concentrations including low (< 1.5 mg/L), medium (~ 4 mg/L), and high DO (> 15 mg/L). High DO concentrations increased the photolysis rate by 3- to 14-fold for all five OMPs, compared with low levels. DO photolysis can potentially form O3 and •OH, leading to indirect photolysis of the OMPs. The relative contribution of •OH and O3 to OMP photodegradation was elucidated using quenching experiments and a probe experiment with cinnamic acid, respectively. Overall, DO affected OMP photolysis at 222 nm, which should not be ignored in future research.

Enhanced Adsorption of Per- and Polyfluoroalkyl Substances (PFAS) by Nanoscale Inorganic Boron-Based Adsorbents

TAJRIN ALOM NIZHUM
Civil Engineering
Advisor: Jiale Xu, Ph.D., Civil, Construction and Environmental Engineering

Per- and polyfluoroalkyl substances (PFAS), commonly referred to as "forever chemicals," are persistent contaminants in drinking water, posing serious health risks due to their toxicity. Among the most effective PFAS removal techniques to parts-per-trillion (ppt) levels are adsorption-based methods, with granular activated carbon (GAC) and ion exchange (IX) resins being the industry standard. However, newly established Maximum Contaminant Levels (MCLs) by the U.S. EPA are expected to increase demand for adsorbents, necessitating the development of more sustainable and cost-effective alternatives. This study evaluates the performance of two inorganic adsorbents—pristine boron and boron-doped silica gel—in the removal of ten PFAS compounds from water. Boron-doped silica gel, synthesized via nanotechnology, exhibited a significantly higher adsorption capacity than pristine boron. At pH 7.0, pristine boron achieved an adsorption capacity of 0.3459 mg/g at 1 g/L dosage, whereas boron-doped silica gel demonstrated a remarkable adsorption capacity of 285.8455 mg/g at 0.5 g/L dosage. For both adsorbents, PFAS adsorption was influenced by molecular structure, with longer-chain PFAS exhibiting higher adsorption than their shorter-chain counterparts. Additionally, PFAS with sulfonic acid head groups were more effectively adsorbed than those with carboxylic acid head groups of the same chain length. These findings highlight the potential of boron-doped silica gel as a highly efficient and sustainable adsorbent, offering a promising alternative to conventional methods for PFAS removal in water treatment applications.

Personalized Vehicle Ergonomics for Aging Drivers: Leveraging Ai and Machine Learning for Enhanced Comfort and Safet

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The integration of advanced ergonomics into automotive design is increasingly vital as the global population ages, necessitating user-centered solutions. This dissertation explores how advanced data analytics, artificial intelligence (AI), and machine learning can create personalized ergonomic solutions for aging vehicle users to enhance comfort, safety, and usability. Traditional ergonomic approaches rely on generalized anthropometric data and manually adjustable features, which often fail to meet the unique needs of older drivers and passengers. Age-related changes, such as reduced flexibility, slower response times, and diminished sensory acuity, require ergonomic adaptations that standard designs cannot adequately provide. This study identifies key ergonomic factors affecting aging populations, including body dimensions, posture, cognitive load, and environmental elements such as noise and vibration. By analyzing these factors, it outlines how aging users interact with vehicle systems and the ergonomic challenges they face. The core focus of this research is the role of data-driven technologies in addressing these challenges. Through literature reviews and analysis of current practices, the study assesses how AI and machine learning can predict ergonomic needs and dynamically adjust vehicle settings in real time. These technologies leverage large datasets on user behavior and preferences to optimize seat positioning, dashboard layout, and climate control, reducing strain and improving usability for older adults. Beyond physical and cognitive ergonomics, this research also examines the impact of environmental and aesthetic factors on user satisfaction. Noise reduction, climate regulation, and visually comfortable interiors play a crucial role in creating an accessible and enjoyable driving experience for aging users. By incorporating these elements, the study presents a holistic approach to vehicle ergonomics. This research contributes to the field by demonstrating AI's potential in ergonomic design and personalization. For industry professionals, it provides practical frameworks for integrating these technologies to meet the needs of aging populations. Ultimately, this dissertation advocates for a user-centered approach to automotive design that enhances safety, comfort, and satisfaction for older drivers and passengers.

