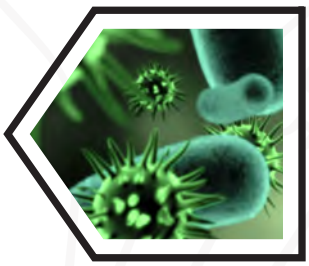
north dakota state university

# ndsu

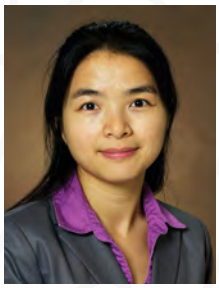
# student research days

2024



welcome

## MESSAGE FROM RESEARCH AND CREATIVE ACTIVITY



Welcome to 2024 NDSU Student Research Days!

We are so excited to have you with us today with 60 groups of undergraduate researchers to share their successes in discovering new knowledges to our community.

At NDSU, we value undergraduate research, and the impacts that the research has brought to the university, our region and the nation. Student Research Days provides a great opportunity for student researchers to communicate these important findings with you and other stakeholders, to learn from their peers and to gather new information that may span more interdisciplinary collaborations. Your participation means a lot to the student researchers, and we appreciate your commitment to excellence in undergraduate research. The Office of Research and Creative Activity is once again excited to continue to support undergraduate research through NDSU EXPLORE.

Thank you for your support of Student Research Days and enjoy the celebrations of student research!

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

## MESSAGE FROM GAMMA SIGMA DELTA

To all members of Gamma Sigma Delta (GSD), GSD competitors, as well as everybody else who presents at or attends NDSU Research Day 2024. GSD was founded in 1913 as the international honor society for agriculture. The NDSU chapter has members from diverse fields within agriculture at faculty, staff, graduate student, and undergraduate student level. We are happy to be a part of NDSU Research Day 2024 with numerous students presenting posters and giving oral presentations. I look forward to seeing all of you and watch our outstanding students compete!

Birgit M. Pruess, Ph.D.
Gamma Sigma Delta, NDSU Chapter President

## MESSAGE FROM THE GRADUATE SCHOOL

On behalf of the NDSU Graduate School, welcome to Student Research Days 2024.

Graduate students are performing exceptional research across the NDSU campus, in the agricultural fields and green houses, in research laboratories, in classrooms, in healthcare settings, in fabrication shops and more. It is our privilege to invite you to learn about their research. The graduate students participating today exhibit excellence and integrity, exemplifying the research mission of NDSU, as they advance toward realizing their scholarly and professional goals.

Be curious, ask them questions. Engage them, learn about their plans to complete their degrees and what they want to pursue after graduation.

Please note in this program book a long list of advisors and mentors who supported the graduate students presenting today. We need to thank them for their dedication to graduate students. Their service in guiding graduate students helps them to develop into the brilliant scholars presenting today and continue to shine after graduation.

We also need to thank the faculty and staff serving as evaluators. Without their service, this event is not possible, and we hope that learning about projects across campus can serve as a return for your dedication.

And, finally, a warm Bison welcome to guests from beyond the campus. Thank you for joining us to learn about research at NDSU and to meet the graduate students who greatly contribute to the research success of the campus.

We hope everyone enjoys exploring the vibrant community of graduate student researchers who have gathered to share their innovative and impactful work with you.

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

and NDSU Graduate School Staff

2024

# schedule

ALL SESSIONS WILL BE HELD IN THE MEMORIAL UNION

## TUESDAY, APRIL 9

EXPLORE (UNDERGRADUATE) SCHEDULE

10 a.m. – noon
Poster Session
Ballroom B

12:15 – 1:30 p.m.
Lunch for students with speaker Matthew Warner, Ph.D.
"How to Apply to Graduate School"
Ballroom A

1:30 – 3 p.m. Oral Presentation Sessions
Hidatsa Room

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

## WEDNESDAY, APRIL 10

GRADUATE STUDENT SCHEDULE

10 a.m. – noon Poster Session
Ballroom B

12:15 – 1:15 p.m.
Lunch
Ballroom A

1:30 – 3 p.m. Oral Presentation Sessions
Various Rooms

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

# undergrad participants

## EXPLORE ORAL PRESENTATIONS:

**AJ Colletti**
Psychology

**Selah Mueller**
Environmental Engineering

**Kathryn Quenette**
Civil Engineering

## EXPLORE POSTER PRESENTATIONS:

**Abuk Akech**
Psychology

**Colten Alme**
Mechanical Engineering

**Kian Ansarinejad**
Computer Science

**Adam Bendewald**
Biochemistry and Molecular Biology

**Jenna Bergantine**
Interior Design

**Abigail Berger**
Biological Sciences

**Bethany Bespoyasny**
RaMP Student

**Melinda Clements**
Interior Design

**Andrea Clarisse Corrales**
Biochemistry

**Regan Delozier**
Biological Sciences

**Kira Eliason**
Environmental Engineering

**Lora Ensign**
Pharmacy

**Kayle Farran**
Interior Design

**Samuel Fernholz**
Exercise Science

**Christy Finck**
Animal Science

**Ava Fremgen**
Biological Sciences

**Savannah Green**
Sport Management

**Joelle Hannam**
Psychology

**Austin Harmsen**
Biochemistry and Molecular Biology

**Trinity Hodorff**
Biological Sciences and Psychology

**Garrett Honzay**
Biochemistry and Molecular Biology

**Stephanie Hubbard-Howard**
Interior Design

**Jenna Huwe**
Medical Laboratory Science

**Sophia Johnson**
Interior Design

**Savanah Klegon**
Biochemistry and Molecular Biology

**Travis Kruse**
Pharmacy

**Amellia Kuhn**
Pharmacy

**Kyla Larson**
Anthropology

**Hieu Le**
Psychology

**Sara Long**
RaMP Student

**Sage Longtin**
RaMP Student

**Carson Markovic**
Microbiology

**Victor Martinez**
Pharmacy

**Michaela Mastrud**
Biological Sciences

**Baylee Miller**
Anthropology

**Isaac Mills**
Biological Sciences

**Kaitlyn Mills**
RaMP Student

**Erin Morris**
Interior Design

**Morgan Niemiller**
Interior Design

**Alyssa Olson**
Respiratory Care / Pre-Med

**Koby Pearson-Bortle**
Biological Sciences

**Jada Persaud**
Psychology

**Ashley Peters**
Civil Engineering

**Shae Pfenning**
Anthropology

**Sophia Portner**
Natural Resource Management

**Kathryn Quenette**
Civil Engineering

**Dilorom Rasuleva**
Biological Sciences

**Katherine Schmidt**
Biological Sciences

**Lindsay Seevers**
Animal Science

**Michelle Stagl**
RaMP Student

**Makenzi Stluka**
Mechanical Engineering

**Jacob Summers**
Biological Sciences

**Katy Takumi**
RaMP Student

**Cheyenne Tandberg**
Biological Sciences

**Curtis Thompson**
Chemistry

**Marissa Tiegen**
Biological Sciences

**Grace Tiffany**
Biochemistry and Molecular Biology

**Alexis Trester**
Biological sciences

**Rachel Trusty**
Biological Sciences

**William Tupa**
Physics and Mathematics

**Sophie Viger**
Mechanical Engineering

**Cady Wang**
Microbiological Sciences

**Joshua Ward**
Biological Sciences and
Business Administration

**Heidi Wehausen**
Biological Sciences

**Kelsey Westrick**
Interior Design

**Madeleine Williams**
Biological Sciences

# undergrad advisors + mentors

## COLLEGE OF AGRICULTURE, FOOD SYSTEMS, AND NATURAL RESOURCES

**Christopher Byrd**
Ph.D., Animal Sciences

**Kendall Swanson**
Ph.D., Animal Sciences

**Barney Geddes**
Ph.D., Microbiological Sciences

**Danielle Condry**
Ph.D., Microbiological Sciences

**Glenn Dorsam**
Ph.D., Microbiological Sciences

**Febina Mathew**
Ph.D., Plant Pathology

**Juan Osorno**
Ph.D., Plant Sciences

**Aaron Ostlund**
M.S., School of Natural Resource Sciences

**Thomas DeSutter**
Ph.D., School of Natural Resource Sciences

## COLLEGE OF ARTS AND SCIENCES

**Angela Hodgson**
Ph.D., Biological Sciences

**Britt Heidinger**
Ph.D.,Biological Sciences

**Jiha Kim**
Ph.D., Biological Sciences

**Katie Reindl**
Ph.D., Biological Sciences

**Kendra Greenlee**
Ph.D., Biological Sciences

**Matthew Smith**
Ph.D., Biological Sciences

**Ned Dochtermann**
Ph.D., Biological Sciences

**Steven Travers**
Ph.D., Biological Sciences

**Timothy Greives**
Ph.D., Biological Sciences

**Dmitri Kilin**
Ph.D., Chemistry and Biochemistry

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

**Hariharaputhiran Subramanian**
Ph.D., Chemistry and Biochemistry

**Kenton Rodgers**
Ph.D.,Chemistry and Biochemistry

**Mukund Sibi**
Ph.D., Chemistry and Biochemistry

**Svetlana Kilina**
Ph.D., Chemistry and Biochemistry

**Bakhtiyor Rasulev**
Ph.D., Coatings and Polymeric Materials

**Eugene Caldona**
Ph.D., Coatings and Polymeric Materials

**Yongki Choi**
Ph.D.,Physics

**Erin Conwell**
Ph.D., Psychology

**Katherine Duggan**
Ph.D., Psychology

**Mark Nawrot**
Ph.D., Psychology

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

**Ellen Rubinstein**
Ph.D., Sociology and Anthropology

**John Creese**
Ph.D., Sociology and Anthropology

**Kristen Fellows**
Ph.D., Sociology and Anthropology

## COLLEGE OF ENGINEERING

**Jiale Xu**
Ph.D., Civil, Construction, and Environmental Engineering

**Nita Yodo**
Ph.D., Civil, Construction, and Environmental Engineering

**Syeed Iskander**
Ph.D., Civil, Construction, and Environmental Engineering

**Ying Huang**
Ph.D., Civil, Construction, and Environmental Engineering

**Harun Pirim**
Ph.D., Industrial and Manufacturing Engineering

**Chad Ulven**
Ph.D., Mechanical Engineering

## COLLEGE OF HEALTH AND HUMAN SCIENCES

**Kelsey Slater**
Ph.D., Health, Nutrition, and Exercise Sciences

**Ryan McGrath**
Ph.D., Health, Nutrition, and Exercise Sciences

**Carmen Kho**
Ph.D., Human Development and Family Science

**Buddhadev Layek**
Ph.D., Pharmaceutical Sciences

**Elisabetta Liverani**
Ph.D., Pharmaceutical Sciences

**Natasha Fillmore**
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

**Marisa Ahlering**
Ph.D., The Nature Conservancy

**Mandy Guinn**
M.S., United Tribes Technical College

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



## Involvement of cortical area MT in the perception of depth from motion explored with Transcranial Magnetic Stimulation

**ABUK AKECH**
PSYCHOLOGY

**FACULTY MENTOR:** Mark Nawrot, Ph.D. - Psychology

The unambiguous perception of depth from motion requires the integration of visual retinal motion with a signal indicating pursuit eye movement direction. In previous work (Nawrot and Johnson, 2023, ECVP), we used Transcranial Magnetic Stimulation (TMS) to show that the Frontal Eye Field (FEF) may be the source of the necessary pursuit signal. In the current study, we used TMS to investigate the role of cortical area MT in these computations. Right hemisphere MT was localized as the region approximately 5 cm lateral and 3 cm superior to the inion that, when stimulated, produced visible phosphenes in the contralateral visual field. Following localization, triple-pulse (33 Hz) TMS was applied to the right MT of 35 participants either 30 msec before (early stimulation) or 90 msec after visual stimulus onset (late stimulation) during the performance of three different psychophysical tasks: i) pursuit, ii) translational motion perception, and iii) MP depth perception. The pursuit task was a step-ramp. Psychophysical tasks required the observer to report perceived depth or perceived motion direction (2AFC) of a computer-generated random-dot stimulus making a single translation (leftward or rightward) of duration (t). Between trials, t varied in two interleaved staircases, one for each direction of translation. TMS of right hemisphere MT produced a small decrease in pursuit latency in the contraversive direction (7 msec early and 5 msec late), but no change in ipsiversive pursuit. For depth perception, TMS produced 14 msec (early) and 20 msec (late) of speeding for leftward stimulus translation. For rightward stimulus translation, TMS produce 13 msec of speeding for late, but no change for early stimulation. There was no change in motion perception latency for either direction of stimulus translation, for either early or late TMS. The concordance of pursuit and depth effects suggests MT may have a role in their integration.

## Disease Prediction from Protein-Protein Interactions Using Graph Neural Networks

**COLTEN ALME**
MECHANICAL ENGINEERING

**FACULTY MENTOR:** Harun Pirim, Ph.D. - Industrial and Manufacturing Engineering

**OTHER CONTRIBUTORS:** Yusuf Akbulut, Industrial and Manufacturing Engineering

Protein-protein interaction (PPI) networks play a fundamental role in understanding biological processes, yet experimental techniques often generate noisy and incomplete data. PPIs associated with various diseases can be merged for use in disease prediction. Graph neural networks (GNNs) offer a promising avenue for extracting meaningful insights from PPI networks by leveraging relevant knowledge and network topology. In this project, we aim to harness GNNs for node-level prediction tasks, aiming to improve the accuracy and interpretability of predictions on PPI networks. By integrating data from prominent databases such as STRING, UniProt, and DisGeNet, we retrieve comprehensive information to be integrated into the PPI data. Utilizing Cytoscape, we determine functional annotations of protein clusters, revealing their biological significance. Subsequently, we apply GNNs to predict childbirth disorders from protein-protein interactions, evaluating model performance through accuracy scores. This interdisciplinary approach combines biomedical research with machine learning techniques, offering new insights into biological systems. Our findings not only advance our understanding of PPI networks but also have practical implications in disease classification. Ultimately, this research contributes to the growing body of knowledge in biomedical research and paves the way for innovative applications in precision medicine.