Aqueous and Soil Arsenic Bioremediation Using Different Bacterial Cultures

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Arsenic is a naturally occurring carcinogenic metalloid, typically present in two states, As (III) or arsenite and As (V) or arsenate. More than 200 million people in the world are affected by arsenic contamination. People usually suffer from the arsenic contamination either through drinking water or food grown in contaminated soils. This abstract provides an overview of effective remediation strategies using bacteria. Bioavailability of arsenic to plants in water and

soils is strongly influenced by microbial activities. The mechanisms underlying arsenic remediation through biochemical routes, involve oxidation of arsenite, methylation of arsenic, biosorption, bioprecipitation, and bioaccumulation. The significance of the microorganisms in As toxicity amelioration in soil, factors affecting the microbial remediation, interaction of the plants with As resistant bacteria, and the effect of microorganisms on plant arsenic tolerance mechanism are discussed. Further, it includes information about the factors and stimulants that affects and assists microbes in arsenic removal, to be utilized for improvement in microbial remediation. Challenges and future research directions in developing and applying microbes for arsenic remediation are addressed, emphasizing the importance of genetic engineering and technological innovation to address this pressing environmental and public health concern.

Reproductive Senescence in the Pollinator, *Megachile rotundata*

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The disposable soma theory posits that organisms allocate limited resources between reproduction, maintenance, and growth, resulting in trade-offs, particularly as they age. In this study, we examined age-related reproductive senescence in *Megachile rotundata*, a solitary bee and important agricultural pollinator. We hypothesized that, similar to social bees, aging females would show declines in foraging behavior and reproductive fitness. Contrary to this hypothesis, we found no evidence of reproductive senescence in *M. rotundata* within the timeframe observed. Instead, older females increased their foraging rate, leading to larger provisions and offspring. We also observed that older bees exhibited improved foraging efficiency, likely due to learning and muscle physiology changes. Our results challenge conventional assumptions about reproductive senescence in solitary bees and suggest that older *M. rotundat*a may contribute to more efficient pollination, with implications for pollinator management. This study provides new insights into the aging process in solitary bees, emphasizing the need for further research into the mechanisms behind age-related behavioral and reproductive changes.

PFAS in Pelagic Sargassum: A Growing Concern for the Mexican Caribbean Coastline

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Global pelagic Sargassum blooms have intensified since 2011, affecting over 30 countries worldwide and raising significant environmental and economic concerns. This study investigates the accumulation and distribution of PFAS in Sargassum, marking the first exploration of PFAS in this seaweed. We analyzed 40 PFAS in Sargassum collected from the Mexican Caribbean coastline and identified ten PFAS, with a total concentration of 3.88±0.19 ng g^{-1} (dry mass basis), where perfluorocarboxylic acids dominated (80.7%) over perfluorosulfonic acids (19.3%). Long-chain PFAS accounted for 57.1% of the total PFAS, with short-chain PFAS making up the remainder. PFAS concentrations varied significantly across Sargassum components, with the highest levels in blades, followed by stems and bladders. The distribution was influenced by surface area, dry mass fraction, and elemental composition. Despite comprising only 10% of total dry mass, bladders exhibited significant adsorption of long-chain PFAS possibly due to their high lipid content and porous structure. Additionally, the bioaccumulation factors (Log BAF) of the measured PFAS in Sargassum significantly increased with the carbon chain length of PFAS. Annual PFAS loading was estimated at 0.51–3.02 kg along the Mexican Caribbean coastline and 34.46–47.21 kg in the Atlantic Sargassum Belt. These findings highlight Sargassum's role as a PFAS vector, complicating its use and disposal while presenting opportunities for pollution mitigation.

Formation of N-Nitrosodimethylamine from Point-of-Use Dechloramination by Catalytic Activated Carbon

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Catalytic activated carbon (CAC) is a class of commercial activated carbon (AC) designed with enhanced dechloramination performance for point-of-use (POU) application. However, it is unclear whether CAC affects the concentration of disinfection byproduct n-nitrosodimethylamine (NDMA) in tap water. In this work, three steps of experiments were conducted to compare CAC and conventional granular AC (GAC) – F400. First, dechloramination kinetics were tested using fresh AC materials after washing three times with deionized water to remove powders. CAC exhibited similar second-order decay rate constants for monochloramine (NH_2Cl) as F400 in the range of 3.07–3.13 × 10-4 L/(g·s). Secondly, to evaluate long-term performance, 1 g/L of AC was spiked with 4.1 mg/L NH_2Cl every 12 hours for 32 rounds in phosphate-buffered DI water at pH 6.8, and NH_2Cl and NDMA concentrations were measured at the end of each 12 hours. For NH_2Cl, the average final concentration in CAC experiments was 0.4 mg/L, half of that (0.8 mg/L) for F400, suggesting CAC indeed achieved enhanced dechloramination in the long run. For NDMA, liquid-liquid extraction and GC/MS analysis were conducted with a detection limit of 125 ng/L. Only after 13 rounds, NDMA concentration higher than detection limit was observed, which further increased by 7 more rounds to a plateau value around 900 ng/L for CAC and 650 ng/L for F400. CAC generated more NDMA than GAC through catalytic dechloramination. Lastly, flow-through experiments at 5 min of EBCT to simulate POU application were conducted using real tap water with an average of 1.4 mg/L NH2Cl and 7.2 ng/L of NDMA. NDMA was analyzed by solid phase extraction at a detection limit of 1.44 ng/L. Effluent NDMA concentration continuously increased for 45 days to 17.2 ng/L for CAC and 10.2 for F400 and sustained this high NDMA level for more than 25 days. Overall, our study suggested a high risk of CACs in generating NDMA at POU application.