## Analysis of SPP Historic Outages Dataset for Future Outage Predictions

**KIAN ANSARINEJAD**
COMPUTER SCIENCE

**FACULTY MENTORS:** Ying Huang, Ph.D. – Civil, Construction and Environmental Engineering; Nita Yoda, Ph.D. – Civil, Construction, and Environmental Engineering

Power outages are not only disruptive but also pose significant challenges to the reliability and stability of electrical grids. Identifying trends and predicting future outage occurrences is crucial for effective outage management and infrastructure planning. However, there is a gap in comprehensively analyzing historical outage data to derive actionable insights. This project aims to address this gap by leveraging data analysis techniques to extract meaningful trends and patterns from the Southwest Power Pool (SPP) Historic Outages Dataset. The analysis in this study focuses on extracting key statistics (totals, averages, maxima/minima) of outage counts categorized by year, quarter, and month. This initial step aims to reveal potential seasonality or temporal trends within the data. Data visualizations will be employed to effectively showcase these findings. Furthermore, the project delves into comparisons between different outage categories. This includes equipment type versus outage duration, equipment type versus outage priority, priority versus duration, and the relationship between priority and outage rating. The ultimate goal is to leverage Python libraries like NumPy and Pandas to perform data prediction tasks. The project envisions analyzing historical data (2020-2022) to forecast future trends and outage occurrences. This will involve comparing predictions with pre-approved outage data from 2023 or 2024. Regression analysis, time series analysis, and correlation analysis are potential techniques to be explored for this purpose. The project also acknowledges the potential benefits of incorporating machine learning and deep learning approaches. These techniques can potentially improve prediction accuracy by leveraging a larger volume of historical data. Feature selection methods will be employed to address situations where the data size becomes unwieldy.

## The Role of Surface Glu37 and Lys32 in Coproheme III Transfer from Coproporphyrin Ferrochelatase to Coproheme Decarboxylase

**ADAM BENDEWALD**
BIOCHEMISTRY AND MOLECULAR BIOLOGY

**FACULTY MENTOR:** Kenton Rodgers, Ph.D. – Chemistry and Biochemistry

**OTHER CONTRIBUTORS:** Olivia Stiller, Chemistry and Biochemistry; Gudrun Lukat-Rodgers, Ph.D., Chemistry and Biochemistry

Coproporphyrin ferrochelatase (CpfC) is the penultimate enzyme in the coproporphyrin-dependent heme *b* biosynthesis pathway. This recently discovered pathway, present only in Gram-positive bacteria, diverges from the canonical protoporphyrin-dependent pathway, making it a candidate for antimicrobial research and development. CpfC catalyzes the insertion of ferrous iron into coproporphyrin III, yielding coproheme III (CH3). Coproheme decarboxylase (ChdC) then catalyzes the sequential hydrogen peroxide-dependent oxidative decarboxylation of propionate groups at β-pyrrole positions two and four, giving rise to the vinyl groups of heme *b*. This research investigates thermodynamic and mechanistic aspects of CH3 transfer from the CpfC – product complex, CH3:CpfC, to ChdC. Specifically, the involvement of a putative CpfC:CH3:ChdC precursor complex in the transfer reaction is being addressed by replacing the charged surface amino acids Lys32 and Glu37 of CpfC with hydrophobic Ala and Leu residues, respectively. These surface variations are hypothesized to preclude or inhibit precursor complex formation by eliminating intermolecular ionic interactions that involve these charged surface residues. In the first phase of this project, spectrophotometric titrations of CH3 with CpfC(E37L) and CpfC(K32A) were carried out to quantify the intrinsic thermodynamic stabilities of these enzyme-product complexes. The UV-visible spectra revealed step-wise spectral changes that accompany the formation of the enzyme-product complex. Analysis of these spectral changes by nonlinear least-squares fitting of absorbance change vs titrant concentration afforded the thermodynamic affinities of CpfC and these two variants for its product CH3. The second phase mimics the transfer reaction that occurs in Gram-positive bacteria by spectrophotometrically titrating CH3:CpfC mutants with the CH3 acceptor enzyme, ChdC. The stability and equilibrium constants will be presented and the insight they provide into the structural basis of the transfer mechanism and the specificity of the transfer will be discussed.

## Children's Museums as Informal Learning Environments

**JENNA BERGANTINE**
INTERIOR DESIGN

**SOPHIA JOHNSON**
INTERIOR DESIGN

**ERIN MORRIS**
INTERIOR DESIGN

**FACULTY MENTOR:** Susan Ray-Degges, Ph.D. – School of Design, Architecture and Art

The primary objective of this study is to identify what elements in a museum setting are best suited for the learning, development, and joy of children across diverse ages and abilities. "Learning in museums and other non-school-based environments is referred to as informal or free-choice learning and is qualitatively different learning from that in schools" (Andre et. al., 2016). Various information was gathered from many different scholarly articles regarding exhibit design, accessibility, the interior environment, etc. all oriented towards children. With this environment in mind, a purposive study was conducted, specifically aimed at parents and caregivers of children. This study encompassed a range of inquiries, covering preferences in reception and lobby design, favored exhibit types, personal responses to lighting variations, and the overall interior atmosphere. Despite the study's limited demographic scope, valuable information was gained surrounding exhibit types, personal needs, and the interior environment, helping move forward in designing the Vancouver Children's Museum.

## Phenotypic Plasticity in Thermotolerance of *Brassica rapa* Fast Plants

**ABIGAIL BERGER**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Steven Travers, Ph.D. – Biological Sciences

The impact of climate change on crops is an important area of study due to the fact that we do not know how plants will adapt or acclimate to a warmer world. Understanding how plants have previously adapted or acclimated to heat across a broad range is one approach to understand the mechanisms for tolerating higher temperature averages and extremes. The purpose of this project is to estimate thermotolerance of leaves and pollen from *Brassica rapa* Fast Plants and compare them. The hypothesis is that warmer temperature treatments will be more negatively affected by heat than control temperature treatments. Three estimates of thermotolerance were made on plants growing in two treatments: heat and control. First, cell membrane stability will be assessed in leaf material. Chlorophyll content will also be compared following heat treatments. Finally, photosynthetic rates of heated and unheated plants will be compared. Despite there being differences in plant growth parameters between treatments, there was no statistical difference in thermotolerance between plants from the different treatments. The implication is that breeding for fast plant life cycles, which may have modified other traits, may well play a role in the degree of phenotypic plasticity in this species.

## Microstructure matters: How feather structure varies between populations and across time in a North American songbird

**BETHANY BESPOYASNY**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**FACULTY MENTOR:** Britt Heidinger, Ph.D. – Biological Sciences

In many organisms, both the timing and expression of traits involved in temperature regulation are shifting in response to climate change with important effects on fitness. In birds, one aspect of the phenotype that may be important in this context is feather microstructure. While there is evidence that environmental temperature can impact feather microstructures, the factors that drive these changes are not well understood. These responses are critical to understand in determining which populations may be vulnerable to climate change. The degree to which these microstructures are changing over time is also unknown. To address these questions, an extensive historical and modern specimen collection of House Sparrows (*Passer domesticus*) by Johnston and Selander through the KU Biodiversity Institute of Natural History was sampled. The House Sparrow is an ideal species for this study because of its extensive range over North America, its relatively recent introduction, and high variability in body size and color. We took feather samples from House Sparrows within ten county populations along a latitudinal gradient, which have historical counterparts from the 1960s. Measurements for barb and barbule density were taken from belly, vent, and mantle feathers for each individual sampled. We predict that feather density will increase with latitude, and that it will decrease between historical and modern samples. Increased feather density could lead to more efficient thermoregulation in the wake of rising temperatures, assisting wildlife in coping with a changing world. Additionally, it could be a response to the rise of extreme climatic conditions and weather events, which are expected to increase in the coming decades.

## Student Preference within a Residence Hall

**MELINDA CLEMENTS**
INTERIOR DESIGN

**KAYLE FARRAN**
INTERIOR DESIGN

**STEPHANIE HUBBARD-HOWARD**
INTERIOR DESIGN

**FACULTY MENTOR:** Susan Ray-Degges, Ph.D. – School of Design, Architecture and Art

Living within a residence hall is an experience that most college students have had, and not all experiences have been positive. The purpose of this study is to understand students' preferences within their residence halls and how their living environment can affect their mental health. Creating a supportive residence hall can help students not only academically, but mentally and physically as well (Minotti et al., 2021). Gathering information on mental health, sustainability, and accessibility in relation to student housing can greatly affect the student community. The results found included insights on types of community spaces desired by students, room configurations that students prefer, and how their mental health can be improved by their environment.

## Mental Health of First-Generation College Students: The Role of Grit, Growth Mindset, and Learned Helplessness

**AJ COLLETTI**
PSYCHOLOGY

**FACULTY MENTOR:** Carmen Kho, Ph.D. – Human Development and Family Science

First-generation college students, or students whose parents did not attend or graduate college, face unique challenges compared to their non-first-generation peers. Indeed, research has shown that first-generation college students may experience higher levels of psychological, financial, social, and academic stress. While there is an abundance of research on improving academic outcomes of first-generation college students, less is known about the role of grit, growth mindset, and learned helplessness in affecting first-generation college students' mental health. Grit is defined as passion and perseverance toward achieving goals. In the academic community, the idea that knowledge is achieved through effort is referred to as a growth mindset. Finally, learned helplessness is described as the belief that one lacks the ability to cope with challenging situations. Using a multiple-regression model, the study aims to elucidate the unique contributions of these psychological constructs in predicting mental health outcomes in first-generation college students. This study recruited first-generation college students in the Fargo-Moorhead area to participate in a larger study examining their context and well-being. Using Qualtrics, students reported on their grit, growth mindset, learned helplessness, and mental health amongst other constructs not examined in this study. Results indicated that while grit and learned helplessness were significantly associated with depression and anxiety, growth mindset did not exhibit a significant relationship with mental health outcomes. Specifically, students who reported lower levels of grit also reported higher levels of depression and anxiety. Contrarily, students who reported higher levels of learned helplessness tendencies also reported higher levels of depression and anxiety. These findings underscore the importance of cultivating grit and addressing maladaptive cognitive patterns, such as learned helplessness, in mitigating depression and anxiety. Implications for intervention and prevention strategies are discussed, emphasizing the potential role of enhancing grit and combating learned helplessness in promoting mental well-being in first-generation college students.

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

**ANDREA CLARISSE CORRALES**
BIOCHEMISTRY

**FACULTY MENTOR:** Eugene Caldona, Ph.D. – Coatings and Polymeric Materials

**OTHER CONTRIBUTORS:** Marcel Roy B. Domalanta, Coatings and Polymeric Materials; Mark Rigel R. Ali, Coatings and Polymeric Materials

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.

## Effects of CLP-Induced Sepsis on Spleen Size, Platelet Count, and Bacterial Presence in Female Mice

**REGAN DELOZIER**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Elisabetta Liverani, Ph.D., Pharmaceutical Sciences

Sepsis is the body's extreme immune response to an infection. The spleen, an important immune organ, plays a large role in bacterial clearance and fighting infection, but it is unknown how this organ is affected during sepsis. To further investigate, we induced sepsis in female mice and later harvested the spleen to analyze cell content. Data shows that spleen size and platelet count of wild type (genetically unaltered) mice decrease during sepsis, and anti-platelet drug treatments have little to no effect. Ovariectomized (ovaries removed) mice treated with MRS2279 have a similar spleen size and platelet count to the sham (control) mice, suggesting that MRS2279 could possibly be a successful treatment for septic males and menopausal females. These findings support the idea that spleen size and platelet count decreases during sepsis and offer a solid baseline of data moving forward in finding a successful sepsis treatment.

## Rare Earth Elements in Sands Collected from Southern California Sea Beaches

**KIRA ELIASON**
ENVIRONMENTAL ENGINEERING

**FACULTY MENTOR:** Syeed Iskander, Ph.D. – Civil, Construction and Environmental Engineering

Rare earth elements (REEs) are considered as limiting resources for advancing clean technology and electronics. Because global REE reserves are limited, non-conventional and secondary sources are being investigated for recovery. We analyzed wet and dry sand from seven Southern California beaches for sixteen REEs. These included five light REEs, two medium REEs, and nine heavy REEEs, separated by atomic weight. The mass of the magnetically separated metallic compounds ranged from 15.19—129.91 g per kg of dry sand in the studied beaches, while the total REE concentration ranged from 1,168.1—6,816.7 µg per kg of wet sand (dry sand basis) and 1,474.7—7.483.8 µg per kg of dry sand. Cerium (Ce) and Yttrium (Y) were the most prevalent REEs, ranging from 387.4 – 2,241.1 µg kg-1 and 104.5 – 2,302.3 µg kg-1 of sand, respectively. This study found that light REE concentration accounted for 70—80% of total REEs in the studied beaches. Additionally, Pearson correlation showed the REEs were strongly correlated with each other ($r \geq 0.83$) in the reported beaches, indicating a similar origin. The dominant heavy metals found were Vanadium (V), Chromium (Cr), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), and Strontium (Sr). Dominant minerals identified were quartz, anorthite, ilmenite, and xenotime. Neither the REEs nor the analyzed heavy metals were observed to have ecological or pollution risk. This study identifies beach sand as a potential REE source and demonstrates an easy separation of REEs containing metallic compounds from the sand.

## Interaction of Calmodulin with the pseudo kinase CAMKV

**LORA ENSIGN**
PHARMACY

**FACULTY MENTOR:** Stefan Vetter, Ph.D. – Pharmaceutical Sciences

Calmodulin (CaM), a calcium-binding protein, plays a crucial role in regulating the function of many cellular processes by binding to select proteins in a calcium-dependent manner. Several calmodulin regulated proteins are important drug targets. Therefore, there is a need 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. The first objective of this research project was to experimentally confirm that calmodulin binds to the predicted CaM-binding region of CAMKV in a calcium-dependent manner. The second objective was to determine the binding affinity of the interaction. We first expressed calmodulin recombinantly in *E.coli* and used a multi-step protocol to purify it. The purified protein was then used to measure binding to a synthetic peptide corresponding to the putative CaM-binding region of CAMKV. We used fluorescence spectroscopic titration methods to estimate the binding affinity between calmodulin and the peptide. The poster shows the process and results of the calmodulin purification process and presents the results of the binding studies between calmodulin and the CAMKV derived peptide.

## Integrin β1 Inhibition leads to Reduced Extracellular Matrix Expression in Pancreatic Cancer Cell Lines

**SAMUEL FERNHOLZ**
EXERCISE SCIENCE

**FACULTY MENTOR:** Sijo Mathew, Ph.D. – Pharmaceutical Sciences

**OTHER CONTRIBUTORS:** Md Saimon Mia, Pharmaceutical Sciences; Sreyasi Pal, Pharmaceutical Sciences

The objective of this study is to lower the expression of extracellular matrix proteins (ECM) in pancreatic cancer cell lines through the inhibition of integrin β1. This inhibition was done using Integrin β1 Sh-RNA plasmid. Clones were developed using this and puromycin to narrow down selections. These samples were then used in qRTPCR and western blotting to determine protein expression. A Matrigel assay was ran to determine differences in tumor growth. The function of the cells was determined with cell spreading and adhesion assays. We found decreased expression of integrin β1, integrin alpha 5, vitronectin, and fibronectin in the Panc-1 clones. It was also found that cell spreading, cell adhesion, and tumor growth were all significantly decreased with the Panc-1 clones. These results show a decrease in extracellular matrix proteins, reduce cancer cell function through adhesion and spreading, and decreased tumor growth through the knock down of integrin β1.

## Effects of Extruded Protein Supplements for Cattle Fed Forage-Based Diets

**CHRISTY FINCK**
ANIMAL SCIENCE

**FACULTY MENTOR:** Kendall Swanson, Ph.D. – Animal Sciences

**OTHER CONTRIBUTORS:** Pauliane Pucetti, Animal Sciences; Julia Travassos, Animal Sciences; Zac Carlson, PhD, Animal Sciences

Protein supplementation to cattle fed low to medium-quality forages often results in increased forage intake and improved performance. There is a need to develop improved supplementation strategies using protein supplements produced from the ethanol and soybean processing industries in North Dakota. This experiment examined the effects of cattle fed a forage-based diet and supplemented with an extruded (in cake/large pellet) or meal of dried corn distillers grains (DDGS) with solubles or soybean meal and soybean hulls formulated to contain the same concentration of protein as DDGS. Five Jersey steers were used in a 5×5 Latin square design and housed in individual pens with individual feeding bunks where they were fed five dietary treatments for 16 days per diet. The 5 dietary treatments were: 1) no supplement, or supplementation with 2) DDGS fed as meal, 3) DDGS fed as extruded cake, 4) soybean meal/soyhulls fed as meal, and 5) soybean meal fed as extruded cake. Supplements were fed at 0.5% of body weight (dry matter basis). Medium-quality hay was fed for ad libitum intake. For the final 5 days of each period, feed intake was measured along with total fecal collection using fecal collection bags. Feed and fecal samples were dried in a 60°C oven and dry matter. Dry matter intake, dry matter excretion, amount of dry matter digested, and dry matter digestibility (5 of intake) will be presented. Data could lead to the development of improved feed supplements for cattle producers and provide added markets for DDGS and soybean meal produced in North Dakota.

## Exploring Cold Tolerance of *Pteromalus venustus*

**AVA FREMGEN**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Kendra Greenlee, Ph.D. – Biological Sciences

Insects are vital players in food production. 75% of all produce grown in the US are reliant on bees for pollination (United States Geological Service). *Megachile rotundata* is one such pollinator who specializes in pollination of alfalfa. *Pteromalus venustus* is a parasitic wasp and a major pest to *M. rotundata*. Current management techniques of *P. venustus* are ineffective or adverse to the bees. In hopes of finding a more effective treatment to reduce parasitism rates, I explored the use of cold temperatures for extermination. I began by using a differential scanning calorimeter (DSC) to find the super cooling point of both *M. rotundata* and *P. venustus* larvae. Unfortunately, the super cooling point of the *P. venustus* was significantly lower than that of the *M. rotundata*, meaning flash freezing would harm our bees instead of the wasps. I later tried prolonged cold exposure at both 15 C and 20 C for up to a two-week period. Once again, *P. venustus* larvae proved tolerant to the cold and not only survived the temperatures, but also regularly went on to pupate. While further investigations into use of cold treatment are undergoing, these results suggest exploration into other treatment options such as gas exposures may prove more efficient.

## Making an Impression: Eye Tracking Analysis of Sponsorship Positioning in Major League Baseball

**SAVANNAH GREEN**
SPORT MANAGEMENT

**FACULTY MENTOR:** Kelsey Slater, Ph.D. – Health, Nutrition and Exercise Sciences

In a review of literature focusing on sponsorship in sport, there seems to be a consensus that advertising through sport has value. However, there is minimal literature on the effectiveness of Major League Baseball (MLB) sponsorship, particularly with the new introduction of sleeve patches during the 2023 season. The purpose of this research is to examine sponsorship effectiveness in professional sport through MLB broadcasts and to understand the relationship between gameplay and viewer gaze on in-game advertisements. The following research questions were developed: How does signage positioning influence viewer attention? How is viewer attention for sponsor signage during a professional baseball game affected by game action? The content of the study was created by searching for games on the official MLB YouTube channel where both teams participating had sleeve patch sponsors. After IRB approval, Individuals were then recruited to participate in eye-tracking research. Using iMotions software, participants were instructed to watch a total of seven clips, amounting to 40 minutes of content. Participants were withheld the information relating to the purpose of this study to help eliminate bias. Data collected included gaze hits on sponsorship ads and the duration of the impressions on specific advertisements. During the data collection process, it was noticeable that traditional sponsorship signage was attracting more attention when there was no game play. While game action was occurring, many participants had their focus on the athletes performing the game action. Even though there is limited research on sleeven patch sponsors in the context of professional baseball, the researchers expected this study to mirror other sponsorship effectiveness in sport research where ball position during soccer games did impact sponsorship gaze (Boronczyk et al., 2018). Further research needs to be done to further prove the effectiveness of sponsorships within a professional sport setting. Sport sponsorship research can help guide sport organizations to create the most effective and cost-worthy sponsorship packages for interested businesses. Research in this context is a sales tool, which is crucial to help organizations generate revenue. It's important to understand what fans/consumers look for and what attracts their attention to sponsorships.

Reference: Boronczyk, F., Rumpf, C. and Breuer, C. (2018). Determinants of viewer attention in concurrent event sponsorship. *International Journal of Sports Marketing and Sponsorship*, 19(1), 11-24. https://doi.org/10.1108/IJSMS-09-2016-0063

## Sociodemographic factors and sleep: An intersectional framework

**JOELLE HANNAM**
PSYCHOLOGY

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Introduction: Understanding the impact of multiple demographic factors on sleep is an important consideration for health interventions and health equity. Although disparities in sleep associated with sociodemographic factors are well-documented, most studies do not use intersectional frameworks. Here, we evaluated whether sociodemographic factors interacted with each other in predicting multiple sleep outcomes, consistent with an intersectional framework. Methods: This study uses data from the NDSU National COVID Study, which has followed 300 American adults across five waves of data collection since April 2020. The current analysis includes data from Wave 1 (April 2020) in 263 participants with complete data on demographics, sleepiness, sleep health, sleep disturbance, sleep-related impairment, insomnia, and bedtime procrastination. Participants reported a range of identities (51% male, 25% people of color, 12% LGBTQ, Mage = 44, MSES = 5 on a 10-point scale). Using correlations and regressions, we examined whether age, sex, socioeconomic status, race/ethnicity, and LGBTQ status were associated with sleep. Regression interactions were used to test whether consideration of intersectional identities enhanced the prediction of sleep, over and above linear effects. Results: Sociodemographic factors best predicted bedtime procrastination (~18% of the variance), followed by insomnia (15%), sleep disturbance (14%), sleep-related impairment (14%), and sleep health (8%). Sociodemographic factors did not significantly predict sleepiness. Across sleep outcomes, age was the strongest predictor of sleep (MB = 0.28), followed by sex (MB = 0.18), socioeconomic status (MB = 0.17), race/ethnicity (MB = 0.10), and LGBTQ status (MB = 0.03). Interactions between sociodemographic factors were not statistically significant. Conclusion: We found sociodemographic factors were additively related to self-reported sleep. Although there were no significant interactions within the sociodemographic level, interactions may still be present across levels. Interactions between sociodemographic factors and individual, interpersonal, community, and policy-level factors, would be consistent with the socioecological model of sleep.

## Catalytic Nucleophilic Trifluoromethylation of Nitroolefins

**AUSTIN HARMSEN**
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**FACULTY MENTOR:** Hariharaputhiran Subramanian, Ph.D. – Chemistry and Biochemistry

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Trifluoromethylated organic small molecules are of great significance due to the presence of fluorine atoms. Owing to unique properties such as membrane permeability and lipophilicity. These small molecules are used in modern pharmaceuticals (efavirenz, mefloquine, etc.) and agrochemicals. In our lab, we focused on developing a catalytic synthetic protocol for the introduction of a trifluoromethyl group. In this protocol, the trifluoromethyl group was added as a nucleophile (-$CF_3$-) to electron-deficient alkenes such as nitroolefins. The outcomes of this project will be discussed in this poster.

## Evolving Cancer Research: Progressing from 2D to 3D Modeling

**TRINITY HODORFF**
BIOLOGICAL SCIENCES, PSYCHOLOGY

**RACHEL TRUSTY**
BIOLOGICAL SCIENCES

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**FACULTY MENTOR:** Jiha Kim, Ph.D. – Biological Sciences

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Breast cancer has been an ever-persistent issue to world health with a woman being diagnosed every 14 seconds. In 2022, approximately 2.3 million women were diagnosed with breast cancer and around 670,000 passed away. Despite the significant improvements in research, the breast cancer death rate is still 2.5%. The main reason behind this is metastasis, however, evolving research models may provide improvement as they are an essential step in furthering cancer research. The majority of research being done using 2D models has conditional restraints, as cancer cells do not mimic the original morphological and genotypical behaviors, which are shown inside the 3D human body. These limitations led to a design improvement named "3D cell culture Model". The aim of the current study is to explore the gap between traditional 2D and 3D models. For this current research we used biopsy tissue chunks from adult breast cancer patients. In this study we cultured the cells in monolayer, which is considered as "2D cell culture Model". We found that the 2D system is not a sufficient way to establish the cell lines from those biopsy tissues with the success rate for cell line establishment being around 25% which is considered very low. After analyzing the results, we found that, over the generations 2D cultured cancer cells are changing their natural structures and some gene expression as well, which is not a common phenomenon for tumors. Also, our results revealed that in the 2D system cancer cells are growing without any stress and they are not undergoing death processes. Whereas, inside the body and in 3D models, cancer cells go through all the stages of the cell cycle including the death phase. Altogether, this current study has concluded that 3D culturing in breast cancer research is advantageous in comparison to traditional 2D modeling. The long-term goal for this study is to further explore cell mechanisms that occur in 2D conditions and make a comparative study against 3D modeling conditions.

## Effects of Surface Mutations on the Thermodynamics of Coproheme III Transfer from Coproporphyrin Ferrochelatase to Coproheme Decarboxylase

**GARRETT HONZAY**
BIOCHEMISTRY AND MOLECULAR BIOLOGY

**DEPARTMENT MENTOR:** Gudrun Lukat-Rodgers, PhD – Chemistry and Biochemistry

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Heme *b* is an essential molecule for life. Hemoproteins serve many functions within the cell including oxygen transport, electron transport, heme trafficking, small molecule sensing, and catalyzing specific biological reactions. Gram-positive bacteria use a novel coproporphyrin-dependent pathway in the biosynthesis of heme *b*. Coproporphyrin III ferrochelatase (CpfC) catalyzes the insertion of ferrous iron into the porphyrin ring of coproporphyrin III to yield coproheme III (CH3). The CH3 is transferred to the final enzyme in the pathway, coproheme III decarboxylase (ChdC), which catalyzes the two-step, $H_2O_2$-dependent conversion of CH3 to heme *b*. To evaluate the thermodynamics of the transfer of CH3 from CpfC to ChdC, the dissociation constants for CpfC:CH3 and ChdC:CH3 complexes were measured. The equilibrium constant for transfer of CH3 from CpfC to ChdC ($K_T$) was determined by spectrophotometric titration of the CpfC:CH3 complex with ChdC which yielded CpfC and ChdC:CH3. Amino acids Trp229 and Glu36 on the surface of the CpfC structure have been identified as candidates for involvement in formation of a precursor CpfC:ChdC complex that facilitates coproheme III transfer. These surface amino acids were mutated, the resulting CpfC variants, CpfC(W229A) and CpfC(E36L), were isolated and purified, and their affinities for CH3 were measured. The goal of this study was to determine if these mutations affect the transfer of CH3 from CpfC to ChdC. This was quantitatively assessed by spectrophotometric titrations of the CH3 complexes of wild-type and mutated CpfCs with wild-type ChdC. The thermodynamic parameters of the CH3:CpfC variants' transfers to ChdC will be presented and interpreted through comparison with those of the wild-type enzyme. Following the transfer of CH3, the $H_2O_2$-dependent CH3:ChdC oxidative decarboxylation was investigated. Spectrophotometric titrations of CH3:ChdC with $H_2O_2$ will be presented to analyze the effect of titrimetric addition stoichiometry of $H_2O_2$ for the ChdC reaction.