Development of an Integrated Airflow and Spectroscopy-based Model Apparatus for Automated Detection and Separation of Red Sunflower Seed Weevil Infested Seeds.

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Sunflower (*Helianthus annuus* L.), one of the world's most important oilseed crops, plays a significant role in global agriculture due to its high oil content and versatility in applications like biodiesel, animal feed, and papermaking. However, sunflower production faces significant challenges from pests, particularly the red sunflower seed weevil (*Smicronyx fulvus*), which causes severe economic losses by damaging seeds during their development. Current methods for assessing seed damage rely on manual inspection, which is time-consuming, labor-intensive, and prone to human error. Therefore, this study seeks to develop an integrated model apparatus combining airflow separation and hyperspectral imaging for automated detection and separation of red sunflower seed weevil-infested seeds. The research methodology involves: (1) Evaluating the aerodynamic properties of healthy and infested sunflower seeds using a vertical air column separation system, (2) design and develop an integrated detection system featuring a FX17e NIR Hyperspectral Camera with built-in conveyor, and (3) implementation of machine learning models for automated classification. Initial results include a detailed design of the integrated model apparatus to visualize the system's operational flow and user interface prototypes for control and monitoring interfaces using SolidWorks and blender 3D design software. The aerodynamic study used four varieties: EE18-undamaged, NF2 with 6% infestation, 404 with 30%, and WRRF-7 with 70% infestation. Preliminary findings show that terminal velocities and drag coefficients varied with moisture content (8-16% d.b.) and infestation levels, providing a basis for differentiating between healthy and infested seeds prior to the application of machine learning models. This innovative approach could greatly enhance post-harvest processing efficiency and address a major pest management challenge for this critical global crop, especially in North America.

Far-UVC (222 nm) Treatment for Enhanced Removal of N-Nitrosamines and 1,4-Dioxane in Wastewater Recycling

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The escalating demand for safe wastewater recycling necessitates advanced treatment methodologies to effectively eliminate carcinogenic contaminants, notably N-nitrosamines and 1,4-dioxane. This study rigorously evaluates the potential of far-UVC irradiation, specifically at 222 nm, as a superior alternative to conventional low-pressure mercury lamps (254 nm) for the degradation of these persistent pollutants. Utilizing both direct photolysis and advanced oxidation processes (AOPs), we sought to quantify the enhanced removal capabilities of far-UVC. In direct photolysis experiments, far-UVC demonstrated a remarkable increase in degradation rates, surpassing those of UV254 by more than tenfold for both nitrosamines and 1,4-dioxane. We observed that the molecular structure of nitrosamines, particularly longer alkyl chains and cyclic configurations, significantly influenced quantum yields, indicating a structure-activity relationship in the degradation process. While AOPs employing NH_2Cl, $NHCl_2$, and H_2O_2 of 0.29 mM yielded only minor improvements about 7% to 25% in N-nitrosodimethylamine (NDMA) removal, the combination of far-UVC and NH_2Cl proved highly effective for 1,4-dioxane removal, achieving a degradation rate of 1.3 cm^2/mJ, substantially exceeding that of UV254. However, the complexity of real water matrices reduced removal efficiencies, highlighting the impact of competing constituents. Despite this challenge, our findings underscore the viability of far-UVC as a sustainable and energy-efficient technology for controlling persistent carcinogenic contaminants in wastewater recycling systems, paving the way for safer and more reliable water reuse.

Adsorption of ethyl ether on silicon supported graphene- the search for a metal-free catalyst

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Chemistry
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The adsorption of ethyl ether (CH_3CH_2–O–CH_2CH_3) on graphene-silicon at ultrahigh vacuum conditions has been studied to understand its potential as a metal-free catalyst. Kinetic experiments (thermal desorption spectroscopy) and spectroscopic analysis, including Auger electron spectroscopy and Raman spectroscopy, were done to examine the interaction of ethyl ether with the graphene surface. Despite that other molecules dissociate, ethyl ether undergoes only molecular adsorption on silicon-supported graphene, with no evidence of dissociative adsorption or catalytic activation. These findings provide insights into the surface chemistry of ethyl ether on graphene-based materials and contribute to the development of graphene surfaces for catalytic applications.