## Evaluating AMHR2 Signaling in Airway Smooth Muscle Cells

**JENNA HUWE**
MEDICAL LABORATORY SCIENCE

**DEPARTMENT MENTOR:** Sathish Venkatachalem, Ph.D. – Pharmaceutical Sciences

Asthma is a chronic condition that is estimated to affect 30 million Americans, with the diagnosis rate increasing each year. Interestingly, there appears to be a sex-dependent risk for asthma due to the observation that after puberty women comprise the majority of new asthma diagnosis. Several sex hormones have been investigated for their role in this sex-dependent risk, with a focus on the most prevalent hormones testosterone and estrogen. Both of these hormones have been found to alter different cellular responses in lung tissues; One of these affected cell types, airway smooth muscle cells (ASM), have a well-established role in the pathogenesis of asthma. In this project, we explored the potential role of an understudied hormone, Anti-Mullerian Hormone (AMH), in regulating ASM physiology. AMH is a lesser studied sex hormone that is known to influence the growth rates of cells and has a difference in expression between males and females. We hypothesized that AMH may have a signaling role within the lung and influence the resident cells. In this study we used primary human ASM cells and maintained cultures up to the 5th passage. We treated these cells with a range of AMH concentrations (5-40 ng/mL) that spanned physiological concentrations observed in humans. During asthma, the growth rates of ASM change and this results in hypertrophy and hyperplasia. We monitored the effects of AMH treatment on proliferation markers as well as sex hormone signaling in this study. Expression of mRNA was quantified using RT-qPCR, and protein was evaluated via Western blotting. Proliferation rates were quantified using MTT assays. We observed expression of AMHR2, AMH's respective receptor, within ASM. Treatments with AMH induced changes in expression of certain genes, suggesting AMHR2's signaling is relevant to ASM physiology. Treatments with AMH affected the expression of proliferation markers, suggesting a role in moderating ASM proliferation. These early findings suggest that AMH may play a role in the lung and could contribute to the pathogenesis of asthma.

## The Link between Vasoactive Intestinal Peptide (VIP) and Intestinal and Liver Glycogen Levels in Mice

**SAVANAH KLEGON**
BIOCHEMISTRY AND MOLECULAR BIOLOGY

**FACULTY MENTOR:** Glenn Dorsam, Ph.D. – Microbiological Sciences

**OTHER CONTRIBUTORS:** Razia Dawlaty, Microbiological Sciences

Human obesity afflicts more than 40% of adults, contributes to Type-2 Diabetes (T2D), and costs 179 billion dollars annually in health care. Obese humans have elevated plasma VIP, a neuropeptide involved in the regulation of mammalian feeding behavior. Human polymorphisms (e.g., altered DNA sequence) in the VIP gene that increase expression are strongly associated with human obesity and fat mass accumulation. In contrast, VIP knockout mice (KO), have a lean phenotype and a defective fat storage program. Unpublished data from our group have uncovered a link between VIP signaling and intestinal gluconeogenesis (IGN), a metabolic process that regulates weight management and heathy fat storage. VIP deficient mice have elevated jejunal G6Pase expression, the rate-limiting enzyme for IGN. Therefore, we hypothesize that deficient VIP signaling causes an increase in G6Pase expression, thereby depleting intestinal glycogen stores and rendering the intestines unable to maintain weight management and healthy fat storage in a fed state. To test this hypothesis, we will measure glycogen content in jejunal samples from VIP WT and KO mice. We expect to find substantially reduced glycogen content in KO animals that is anticipated to explain an underappreciated physiological role for intestinal glycogen content in regulating body weight and fat storage. Such data may implicate VIP signaling as a targetable pathway to mitigate human obesity.

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## Panobinostat BSA Nanoparticles

**TRAVIS KRUSE**
PHARMACY

**FACULTY MENTOR:** Buddhadev Layek, Ph.D. – Pharmaceutical Sciences

Pancreatic cancer accounts for 3% of total cancer, however, its mortality is very high accounting for the third leading cause of cancer death. Pancreatic cancer's innate resistance to chemotherapeutic drugs and its ability to spread to other organs leads to its high death rate. Furthermore, conventional chemotherapies are flawed with low tumor distribution and chemotherapy-associated toxicity. Thus, there is a need for a new treatment model for the effective treatment of pancreatic cancer. Panobinostat is a histone deacetylase inhibitor that was improved for multiple myeloma by the FDA in 2015. It has also shown its efficiency against solid tumors in pre-clinical trials. Improving Panobinostat's bioavailability and reducing its dose-related toxicity will further enhance its effectiveness against pancreatic cancer. Nanoparticles have been used as a delivery system to enhance tumor-targeted delivery and minimize chemotherapy-associated toxicity. This research has investigated formulating bovine serum albumin (BSA) nanoparticles to enhance the delivery of Panobinostat to the tumor site, enhancing its efficacy and reducing dose-related toxicity. We prepared Panobinostat BSA nanoparticles and tested the physicochemical characterization of the nanocarriers. Our results showed a size of 160.5nm, charge -26.5mV, and loading of 3%. The in vitro study revealed that Panobinostat BSA nanoparticles exhibited higher cytotoxicity against mice pancreatic cancer cells (KPC) as compared to free Panobinostat. In our future study, we will be conducting the release characteristics of the Panobinostat BSA nanoparticles as well as their in vivo efficacy.

## Effect of PPARα In Cardiac Muscle on Lipid Storage and Utilization

**AMELLIA KUHN**
PHARMACY

**ALYSSA OLSON**
RESPIRATORY CARE / PRE-MED

**FACULTY MENTOR:** Natasha Fillmore, Ph.D. – Pharmaceutical Sciences

Excessive accumulation of lipids in cardiomyocytes can cause many health risks such as insulin resistance or diabetic cardiomyopathy. Peroxisome proliferator-activated receptor (PPARα) plays a key role in fat metabolism. We wanted to study what regulates lipid storage and utilization in the heart. We studied cardiac-specific PPARα knockout (PPARα KO) hearts. We analyzed the results of which proteins were present in different groups; high-fat diet vs low-fat diet, male vs female, and control vs PPARα knockout. Control groups and PPARα KO groups of mice were fed either a high-fat or low-fat diet for five weeks to simulate obesity. Using samples made from cardiac tissue from these different groups, western blots were run. We analyzed those western blots measuring proteins in the electron transport chain (Oxidative Phosphorylation), and lipid droplet-associated proteins Perilipin 5 (Plin 5) and Perilipin 2 (Plin 2). Plin 5, a protein that is greatly expressed in cardiac tissue, can promote lipid accumulation and metabolism in cardiomyocytes. Plin 2, which is a protein of the same family, is a lipid droplet-associated protein. According to another study, Plin 2 is a key piece in lipid accumulation within cardiac cells. Based on the roles of these proteins, the goal was to understand if removing PPARα would protect against lipid accumulation in cardiac tissue. If we obtained results about what proteins were expressed in the samples, we could potentially hypothesize the effect the proteins would have on lipid storage and utilization. Going forward, we would like to understand if this knockout of PPARα is linked to insulin resistance or cardiomyopathy.

## The Remnants of Bonanza Farming on North Dakota's Great Plains

**KYLA LARSON**
ANTHROPOLOGY

**FACULTY MENTOR:** Kristen Fellows, Ph.D. – Sociology and Anthropology

Tenant farming in North Dakota arguably stemmed from the large-scale industrialized ways of Bonanza farming in the 1870s. Questions such as who the people running the tenant farms after the shift to a more privatized approach are, and their way of life are vaguely discussed in historical research. Instead, research focuses on the successes and failures of Bonanza Farming. Archaeological artifacts serve as evidence and allow for new narratives that might have otherwise been silenced through the lack of historical documentation. The first season of this project looked at different types of primary and secondary documents, aerial photography, GIS, and conducted archaeological survey and excavation to triangulate between sources and develop a better understanding of the site and topic. Preliminary findings of nails and other artifacts found at structure #1 suggest this was a small pole barn/shed. The high concentration of material culture also suggests this area was commonly used. Understanding the use of space in an environment known to be seasonally fast-paced and work-driven can give insight into what these tenant farmers focused on during peak season and enjoyed during the off-season.

## Effects of predation on behavioral correlations in *Gryllodus sigillatus*

**HIEU LE**
PSYCHOLOGY

**FACULTY MENTOR:** Ned Dochtermann, Ph.D. – Biological Sciences

Evolutionary ecologists are increasingly interested in the importance of behavioral correlations in shaping evolutionary outcomes. However, the effects of predation on behavioral correlations that incorporate within-individual plasticity are well less understood. We repeatedly measured exploratory behavior and latency to emerge from shelter in banded crickets (*Gryllodes sigillatus*, $N \approx 98$) both before and after exposure to African fat-tailed gecko (*Hemitheconyx caudicinctus*). This allowed us to estimate among-individual correlations (i.e. behavioral syndromes) and within-individual correlations (i.e. correlated plasticity) before and after selection. We found limited support for changes in among- and within-individual correlations as well as for correlational selection. Our results highlight the importance of considering the response of both among- and within-individual correlations and of properly estimating selection when considering the current utility of behavioral correlations.

## 35 years of dry bean production: a retrospective analysis of seed yield gains in North Dakota

**SARA LONG**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**FACULTY MENTOR:** Juan Osorno, Ph.D. – Plant Sciences

**OTHER CONTRIBUTORS:** Jose C. Figueroa-Cerna, Plant Sciences

Edible legumes, specifically dry bean (*Phaseolus vulgaris L.*), have been a fundamental source for human consumption of protein worldwide. This legume has also contributed significantly to the world's agricultural economy. Plant breeding programs utilize various genomic markers, as well as phenotypic data to select genotypes for future breeding and release as improved varieties. Quantitative traits, such as seed yield, are affected by an array of genes, instead of a single gene. This makes breeding more difficult, plus breeders must find a balance between amplifying traits for certain factors, like disease resistance and agronomic traits, without compromising seed yield. Seed yield is the amount of seeds produced, or grown, per unit area of land (kg/ha). Farmers want to have the highest possible seed yield in the least amount of land used. The objectives of this study are to examine seed yield gains of dry bean cultivars and breeding lines using historical data from field experiments conducted in various locations across North Dakota and Minnesota. The five dry bean market classes selected for this study were pinto, navy, black, kidney, and great northern. The data collected for this project was retrieved from over 65,000 entries within handwritten field books and a computerized relational database spanning 35 years. Statistical analyses, such as linear mixed models, and linear regression analysis, are being run to investigate the change in seed yield across the study period by year and market class. We are evaluating what could possibly influence seed yield such as location, varieties, air temperature, total rainfall, or a combination of those factors. The goal is to determine if seed yields have increased across the study period, per area unit, and market class, and if so at what quantities. Our preliminary results have shown that seed yield has increased across four market classes grown in the region by 5.7 kg/ha/year during the last 35 years. The continued research in this study will provide vital information into the specific genetic gain NDSU has provided to seed yield, and ultimately, farmers, industry, consumers, and the economic impact of these gains in the entire value chain.

## Disturbance regime and plant community influence the spatial distribution of total soil carbon stocks in the Northern Great Plains

**SAGE LONGTIN**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**MENTOR:** Marissa Ahlering, Ph.D. – The Nature Conservancy

The Northern Great Plains grassland ecosystem has the capacity to store large quantities of total soil carbon (TSC), which has important implications for climate change mitigation. The spatial distribution of TSC stocks varies based on the influence of the soil forming factors: climate, land use (disturbance regime), topography, parent material, and biota (plant community). As such, there is a need for TSC stock data across various factors to improve management of grasslands for increased ecosystem services. The objective of this study is to assess how the following variables and their interactions influence TSC stocks in the Northern Great Plains: disturbance regime, grass-forb cover, native species cover, % silt, slope, and mean annual precipitation. Identifying the variables that influence the spatially heterogenous pattern of TSC storage in the Northern Great Plains will allow for estimates of a landscape's capacity for TSC storage. This information will contribute meaningful knowledge for adjusting management practices that best optimize TSC storage across the landscape, having serious implications for climate change mitigation. As such, the results of this study will be important in advocating for the protection of our grasslands as a climate mitigation tool with science-based evidence.

## Navigating Cognitive Biases in Vaccine Decision-Making: Insights from Student Responses

**CARSON MARKOVIC**
MICROBIOLOGY

**FACULTY MENTOR:** Danielle Condry, Ph.D. – Microbiological Sciences

Efforts in science communication within education commonly focus on presenting empirical data to support evidence-based decision-making, such as vaccination against SARS-CoV-2 or the influenza virus. However, studies suggest that merely providing data doesn't necessarily increase vaccine acceptance, as decisions are influenced by personal values, beliefs, motivations, and cognitive biases (Raj et al., 2023). Research has primarily examined cognitive biases in parental decisions on childhood vaccinations rather than those for COVID-19 or influenza. This project aims to identify cognitive biases influencing students' decisions on COVID-19 or influenza vaccination. Written responses were collected from undergraduate students in a non-major's biology course pre- and post-lesson to assess the effect of instruction on rationale (n=79). This lesson included analyzing safety and efficacy data, debunking common vaccine myths, and discussing ethics of vaccination requirements. Using thematic analysis, responses were examined for cognitive biases known to affect vaccine decisions. Examples include optimism bias (underestimating risks), omission bias (preferring inaction), ambiguity aversion (preferring known risks), and availability bias (overestimating side effect likelihood if frequently discussed). By scrutinizing both COVID-19 and influenza vaccine decisions, we seek to understand how cognitive biases impact these choices differently. Our goal is to develop targeted instructional strategies based on psychological and science communication principles to help individuals navigate these biases effectively.

## Alamandine Restores Intestinal Epithelial Barrier Integrity by Enhancing the Intestinal Stem Cell Regeneration in Aging

**VICTOR MARTINEZ**
PHARMACY

**FACULTY MENTOR:** Yagna Jarajapu, Ph.D. – Pharmaceutical Sciences

**OTHER CONTRIBUTORS:** Kishore Chittimalli, Pharmaceutical Sciences

Advancing of age is associated with the decreased barrier properties of intestinal epithelium which leads to sterile systemic inflammation and aging-related comorbidities such as cardiovascular diseases. Alamandine (Ala) is a recently discovered peptide of the Renin-Angiotensin system (RAS), which is generated by aspartate decarboxylase enzyme and acts via Mas-related G-protein coupled receptor type D (MrgD) to elicit cardiovascular protective functions. Ala/MrgD pharmacology in colon is unknown. Our preliminary studies in colonic organoids from aging mice have shown that Ala treatment increased the expression of Wnt3 which is required for homeostasis of Intestinal Stem Cells (ISCs). This study tested the hypothesis that activation of MrgD by Ala will restore intestinal permeability in mouse model of aging. Study was carried out in Young mice aging 2-3 months and Old mice aging 22-24 months. Ala was administered by subcutaneous osmotic pump at perfusion rate of 1μg/kg/min and ISC layer was evaluated by immunohistochemistry of Lgr5 and Olfm4 in mice colon. Colonic organoids were prepared from old mice in presence of Ala (10 nM) in combination with either 666-15, cAMP Response Element Binding Protein (CREB) inhibitor (1 μM) or D-Pro$^{7}$-Ang-(1-7), MrgD antagonist (1 μM) or A779, MasR antagonist (1 μM) and expression of Wnt3 was evaluated by using western blotting. Expression of tight junction proteins (Claudin1 and Occludin), Wnt3 and infiltration of macrophages (CX3CR$^{+}$/CD80$^{+}$ cells) in colonic epithelium were determined by immunofluorescence imaging. Colon sections from old mice have shown decreased number of Lgr5/Olfm4 dual positive ISCs compared to young mice which were restored by Ala treatment. Colonic organoid culture demonstrated that Wnt3 expression was mediated through Ala/MrgD/CREB/Wnt3 signaling pathway. Expression of Claudin1 and Occludin were lower in the aging colon compared to young group which were increased by Ala. Increased infiltration of CD80$^{+}$ cells in the old mice were decreased by Ala. These novel findings provide evidence for targeting Ala/MrgD pathway for restoring intestinal barrier integrity in aging.

## Examining the Feasibility of Implementing Handgrip Strength in an Internal Medicine Resident Clinic

**MICHAELA MASTRUD**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Ryan McGrath, Ph.D. – Health, Nutrition and Exercise Sciences

Background: Handgrip strength (HGS) is a feasible health biomarker. Despite the predictive value of HGS, this tool may not be used in clinical settings. We sought to evaluate the feasibility of implementing HGS in an internal medicine resident clinic. Methods: Generally healthy adults aged at least 65-years that visited an internal medicine resident clinic were eligible for HGS assessments. Persons completing HGS assessments squeezed a handgrip dynamometer twice on each hand with maximal effort, and then completed a questionnaire about their HGS experience. Completion rates were monitored. Physicians also completed questionnaires about HGS and were provided with didactic education. Implementation was phased in during the study period to support this transition. Results: Completion rates during Phase 1 were 11.0%, while rates increased to 11.6% during Phase 2. Patient questionnaires showed overall great understanding and high value in HGS. Physician questionnaires showed that they also saw HGS as somewhat valuable but completed it less frequently than expected. This was mostly due to time constraints in the clinic. Discussion: While implementation of HGS is increasing, patient feedback about HGS testing was excellent, and physician feedback was supportive. Given the positive feedback from patients and physicians, ongoing effort to implement HGS assessments will help to improve healthcare for older adults.

## The Misuse of Trust: Fem in College Improv

**BAYLEE MILLER**
ANTHROPOLOGY

**FACULTY MENTOR:** Ellen Rubinstein, Ph.D. – Sociology and Anthropology

Men significantly outnumber women in comedy, and according to Oxford Student, 75% of female stand up comedians experience sexual harassment on the job. As a fem-presenting person, I have also experienced such things in the comedy space here on campus. Given this, I chose to conduct research on how women and fem presenting people are treated in comedy spaces, specifically college improv comedy clubs. Improv comedy is a comedic form where the performers get a suggestion from the audience and create a scene based on that suggestion. There are no scripts, meaning this style of comedy relies on trust and support from your scene partners. I used past and present members of North Dakota State University's improv comedy club as my subjects. The project spanned over six weeks and consisted of participant observations, group "freeform" interviews, and solo semi-structured interviews. I conducted 4 interviews, 2 solo and 2 groups. I personally reached out to current members and alumni and asked which interview style they'd like to participate in if willing. For my participant observations, I spent 4 hours a week in the field, and on weeks that there was a performance, it was 6 hours. With this research, I learned about the difficulties fem-presenting people face in improv and the gross behaviors they had endured by their male counterparts. I will continue my research by looking further into NDSU's code of conduct and values along with other ethnographies that cover similar topics. With this data, I hope that NDSU will be able to adapt their resources in order to better protect vulnerable populations on campus, like in the case of fem-presenting people.

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## Freeze Tolerance of the Sugar Beet Root Maggot

**ISAAC MILLS**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Kendra Greenlee, Ph.D. – Biological Sciences

The Sugar Beet Root Maggot (SBRM), *Tetanops myopaeformis*, is a severe pest to the Sugar Beet Root in much of the high plains area. SBRM are freeze tolerant, meaning that they can survive internal ice formation. They do this by producing ice-nucleators, heat shock proteins, and accumulating cryoprotectants. We expect cold acclimated (2022) SBRM to have a clear pattern of ice formation, while non cold acclimated SBRM (2023) will have no freezing pattern. To test the hypothesis, SBRM were recorded with an infrared camera on a chill plate ramped to -20°C. We will observe freezing patterns, freezing event duration, and supercooling point measurements to determine if maggots localize ice nucleators for future research. We expect that freezing will be slow in cold acclimated maggots, as controlled ice formation decreases the likelihood of damaging cells. SBRM were collected from sugar beet fields in St. Thomas, ND (2022) and cold acclimated at 4°C in the lab or from Thompson, ND (2023) which were not cold acclimated and stored at 15°C. Maggots were rinsed, dried, and weighed before being placed on a chill plate wrapped in aluminum foil. SBRM were acclimated to 4°C for five minutes. After the acclimation period, maggots were recorded while being shielded with aluminum to control the temperature in the testing area. The chill plate was decreased at 1°C/min, and held at -20°C for 40 min. After the recording was concluded the chill plate was ramped back up to 4°C at 1°C/min and specimen was evaluated for survival between 24 to 72 hours (about 3 days). Data was processed using JMP, and thermal videos were processed through FLIR Thermal Studio Pro. Results from current observations have shown that none of the noncold acclimated maggots (N=22) froze, however 65% of the cold acclimated maggots (N=17) did freeze. The maggots that froze have an average surface temperature of -7.37°C and average 14.05 mg. I expect to find a common location within the SBRM's 11 segments where the supercooling/freezing point begins. Our goal is to identify the location of the cryoprotectants for future research in freeze tolerance and cold physiology.

## Phylogenetic relationship and subspecies boundaries of *Myotis spp.* in the North Great Plains

**KAITLYN MILLS**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**FACULTY MENTOR:** Mandy Guinn, MSc – United Tribes Technical College

Bats may have gained negative stereotypes over time, but they are vital to our survival as humans. Without bats, the risk of food insecurity across the nation increases because of the ecosystem services they provide. For example: they help pollinate important plants, prevent the spread of insect-borne viruses, and save the agriculture industry billions of dollars annually because of their insectivorous diet. Since 2006, White Nose Syndrome (WNS), a fungal infection of the subcutaneous tissue, has been sweeping across the U.S. infecting bat populations and creating a devastating epidemic. WNS spreads via close contact, so during hibernation, the fungus can spread infecting the majority of a colony. This infection disrupts their torpor during winter, – causing frequent arousals– and without readily available food sources, fat preserves deplete too soon. Mortality rates are between 90-100% for infected bats. In order to understand the host-pathogen interactions and future implications of WNS, our project focused on understanding the genetic variation in bats colonies in the Northern Great Plains (NGP). The results from this project will allow us to reconstruct a shallow evolutionary history and delimit species boundaries in the Great Plains Region. Once *M. lucifugus* subspecies boundaries and phylogenetic relationships to other bat species in this region have been established, we will be able to conduct future research and identify any genome-wide responses to WNS in *M. lucifugus*. For this project, DNA was obtained by taking a 'wing punch' – a small 3mm sample of their wing tissue– in the field. Then, we extracted the DNA and utilized two techniques, metabarcoding and microsatellites, to obtain loci of interest. Sequences for each locus will be aligned using MAFFT. We will employ Modeltest NG and Partition Finder to select molecular models based on AIC scores. Species trees will be constructed via BEAST 2.6.3 to infer subspecies relationships and delimit lineages. Species and gene trees will be compared using ASTRAL-III, which will provide measures of support for resulting phylogenetic hypotheses. Results are currently pending.

## Innovative Pathogen Disinfection Using Far UVC Light

**SELAH MUELLER**
ENVIRONMENTAL ENGINEERING

**FACULTY MENTOR:** Jiale Xu, Ph.D. – Civil, Construction and Environmental Engineering

The most common chemical means of wastewater treatment have harmful disinfection byproducts (Crittenden et al.). Wastewater treatment plants have begun adopting UV disinfection as a safer and at times cheaper alternative, though direct contact with UVC light is harmful to human skin, and the lamps aren't as effective against enveloped viruses (Ma et al., "Coronaviruses and Phage Phi6") or certain vegetative bacteria (Ma et al., "Common Pathogens and Surrogates"). Far-UVC emits 222nm wavelength UV rays that do not harm human tissues. This study examines the effectiveness of Far-UVC disinfection used in conjunction with peracetic acid (PAA) to meet effluent residual requirements. By isolating fecal indicator bacteria from wastewater samples, treating them with Far-UVC light and PAA, and then growing either *Enterococcus* or *Escherichia coli*, we've found that Far-UVC is an effective method of disinfection, especially at high fluences and high fluence rates. It was observed that the lowest normalized bacteria concentration, 0.63, was achieved at a fluence of 40 mJ $cm^{-2}$ and a fluence rate of 0.56 mW $cm^{-2}$.

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## Single Parents and Children Raised in a Single Parent Home: How to Provide Relaxation in Interior Environment

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INTERIOR DESIGN

**KELSEY WESTRICK**
INTERIOR DESIGN

**FACULTY MENTOR:** Susan Ray-Degges, Ph.D. – School of Design, Architecture and Art

Using a mixed methods approach, the survey targeted people over the age of 18 who were either single parents or children of a single parent. Results from the single-parent participants and children of single parents reveal the significant stressors that they faced in their lives. The data sheds light on the importance of natural light, biophilia, and various interior elements such as textures, materials, and color schemes in promoting relaxation for these individuals. The survey also captures the significance of social interaction for children, indicating the need for spaces that balance solitude and group activities. The study found that creating wellness spaces tailored for single parents requires a holistic approach, considering both the needs of parents and their children. Integrating childcare services within wellness facilities is crucial in addressing single parents' time constraints. Having an integrated childcare facility allows the parent to fully de-stress and take time for personal wellness in which they wouldn't otherwise have the means to do. Design elements such as natural light, biophilia, soft music, and thoughtful spatial planning contribute significantly to the overall sense of relaxation for single parents and their children. The research findings provide valuable insights for designing community wellness spaces that promote inclusivity and well-being for single-parent families. The insights gained from this research offer a foundation for future design decisions, promoting the development of community wellness spaces, and catering to single-parent households' unique challenges and preferences.

## Carnivore scents elicit investigatory behavior of carnivores

**KOBY PEARSON-BORTLE**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Matthew Smith, Ph.D. – Biological Sciences

Organisms, such as mammals, use scents from other animals to obtain information for survival, predation, competition, and reproduction. Scent lures made up of animal musk, glands, and urine have been used to attract mammalian carnivores for trapping, hunting, and research purposes. Despite the vast usage of scent lures, there is a lack of knowledge in the effectiveness of using predator scents to selectively attract carnivores. To fill in this gap of knowledge, we examined the attractiveness of carnivores between a prey scent, beaver gland, and two carnivore scents, mink gland and bobcat gland. Carnivores that were in the vicinity of the scent were observed using camera traps. We also assessed their behavior if they investigated the scent by sniffing or were simply passing by. The results show that there was no difference in the number of observations between the three scents. However, there was a significant difference in the behavior for each scent, showing that carnivores investigated mink and bobcat gland more often than beaver gland. In the species observed, it was also found that behaviors varied between species and scents. Our findings show that scent surveys should take a step further and observe the behaviors of carnivores instead of just the number of observations. Deploying carnivore scents is a better alternative than prey scents to selectively attract carnivores.

## Does Perceptual Salience Affect Artificial Language Learning?

**JADA PERSAUD**
PSYCHOLOGY

**FACULTY MENTOR:** Erin Conwell, Ph.D. – Psychology

What makes a language easier for people to learn? We addressed this question using an artificial language consisting of a prefix form and a reduplication form. The prefix language used the affixes te- and po-, to indicate the singular and plural, respectively. The reduplication language used partial reduplication to indicate the singular and total reduplication to indicate the plural. About one third of the plural words in this study were irregulars. The irregular words followed the pattern of the other language. Participants' learning was tested through both production and comprehension tasks. The results of this study indicate that the more perceptually salient language (reduplication) was harder for participants to learn than the affix version. The regular words were also harder for participants to learn. Although reduplication seems more perceptually salient, participants learned the affix language more easily possibly due to their familiarity with affixes.