Mapping the Structural Dynamics of IMAs Using Site-Directed Spin Labeling and EPR

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Coatings and Polymeric Materials
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Therapeutic peptides are a promising class of pharmaceutical compounds with the potential for treating various diseases. However, their effectiveness is often limited by physicochemical and biological barriers. In particular, some peptides have poor aqueous solubility, while others are prone to aggregation, affecting their stability and therapeutic performance. A promising strategy to overcome these challenges involves incorporation of peptides into polymeric assemblies made from stimuli-responsive macromolecules. We recently have demonstrated that sensitive to environmental polarity invertible polymeric micellar assemblies (IMAs), act as macromolecular hosts, facilitating the delivery of both small-molecule drugs and functional polypeptides in aqueous environments. Although the structural basis of IMAs has been characterized, there remains a limited understanding of how their local crowding and local polarity change upon loading with large (such as peptides) cargos, or in response to environmental polarity shifts. Additionally,

the precise localization of complex cargo within IMAs upon loading remains unclear. In this work, we utilize Electron Paramagnetic Resonance (EPR) spectroscopy in combination with Site-Directed Spin Labeling (SDSL) to investigate the structural dynamics of IMAs formed from PEG600PTHF650 (synthesized from polyethylene glycol with a molecular weight of 600 g/mol, and polytetrahydrofuran with a molecular weight of 650 g/mol). Specifically, we analyze the effects of incorporating spin-labeled macromolecular cargo synthesized from polyethylene glycol and polycaprolactone, as well as the conformational changes in IMAs induced by shifts in medium polarity from polar to less polar environments.

The Plastic Footprint of Fruit Packaging: Strategies for Minimizing Climate Impacts via Optimizing Packaging Design and Use

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Plastic packaging is unavoidable in the fruit supply chain, yet their footprints remain a concern. Thus, we studied the footprint of plastic fruit packaging, focusing on the effects of packaging type, size, and polymer composition. We used CO_2 content of plastic packaging as a proxy for the plastic footprint, as it reflects the plastics embodied in packaging, providing a consistent metric for assessing environmental impact. Eighteen varieties of fruits in different packaging forms available in U.S. supermarkets, including open stock, bagged, boxed, bottled, and wrapped, were investigated. Smaller packaging led to a higher CO2 content per unit weight than larger packaging, revealing the importance of the packaging-to-product ratio. An exponentially decreasing correlation ($p<0.05$) was observed between the weight of fruits packed and the normalized CO2 content of various boxed and bagged plastic packaging. Highlighting a critical weight breakpoint that significantly influences overall impact, switching from 1–2 kg to 0.1–0.25 kg of fruit per package can raise the plastic footprint by 98%. Among packaging options, open stock bags had the lowest CO2 content (2.28±0.02 g/kg of fruit), though their thin walls often require supplementary check-out bags, potentially tripling the plastic footprint. Boxed packaging had the highest CO2 content, reaching 168.53±41.51 g CO2/kg of fruit, along with polymer contents of 49.39±17.72 g PET/kg, 1.34±0.72 g PE/kg, 0.26±0.11 g PS/kg, and 1.58±0.53 g PVC/kg. These findings underscore the need for mono-material packaging solutions and improved design standards considering the packaging-to-product ratio as a metric to reduce plastic footprint across the fruit supply chain.

Real-Time Estimation of Human Activity Intensity in Indoor Environments

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Accurate real-time estimation of occupant activity intensity is crucial for occupant-centric building management, healthcare monitoring, and other domains that rely on understanding human movement. However, existing methods often depend on intrusive wearable sensors, discrete activity classifications, or extensive training datasets, which compromise their practicality and generalizability. To address these gaps, we propose a novel Activity Intensity Score (AIS) framework that provides a non-intrusive and continuous measure of activity intensity by analyzing video data. The proposed method applies pose estimation to video data to extract body landmarks, which are then used to compute kinematic parameters including angular velocity, angular acceleration, range of motion, peak speed, movement frequency, and rotational energy across defined kinematic chains (e.g., arms, legs, torso). These parameters are then normalized and combined through an optimized weighted summation to produce a continuous activity intensity metric. Experimental validation was conducted with 20 participants performing various activities from low, moderate, and high intensity. Results demonstrated strong correlations between AIS scores and both activity intensity levels (Spearman's $\rho=0.943$, $p<0.001$) and participants' perceived exertion ratings (Pearson's $r=0.923$, $p<0.001$). Statistical comparisons demonstrated that the AIS values effectively discriminate among these three intensity categories (Spearman's $\rho=0.943$) and significant group differences confirmed by ANOVA ($p<0.001$). Moreover, the AIS exhibited a strong correlation (Pearson's $r=0.923$) with self-reported exertion (Borg RPE), indicating consistency with participants' subjective perceptions. This occupant-invariant and domain-independent method could be used for adaptive HVAC control, workplace ergonomics, and any other fields that benefit from a real-time measure of movement intensity.

thank you!

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Thank you for being part of this celebration of student research!

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