## Maximizing Future Career Potential: The Benefits of Getting an Internship and Job

**ASHLEY PETERS**
CIVIL ENGINEERING

**FACULTY MENTOR:** Thomas DeSutter, Ph.D. – AES School of Natural Resource Sciences

Getting internships or similar job openings is a pivotal step in shaping one's future career trajectory. This abstract discusses the many-sided advantages of obtaining opportunities. Initially, gaining hands-on experience equips individuals with practical skills and insights crucial for success in their chosen field. Furthermore, these opportunities provide a platform for individuals to gain a deeper understanding of their prospective roles, allowing them to align their career aspirations with the reality of the profession. Furthermore, the learning opportunities presented through internships and similar positions foster continuous personal and professional growth. Most significantly, engaging in such experiences opens doors to a wide variety of new opportunities, ranging from networking connections to potential employment prospects. In conclusion, this abstract highlights the benefits of gaining experience through internships and similar positions in shaping a promising and fulfilling career.

## Double Ditch

**SHAE PFENNING**
ANTHROPOLOGY

**FACULTY MENTOR:** John Creese, Ph.D. – Sociology and Anthropology

Double Ditch is a Nationally Registered Historic Site located North of Bismarck, North Dakota, and was home to the Nueta Tribe from 1490 to 1785. The people of Double Ditch lived in round earth lodges that made visible permanent depressions in the earth. The depressions in the earth from the lodges as well as the multiple ditches surrounding these depressions made this site appealing to archaeological and anthropological research because it gives a physical representation of the society's population. Analyzing research findings from archaeological work performed on this site in 2001, that was originally planned for mapping the area of Double Ditch for future management of the site, they found two more ditches that are not visible from the Earth's surface. This finding points researchers to believe that the society had a much deeper history than originally thought. Combining the archaeological findings, the history of these people that made this site their home, and the smallpox virus that nearly wiped them out will give people more knowledge behind the site and treat it and its ancestors with respect and not just a wonder of North Dakota.

## Brine Spills in North Dakota: Analyzing Trends and Impacts (2020-2024)

**SOPHIA PORTNER**
Natural Resource Management

**FACULTY MENTOR:** Thomas DeSutter, Ph.D. – AES School of Natural Resource Sciences

**OTHER CONTRIBUTORS:** Aaron Ostlund, School of Natural Resource Sciences

I collected data on all of the produced water spills reported to the North Dakota Environmental Quality in the last 3 years. Data was analyzed for where in the state the spill occurred, where in the drilling process it occurred, how much was spilled, how far the spill went, the land and surfaces affected, and what protective and later clean up measures were taken. This data will be used to support further research into produced water spill land reclamation and its necessity.

## Assessment of Mechanical Performance of Thermal Spraying Metallized Polymeric Coatings in Harsh Environment Utilizing Sensor Technology

**KATHRYN QUENETTE**
CIVIL ENGINEERING

**FACULTY MENTOR:** Ying Huang, Ph.D. – Civil, Construction and Environmental Engineering

The objective of this project is to investigate the mechanical properties of thermal spraying metallized polymer coating system in harsh environments, employing embedded distributed fiber optic sensors to enable in-house sensing capabilities. Specifically, the innovative coating system aims to enhance the mechanical characteristics of polymer coatings. Thermal spray metallization of polymer-based structures is defined as the application of thermal spray processes to deposit metals onto a polymer substrate. The most commonly applied polymer materials for two different environmental conditions were tested as primers layers. Various metallization material combinations were designed and examined, including pure ZN, A1-15Zn alloy, and A1-50Zn pseudo alloy. Mechanical properties such as hardness and Young's modulus, along with bond properties including bond strength and adhesion, were tested and used as an evaluation criterion to select materials for application in harsh and aggressive environments. The hardness and adhesion test results showed a significant enhancement in the mechanical performance of polymers through wire arc thermal spraying metallization. In addition, to assess the impact of metallization on polymer coating performance and to monitor its real-time performance changes in harsh environments, distributed fiber optic sensors were embedded within the base polymeric coating layer and the metallization layer. The corrosion resistance of the proposed coating system is still being tested.

## Enhancing Epoxy Coatings with Carbon-Based Nano-additives: Mechanical, Anti-abrasion, and Adhesion Properties

**KATHRYN QUENETTE**
CIVIL ENGINEERING

**FACULTY MENTOR:** Ying Huang, Ph.D. – Civil, Construction and Environmental Engineering

This study investigated the enhancement of epoxy resin properties via the introduction of three distinct carbon-based additives: carbon nanotubes (1-D), graphene nanoplatelets (2-D), and nanodiamonds (0-D), representing one-, two-, and zero-dimensional nanoparticles, respectively. The integration of these additives aims to improve polymeric coatings that are applied on various surfaces, by elevating the strength, durability, and resistance to environmental factors such as abrasion. The methodology employed involves the preparation of homogeneous dispersions of epoxy resin with varying concentrations of carbon additives (0.5 to 2.0 wt.%), achieved through high-shear mechanical stirring and ultrasonication. These prepared mixtures were then applied as coatings on steel panels or cast into dogbone-shaped specimens and cured for seven days prior to mechanical evaluation. The study assessed tensile strength, abrasion resistance, and adhesion, examining the effects of varying concentrations of additives. Preliminary results demonstrate that each type of additive distinctly impacts the mechanical and anti-abrasion properties of the epoxy, highlighting the significant role of nanoparticle shape. Moreover, the results indicated that changes in additive concentration further influence these properties. Therefore, this investigation offers valuable insights into the field of advanced coating technologies, and the successful outcomes have the potential to lower maintenance demands and support the integrity management of civil infrastructure.

## Sensitivity of the *Diaporthe aspalathi*, *D. caulivora*, and *D. longicolla* strains causing soybean (*Glycine max* L.) disease to the fungicide Fluopyram

**DILOROM RASULEVA**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Febina Mathew, Ph.D. – Plant Pathology

*Diaporthe*-associated diseases have resulted in an estimated total yield loss of USD 5.8 billion across 29 U.S. states and Canada (Ontario) between 1996 and 2021. Succinate dehydrogenase inhibitor (SDHI)-based foliar fungicides have been increasingly used in U.S. soybean production for disease management. In this study, a total of 55 isolates of *D. aspalathi, D. caulivora*, and *D. longicolla*, obtained from diseased plants sampled from commercial soybean fields, were subjected to in vitro testing using fluopyram-supplemented medium. The objective was to determine the effective fungicide concentration at which 50% of the mycelial growth was inhibited (EC50). The technical grade formulation of fluopyram (SDHI; 98.91% a.i.; Bayer Crop Science) was dissolved in acetone to obtain a stock solution of 100 mg/ml. Fungicide sensitivity was assessed by measuring the radial mycelial growth on 2% water agar supplemented with 0, 0.001, 0.01, 0.1, 1.0, 10, and 100 µg/ml fluopyram. The experiment was conducted twice in a completely randomized design, and each isolate was inoculated with a 6-mm-diameter mycelial plug onto three replicate plates with varying fungicide concentrations. The plates were incubated for five days at 22°C in the dark before measuring the mycelial growth. Significant differences in EC50 values were observed among the isolates of *D. aspalathi* (0.044 to 10.544 µg/ml; $P<0.0006$), *D. caulivora* (0.335 to 8.416 µg/ml; $P<0.0001$), and *D. longicolla* (0.108 to 1.586 µg/ml; $P<0.0001$). These EC50 values could be used in a fungicide resistance monitoring program to determine whether shifts in sensitivity to fluopyram fungicides are occurring in *Diaporthe* populations.

## Effects of Glutathione S-Transferase pi-1 (GSTP1) Knockdown on Pancreatic Cancer Cells

**KATHERINE SCHMIDT**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Katie Reindl, Ph.D. – Biological Sciences

**OTHER CONTRIBUTORS:** Jenna Duttenhefner, Biological Sciences

Pancreatic ductal adenocarcinoma (PDAC) is one of the leading causes of cancer-related deaths in the world with a 5-year overall survival rate of only 13%. Treatment options such as surgical resection followed by chemotherapy and radiotherapy are effective at hindering tumor growth and metastasis. However, only 15% of patients are diagnosed early enough to receive surgical resection. For the remaining 85% of PDAC patients, chemotherapy and radiotherapy are used, but these treatments are often ineffective and extend patient survival by less than a year. Therefore, there is a need to identify new therapeutic targets to enhance treatment efficacy and increase PDAC patient survival. Glutathione S-transferase pi-1 (GSTP1) is an antioxidant enzyme that plays an important role in cellular homeostasis and is known to be overexpressed in PDAC. Knockdown of this gene in PDAC cell lines reduced cell proliferation and increased oxidative stress, demonstrating its potential as a novel therapeutic target. We aimed to further understand the effects of GSTP1 knockdown on cell signaling and gene regulation in the MIA PaCa-2 PDAC cell line. Doxycycline-induced GSTP1 knockdown had a significant effect on global RNA and protein expression. Here, we present validation of these results using western blotting and qPCR to quantify protein and mRNA expression changes. Reductions in the expression of ALDH7A1, a key regulator in lipid peroxidation and CPT1A, which plays an important role in regulating fatty acid oxidation were observed. Additionally, an increase in the expression of DDAH1, a major regulator of nitric oxide levels, was observed. Additional research into the precise role of GSTP1 in PDAC cells as well as a more comprehensive characterization of the effects of GSTP1 knockdown on PDAC cell lines will support its status as a potential therapeutic target for this life-threatening disease.

## Evaluation of formulated topical oleic acid-containing gels for reducing wound pain in a swine biomedical model

**LINDSAY SEEVERS**
ANIMAL SCIENCE

**FACULTY MENTOR:** Christopher Byrd, Ph.D. – Animal Sciences

Each year, millions of humans and animals rely on pain mitigation strategies to improve their quality of life. However, there is still a need for easy-to-use, effective, and affordable pain-reducing products. This study's objective was to evaluate the use of a formulated topical oleic acid gel for reducing wound pain using a swine pain model. Specifically, we hypothesized that the oleic acid gel would reduce pain behaviors and physiological stress in male piglets following surgical castration (a common husbandry procedure conducted in commercial swine production). At 2 days of age, 24 male piglets were enrolled and randomly allocated to 1 of 3 experimental treatments: 1) non-treated castration (n = 8), 2) scrotal lidocaine injection prior to castration (n = 8), or 3) scrotal topical oleic acid gel application after castration (n = 8). All castration treatment procedures occurred between 0938-1140 hours on experimental day 0 (i.e. 5-7 days of age). Pain-related behavioral data was collected on days -1, 0, +1, and +2 relative to the castration procedure. Specifically, each experimental piglet was observed for a period of 60 minutes each day between 1400-1500 hours. Incidence and duration of pain behaviors (prostration, hind-leg lifting, tail wagging, nursing) were observed continuously. Postural behaviors (standing, lying, sitting) were collected using a 2-minute interval instantaneous sampling method. Additionally, 12 piglets (n = 4 from each treatment) underwent heart rate variability (HRV) collection (a measure of physiological stress) for a period of 60 minutes between 0900-1330 hours on each of the behavioral data collection days. Castrated piglets receiving topical oleic acid gel are expected to show lower incidences of prostration, tail wagging, and hind-leg lifting, as well as a higher duration of standing, compared to non-treated piglets. Additionally, we predict pigs receiving the oleic acid gel will exhibit HRV indices indicative of increased parasympathetic activity (and therefore, lower stress) compared to piglets that do not receive topical oleic acid.

## Monitoring daily and seasonal rhythms of roosting blackbirds using acoustic recording systems and comparing signal intensity with in-field blackbird counts

**MICHELLE STAGL**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**MENTOR:** Page Klug, Ph.D. – USDA-APHIS-Wildlife Services, National Wildlife Research Center

Blackbirds (Icteridae) are a common pest of agricultural fields throughout the United States. In North Dakota, they frequently feed on sunflowers prior to migration, which often coincides with harvest, and causes economic hardship for producers. To effectively mitigate this damage, knowledge of blackbirds' movements across the landscape is needed. Autonomous recording systems (ARS) are monitoring devices that provide a noninvasive method for monitoring large aggregations of birds in difficult to reach habitat. We placed eight ARS in cattail-dominated wetlands (night roosts = 2, day roosts = 6) in North Dakota from September to November (2023) to monitor blackbird (Icteridae) aggregations (06:00AM to 09:00PM). We conducted in-field surveys to evaluate if the number of blackbirds present within 50 m of the ARS could be correlated to the sound intensity from avian calls. We established daily phenology at night roosts, including time of first call, roost departure (morning) and return (evening), and daytime loafing activity (i.e., dB patterns throughout the day). We also evaluated daily phenology of blackbirds occupying cattail roosts within sunflower fields (i.e., day roosts), including arrival (morning) and departure (evening), and timing and intensity of midday loafing periods. We evaluated seasonal fluctuations of avian densities in night roosts, given birds do not roost in the same position or even the same roost every night, and identified the progressive reduction in density as fall migration advanced. Understanding the density of blackbirds in roosting habitat will inform the timing and effectiveness of methods aimed at reducing local blackbird numbers and spreading blackbirds across the landscape to reduce blackbird damage to agricultural crops.

## Advancements in Silicon Wafer Port Fabrication through Mechanical Sandblasting Techniques

**MAKENZI STLUKA**
MECHANICAL ENGINEERING

**FACULTY MENTOR:** Yongki Choi, Ph.D. – Physics

This study explores the application of microsandblasting techniques for creating port holes on silicon wafers intended for use in microfluidic deterministic lateral displacement (DLD) devices. Through systematic experimentation and analysis, this research evaluates the effectiveness of microsandblasting in achieving precise port hole formation while minimizing surface damage. The study concludes that the optimal distance for consistent and accurate port hole creation is 4.5 mm away from the silicon wafer. Although alternative distances are feasible, they may yield more variable results. Throughout the investigation, emphasis is placed on maintaining a clean wafer surface to ensure correct conditions for the succeeding step of photolithography is crucial. Findings from this investigation provide valuable insights into the optimization of microsandblasting parameters for port hole fabrication on silicon wafers, offering significant implications for microfluidic device manufacturing processes.

## A Systematic Review of the Reintroduction of Elk into Eastern North America

**JACOB SUMMERS**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Angela Hodgson, Ph.D. – Biological Sciences

Rocky Mountain Elk were once the most common species of ungulate in North America. That is until the Euro-American colonizers ran the species all the way down to just a few pockets left in the western United States. Thanks to reintroduction efforts and successful management of hunting and habitat, they have slowly grown in numbers once again to be a healthy species. Although they are nowhere near the population size they once were, they are slowly making progress. For this study, we conducted a systematic review of primary literature to aid wildlife biologists in their own reintroduction efforts. Data on elk displacement and forage use was compiled from 12 different reintroduction sites. Each site was carefully selected to be on the Eastern half of the U.S. and had data that showed the maximum displacement or the diet selection of the re-introduced herds. The data for displacement was separated, young vs the old and the male's vs females and the data for the diet selection was organized by season. A meta-analysis showed there was no significant difference in average maximum distance traveled from the release site between adults and yearlings at six months ($p=0.42$). However, at 12 months post release, adults traveled significantly longer distances than yearlings (mean difference equals 8.48Km, $p=0.002$). When separated by sex, our data showed no significant difference in distance traveled post release at both six months ($p=0.15$) and twelve months ($p=0.73$). We also studied the variation on diet selection of forbs, graminoids, and shrubs compared across seasons. ANOVA showed there is no significant difference in forage consumption between these categories during the fall, but there is a trend showing a preference for graminoids. During the spring there is also no significant difference in the diet, yet there is a preference for the consumption of shrubs and forbs and a lack of graminoid consumption. During the summer months there is a significant difference with elk eating more forbs than graminoids. We found variation in elk diet across release sites however, this can vary based on location of the herd. For example, North Dakota elk showed a much heavier graminoid diet than other herds because of the lessened availability of forage in other categories. Overall, there is a preference for shrubs and forbs in the spring, this is most likely due to the sprouting trees and bushes that give the first available greenery to the landscape. In the summer, forbs are the preferred choice of forage. Because all categories of forage are in abundance in the summer and forbs are preferred, it can be inferred that forbs are the most desirable forage. During fall, forbs are dead or dying and shrubs are now losing their leaves and their nutritional value, which could explain why there is a trend for graminoids to be the most consumed forage in the autumn months.

## Genetic integration of morphology and behavior in *Gryllus integer*

**KATY TAKUMI**
BIOLOGICAL SCIENCES, RAMP PROGRAM - CHANGE NETWORK

**FACULTY MENTOR:** Ned Dochtermann, Ph.D. – Biological Sciences

Morphology and behavior are known to be intertwined, as morphology can limit the behavioral patterns an individual is capable of, or influence which behavioral choice is optimal for an individual. These connections can also be genetic: just as genetic correlations can link behaviors in a behavioral syndrome, genetic correlations can also link behaviors to morphological traits. Here, we measured morphological features and behavioral responses of western trilling crickets (*Gryllus integer*) collected from four different populations and across several generations. Using the program ImageJ measurements of the head width, pronotum width, pronotum length, femur length, and ovipositor length, were recorded from individuals used in a previous study that investigated behaviors relating to risk taking, open field exploration, and antipredator response. We found correlations that connected morphology and behavior, as well as connections between behaviors and between morphological traits. Correlations varied by population and by generation but shared a similar pattern. Our results expand the understanding of how behavioral syndromes are maintained across populations that differ in their environmental conditions: a shared relationship among genetics, morphology, and behavior.

## Aryl hydrocarbon receptor regulates mitochondrial dynamics in human airway smooth muscle cells

**CHEYENNE TANDBERG**
BIOLOGICAL SCIENCES

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Rationale: Asthma is an inflammatory disease of conducting airways which is associated with abnormal airway responsiveness and remodeling. Airway smooth muscle (ASM) is a major structural cell type of the airway that contributes to airway responsiveness and remodeling. The aryl hydrocarbon receptor (AhR) is a ligand-activated transcription factor which senses environmental pollutants, microbial components, and regulates cellular homeostasis. AhR has been proven protective against inflammation in different cell types and diseases, however, it has been less explored in ASM and asthma. Mitochondrial dynamics, which are known as mitochondrial fission/fusion, is a response of mitochondria to stress within the cell. Inflammation alters these mitochondrial dynamics in asthma. However, how AhR regulates these mitochondrial dynamics in ASM during inflammation and asthma is not known. Therefore, in this work I explored the role of AhR in regulating mitochondrial dynamics 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 Automated Live Cell Imaging system (Biotek). The mitochondrial images were processed using ImageJ and Mitomorph to calculate the form factor/aspect ratio. Furthermore, In the similar settings ASM cells were processed to determine the expression of mitochondrial genes and proteins using qPCR, and Western blotting. Results: TNFα treated human ASM cells demonstrated enhanced form factor and aspect ratio 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. Conclusion: To conclude we found activation of AhR in human ASM cells protects from inflammation induced-alteration in mitochondrial dynamics. This work is clinically significant as it has potential to bring new therapeutic targets to control mitochondrial dynamics in ASM during inflammation and asthma.

## Targeted Synthesis of Warfarin Analogs via β,β - Disubstituted Michael Acceptors

**CURTIS THOMPSON**
CHEMISTRY

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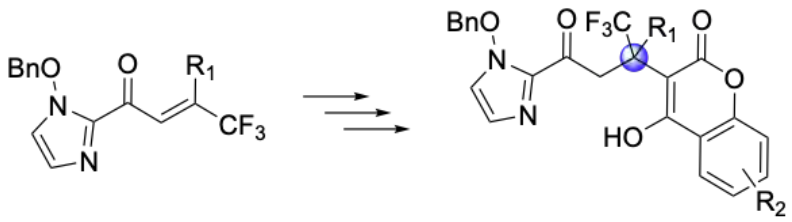


The synthesis of novel warfarin analogs holds significant promise for enhancing therapeutic efficacy and minimizing adverse effects. Warfarin, an anticoagulant drug used to prevent and treat blood clots, contains a chiral center. However, warfarin as a medication exists as a racemic mixture of two enantiomers, with one being more potent than the other. To better enhance the regulation and efficacy of Warfarin, analogs incorporating a quaternary carbon center were designed. To complete the targeted synthesis of the newly developed Warfarin analogs, it was essential to carry out the selective synthesis of β,β--disubstituted Michael acceptors. Our findings related to the method design and development of both the β,β--disubstituted Michael acceptors and warfarin analogs will be presented.

## Unveiling the Potential of Allelopathic Potential of Moss

**MARISSA TIEGEN**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Steven Travers, Ph.D. – Biological Sciences

Allelopathic activity is a biochemical process where a plant species restricts the growth or germination of nearby competing species. I was interested in the potential for moss and liverwort species to allelopathically interfere with the growth of nearby flowering plants and thus reduce the competition for light and nutrients. My hypothesis was that multiple species of non-vascular plant could reduce the root growth rate of lettuce seedlings because the non-vascular plants release inhibitory chemicals. The experimental design was to create "agar sandwich plates" that consisted of two layers of agar with dried moss or liverwort material between them and then measure the growth rate of lettuce seedlings placed on top. There was no effect on the germination or growth rate of the lettuce seeds when plated with the liverwort relative to controls. Moss species similarly did not reduce growth rate of lettuce. Thus, I conclude that there is yet no evidence of allelopathic interactions between these two non-vascular plants and lettuce. However, these types of interactions are generally species specific and warrant additional studies.

## DFT insights into homoleptic and heteroleptic Cu(I) coordinated complexes as potential photosensitizers

**GRACE TIFFANY**
BIOCHEMISTRY AND MOLECULAR BIOLOGY

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Metal coordinated complexes have important potential applications as photosensitizers and emitters, at the red to near-infrared spectral range, in photovoltaics, photocatalysis, and photodynamic therapy. Obtained insights into the relationship between the structure and optical properties of these metal coordinated complexes are important for these potential applications. Ideally, these compounds would be redshifted, optically active, and possess metal to ligand charge transfer. Copper is a particular metal of interest, as it is both an earth abundant metal and may minimize side effects if used in a in bio- and medical applications. Our studies utilize a computational approach to investigate optical properties, more specifically we utilize Density Functional Theory (DFT) and Time-Dependent DFT (TD-DFT) to investigate the ground and excited state properties of Cu(I) bipyridine-based complexes. Validation of the functional used in calculations was done in comparison to experimental absorbance spectra of three synthetically produced Cu(I) complexes. We investigate the effect of the conjugation length of ligands and electron donating/withdrawing ability of their substituting groups on the absorption spectra of Cu(I) homoleptic and heteroleptic complexes. Our analysis of natural transition orbitals shows metal to ligand charge transfer character in most of the lowest optical transitions, which a desired characteristic. Furthermore, heteroleptic compounds result in more redshifted absorption, up to 53 nm, compared to their homoleptic counterparts. However, binding energy calculations imply that many of the homoleptic compounds are more favorable thermodynamically, which may lead to challenges when it comes to the synthesis of their heteroleptic counterparts. Ligand conjugation did positively impact the absorption properties, but that effect was especially significant when nitrogens, which have electron withdrawing capabilities, were added to the extended conjugation. This conjugation trend is only valid within the comparison of either homoleptic or heteroleptic compounds, as homoleptic compounds were less redshifted than the heteroleptic counterparts, despite homoleptic compounds intrinsically having more conjugation.

## Neuroendocrine mechanisms responsible for the transition in feeding behavior related with migratory preparation in red-winged blackbirds

**ALEXIS TRESTER**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Timothy Grieves, Ph.D. – Biological Sciences

Long-distance migration is a phenomenon observed in many bird species across the world. This migration requires extensive lipid storage to fuel such an energy-intensive event. However, little is known about the specific neuroendocrine mechanisms inducing hyperphagia (a drastic increase in feeding behavior) in preparation for migratory flight. Here we will examine changes in two hunger-inducing (orexigenic) genes, ghrelin receptor (*GHSR*) and neuropeptide Y (*NPY*), and two hunger-suppressing (anorexigenic) genes, leptin receptor (*LEPR*) and cocaine- and amphetamine-regulated transcript (*CART*). We collected brains from red-winged blackbirds (*Agelaius phoeniceu*s) from the late summer (September), when birds are molting and beginning to aggregate in roosts to prepare for migration, up to their migratory departure in the fall (early November). We then extracted RNA from hypothalamic tissue punches and quantified expression of the four aforementioned genes using qPCR. We hypothesize that individuals from later in the fall will be closer to migration and therefore show significantly higher expression of hunger-inducing genes and significantly lower expression of hunger-suppressing genes. In addition, a triglyceride assay was performed on trunk blood collected from each individual. Given that high concentrations of triglycerides in circulation are associated with fattening in migratory birds, we predict that those with higher concentrations will also have significantly higher expression of hunger-inducing genes. Our findings will provide insight into the mechanisms that influence seasonal obesity that provides fuel for migratory flight, and a better understanding of these mechanisms could provide targets for treatment of obesity

## Ab intitio Modeling of Superconducting Materials by Exploring Excited Electronic Configuration

**WILLIAM TUPA**
PHYSICS, MATHEMATICS

**FACULTY MENTOR:** Dmitri Kilin, Ph.D. – Chemistry and Biochemistry

The high-pressure hydrogen sulfide material modified by methane keeps its superconductive properties when at room temperature. This makes it a great candidate for industrial applications such as railway systems and power plants. We explore the electronic configuration features of this material relevant to superconductivity. Modification of electronic configurations includes changing the population of electronic states with certain values of spin projection, momentum, and energy. We specifically focus on configurations of electrons with opposite spins and opposite values of momentum interacting via lattice, referred to as Cooper pairs. The goal of this ab initio research is to show that these pairs are available to form in the sulfur trihydride material and can serve as the rational reason for superconductivity. The computed total energy of each electronic configuration is compared to the total energy of the reference neutral singlet configuration.

## Implant Beeswax Coating Delivering Antimicrobial and Pain Relief

**SOPHIE VIGER**
MECHANICAL ENGINEERING

**FACULTY MENTOR:** Chad Ulven, Ph.D. – Mechanical Engineering

Of the 800,000 knee joint replacements performed in the United States each year, one percent of them unfortunately lead to infection. The typical pain level for patients after surgery is as worse or higher than their worst days of pain before surgery, for up to two weeks. This study introduces a multi-purpose coating for knee joint implants, incorporating beeswax and lidocaine to provide multiple benefits. The coating aims to prevent infections and manage pain. Beeswax, commonly used in cosmetics and known for its antimicrobial properties, forms a protective barrier against bacteria, reducing infection risks. The beeswax also becomes the carrier of the lidocaine into the synovial fluid. Lidocaine, a local anesthetic, offers pain relief. The ultra-high molecular weight polyethylene knee joint implants are inherently difficult to adhere a coating to and require some surface modifications. When creating the specimen, salt was incorporated in the outer ring of the polymer and diluted out post processing. This is to create pores on the outside of the specimen, so the beeswax can adhere to the polymer. Making these specimens with salt has caused some processing complications. It has been difficult to get the salt evenly distributed throughout the ring, causing a lot of trial and error. After optimizing the process to manufacture the specimen, performance characterizations will be conducted including compression testing, fatigue, and biocompatibility testing.

## Interplay of Rhizobium Strains: Investigating Conditional Sanctioning Dynamics in Legume-Rhizobium Mutualism

**CADY WANG**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Barney Geddes, Ph.D. – Microbiological Sciences

Legume plants can form a symbiotic relationship with nitrogen-fixing rhizobia, a soil bacterium capable of transforming atmospheric nitrogen into ammonia, a vital nutrient for the plant, and in return, providing carbon. Through a process described as sanctioning, legume plants discriminate between strains based on their efficiency, curbing carbon supply to reduce the rhizobial fitness of ineffective strains and reducing their fixation rates. Utilizing native North Dakotan rhizobia strains, this project tested legumes' sanctioning capabilities by cataloging the effect sanctioning has on legume and nodule growth. The Golden Gate Cloning Method was used to tag root nodule-forming rhizobia with fluorescence proteins to differentiate between multiple rhizobia strains. Additionally, to guarantee equal opportunities between rhizobial strains in the initial stages, all rhizobial strains were diluted to the same concentration utilizing optical density readings. Data was visualized and analyzed by the program Project PRISM to conduct one-tailed t-tests. Effective nitrogen-fixating rhizobial strains witnessed significant increases in nodule size when co-inoculated with less efficient strains ($p < 0.0001$) compared to the same strain inoculated on its own. While the less efficient strains did not demonstrate a comparable decline in size, a significant decrease in nodule numbers existed. This study shows legumes can make highly informed conditional decisions to favor more efficient rhizobial strains. Further experiments would aim to uncover and discover the nature behind unidentified nodules found on some legume plants.

## Impacting STEM Futures: Evaluating the Success and Influence of the ND-ACES Distributed Research Experience for Undergraduates

**JOSHUA WARD**
BIOLOGICAL SCIENCES, BUSINESS ADMINISTRATION

**FACULTY MENTOR:** Danielle Condry, Ph.D. – Microbiological Sciences

The New Discoveries in the Advanced Interface of Computation, Engineering, and Science (ND-ACES) is a cooperative agreement awarded by the National Science Foundation (NSF) and operates across eleven institutions in North Dakota as part of the ND EPSCoR. Part of the Educational and Workforce Development (EWD) pillar is a distributed Research Experience for Undergraduates (dREU). The dREU aims to match undergraduate students interested in research at primary undergraduate institutions (PUIs) and tribal colleges and universities (TCUs) with graduate students and professors at the two Research Intensive (RI) universities in the state. The dREU students spend the summer at the RI University starting their research project and then continue their project, with collaborating faculty mentors, back at their primary institution during the fall and spring semesters. This study analyzes the impact and fulfillment experienced by undergraduate researchers participating in the ND-ACES dREU. This was done by sampling a myriad of critical metrics such as pre/post survey of experience during ND-ACES dREU, personal perceptions of skills gained, return to research, and persistence in STEM. The research findings indicate that student participants in the ND-ACES dREU program have achieved success and satisfaction in their research endeavors. Post-program surveys revealed heightened key competencies like communication, teamwork, and ethical research practices. Furthermore, participants showed persistence in remaining in STEM fields after the experience. Analysis of pre/post-survey data suggests that some participants who had not initially planned to pursue STEM careers have been inspired to do so following their involvement in these programs. This study shows the ND-ACES dREU fosters academic and professional growth among undergraduate students and plays a crucial role in encouraging and sustaining interest in STEM careers, thereby contributing to the broader goals of enhancing the STEM workforce pathway.

## Predicting Acute Oral Toxicity Using Regression Machine Learning

**MADELEINE WILLIAMS**
BIOLOGICAL SCIENCES

**FACULTY MENTOR:** Bakhtiyor Rasulev, Ph.D. – Coatings and Polymeric Materials

Acute oral toxicity testing is used to gain insight into the biological activity of chemicals. Through acute oral toxicity testing, the LD50 value it found. Many industries require that acute oral toxicity testing be done for regulation purposes. Animal testing must be done to calculate LD50 values. A QSAR model predicting the LD50 values for a wide range of molecules would reduce the amount of animal testing necessary. In this study, a QSAR model was developed to predict the LD50 value for chemicals in the rat acute oral toxicity dataset found in the Integrated Chemical Environment (ICE). ICE is a comprehensive collection of toxicity datasets curated with the intention of developing methods to replace animal testing. The ICE dataset has a wide array of chemical compounds, making the prediction of LD50 values difficult. In this work the ICE dataset was cleaned; duplicates and mixtures were removed. The CASID's provided in the ICE dataset were converted to SMILES strings, which were optimized using rdkit. Alvadesc was used to calculate mathematical descriptors, which were used to develop multiple models. Gradient boosting regressor was identified as the most robust model, and hyperparameter tuning was done to optimize the model's performance. This work resulted in a model capable of predicting LD50 values for a wide range of chemicals, which can be used in future works to reduce the amount of animal testing necessary.




# gamma sigma delta participants

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**Natalie Visich**
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**Maria Batool**
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**Aliashgar Bazrafkan**
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# Management Of Sclerotinia Leaf Blight Caused By *Sclerotinia Sclerotiorum* In Sugarbeet (*Beta Vulgaris* L.)

**MAYOWA ADEROJU**
PLANT PATHOLOGY

**FACULTY MENTOR:** Mohamed Khan, Ph.D – Department of Agriculture and Natural Resources

Background: Recent studies have reported *S. sclerotiorum* (Lib.) de Bary as an emerging pathogen of sugar beet (*Beta vulgaris* L.) causing leaf blight, seedling damping off and root necrosis, becoming a fundamental production problem in the Red River Valley of North Dakota and Minnesota. The continuous spread of this pathogen's damaging impact across sugarbeet-producing states necessitates proactive management measures to reduce the risk of potential outbreaks. This study aimed to (1) assess inoculation methods for sugarbeet reaction to *S. sclerotiorum*, varietal response and cross-infectivity, and (2) evaluate fungicide efficacy against Sclerotinia leaf blight three sugarbeet varieties. Methods: Disease evaluation was measured as lesion size. Results: Results from this study indicated that colonized barley inoculum was particularly effective in causing leaf blight on sugarbeet plants ($P$=0.05). Crystal M837 variety showed reduced susceptibility to Sclerotinia leaf blight. Proline and Priaxor provided the most effective control against Sclerotinia leaf blight ($P$=0.05). Cross-infectivity showed that any *S. sclerotiorum* isolates could cause disease in sunflower (*Helianthus annuus* L.), soybean [*Glycine max* (L.) Merr], sugarbeet and canola (*Brassica napus* L.) plants. However, sunflower and canola respectively showed the most susceptibility during the cross-infectivity evaluation both in the detached leaf assay and in the in-planta study. These findings offer critical insights into sugarbeet variety and fungicide selection for effective control of *S. sclerotiorum*. Also, vital information about the cross-infectivity status of major host crops (soybean, sunflower, and canola) provides valuable information for crop rotation decisions towards mitigating losses caused by *S. sclerotiorum*. Conclusion: This study gives a first look into managing S. sclerotiorum, an emerging pathogen of sugar beet and a potential threat to the sugar beet industry.

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1 Bhuiyan, M. Z. R., Lakshman, D. K., Mendoza L. E. D., Mosher, P., and Khan, M. F. R. 2021. *Sclerotinia sclerotiorum* (Lib) deBary causes root rot and necrosis in sugarbeet in Moorhead, MN, USA. J Plant Prot. Res. 61:384–391.

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## Efficacy Of Fungicides In Controlling Seedling Damping-Off And Root Necrosis Caused By *Sclerotinia Sclerotiorum* In Sugarbeet

**MAYOWA ADEROJU**
PLANT PATHOLOGY

**FACULTY MENTOR:** Mohamed Khan, Ph.D – Department of Agriculture and Natural Resources

Background: *Sclerotinia Sclerotiorum* (Lib.) de Bary has been reported to cause seedling damping off, root necrosis and leaf blight in sugarbeet (*Beta vulgaris* L.), becoming an emerging threat to the sugarbeet industry. However, at the moment there is no available information on the management of *S. sclerotiorum* in sugarbeet. This begs for a proactive need for practical management options to control Sclerotinia diseases in sugarbeet. The objective of this study evaluates common fungicides registered for use in other host crops in the Red River Valley of North Dakota and Minnesota for their control efficacy in managing (1) seedling damping off and, (2) root necrosis caused by *S. sclerotiorum* in sugarbeet. Methods: Disease evaluation was measured as lesion size post-inoculation. Results: Results from this study indicated that ACH 166 and Beta 7029 were considered moderately resistant to root infection at all stages ($P$= 0.05). Also, these findings showed that the leaf stage at the time of inoculation plays a significant role in sugarbeet susceptibility to root infection ($P$= 0.05). Proline and Priaxor respectively showed significant control efficacy in reducing seedling damping off, and root necrosis ($P$= 0.05). These findings offer critical insights into fungicide selection for effective control of *S. sclerotiorum* in sugarbeet. Also, vital information about leaf stages and varietal susceptibility provides valuable insights that could help in the development of a robust and integrated fungicide management program towards mitigating losses caused by *S. sclerotiorum* in sugarbeet. Conclusion: This study gives a first look into the fungicide management of *S. sclerotiorum*, an emerging pathogen of sugar beet and a potential threat to the sugarbeet industry.

References

1. Bhuiyan, M. Z. R., Lakshman, D. K., Mendoza L. E. D., Mosher, P., and Khan, M. F. R. 2021. *Sclerotinia sclerotiorum* (Lib) deBary causes root rot and necrosis in sugar beet in Moorhead, MN, USA. J Plant Prot. Res. 61:384–391.
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## Discovery of Molecular Markers for Rapid Development of Disease Resistant Cultivars of Canola

**ZABANGIR ALAM**
PLANT SCIENCES

**FACULTY MENTOR:** Mukhlesur Rhaman, Ph.D. – Department of Plant Sciences

Background: *Brassica napus* L., with a trace amount of erucic acids, glucosinolates, and rich amounts of unsaturated fatty acids, is known as Canola, the world's second most important oil crop. Canola oil is known to promote brain development in infants, prevent heart disease in adults, and protect men and women from colon and breast cancer. *Sclerotinia sclerotiorum* is a soil-borne and necrotrophic fungus that severely infects and causes Sclerotinia Stem Rot (SSR) disease in Canola, costing billions of US dollars. Applying chemical fungicides is not always effective, economical, and eco-friendly. Therefore, it is essential to identify the SSR-resistant canola germplasms. However, morphological screening for SSR resistance is time-consuming, labor-intensive, and costly, necessitating molecular screening. KASP (Kompetitive Allele Specific PCR) marker has the potential to identify the SNP (Single Nucleotide Polymorphism) markers associated with disease resistance. Our objectives were to select stable and significant SNP markers associated with SSR resistance, design KASP primers, and evaluate the efficacy of KASP markers for screening SSR resistance in Canola. Methods: We selected 70 stable and significant SNPs, extracted 100 bases upstream and downstream of the selected SNP position from the reference genome, and designed two forward and one common reverse primer for each SNP marker. DNA was extracted from both resistant and susceptible *B. napus* accessions. PCR was carried out for the most important 47 sets of SNP markers. Results: Among them, 34 sets of KASP primers amplified the target region of the genome, and only seven KASP markers could identify and distinguish resistant lines from the susceptible lines of Canola. Out of these seven, only one KASP marker consistently distinguished resistant canola line with high yield potential. Conclusion: Our results indicate the rapid progress toward developing resistant canola cultivars with high yield potential.

Md Zahangir Alam[1], Luis E. del Rio Mendoza[2] and Mukhlesur Rahman[1]

## A Genome-Wide Association Study Of Sclerotinia Basal Stalk Rot Resistance In Cultivated Sunflower

**SRUSHTIDEEP ANGIDI**
PLANT PATHOLOGY

**FACULTY MENTOR:** Julie Pasche, Ph.D. – Department of Plant Pathology

Background: Sclerotinia basal stalk rot (BSR) is a significant disease affecting worldwide sunflower production. It is caused by the necrotrophic fungal pathogen *Sclerotinia sclerotiorum*. The resistance to this disease is quantitative and genetically complex. Methods: To determine the genetic basis of BSR resistance in sunflower (*Helianthus annuus* L.), genome-wide association mapping was conducted. A diverse panel of 287 sunflower genotypes was inoculated with *S. sclerotiorum* isolate NEB-274. BSR response data were collected using two disease descriptors: mean days to death (MD) and area under the mortality curve (AUMC). The genotyping data consisted of 3.2 million single nucleotide polymorphisms (SNP) markers identified by re-sequencing of the association mapping population. The phenotypic data were correlated with SNP marker data to identify quantitative trait loci (QTL) associated with BSR resistance. Results: The results discovered 10 QTLs with MD and 11 QTLs with AUMC associated with BSR. Conclusion: These identified loci will be used in the future breeding pipeline to develop sunflower hybrids with improved resistance to BSR, employing marker-assisted breeding techniques.

## Mathematical Modeling, Rupture, and Relaxation Characteristics of Soybean Under Compressive Loading

**EMMANUEL BAIDHE**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**FACULTY MENTOR:** Clairmont Clementson - Department of Agricultural and Biosystems Engineering

Background: The mechanical properties of soybeans are crucial in determining the energy requirements for the oil extraction process. This study aimed to investigate the impact of initial pressing height (20, 30, 50 mm) and loading rate (20, 30, 50 mm min-1) on the rupture and relaxation behavior of three soybean varieties: P23A40E, XF31-32N, and EL30-33. The objective was to gain insights into optimizing the oil extraction process for efficient energy utilization. Methods: Standard methods were employed to determine the physical, gravimetric, and mechanical properties. Compression tests were conducted using a TestResources universal testing machine equipped with 5kN and 25kN load cells for single kernel and bulk soybeans, respectively. Mathematical models were utilized to characterize the load-deformation and relaxation properties of bulk soybeans under compression. Results: Single kernel soybean mechanical properties exhibited significant variation based on variety ($p < 0.05$). In bulk soybeans, variety, initial height, and loading rate significantly impacted rupture energy and modulus of elasticity ($p < 0.05$), whereas only loading rate significantly affected rupture stress ($p < 0.05$). Rupture energy increased with higher initial height and loading rate. Generally, lower loading rates and initial heights tended to produce higher modulus of elasticity, though this was dependent on soybean variety. The study also identified that different mathematical models, such as third-order tangent curve models for P23A40E and EL30-33, and a second-order model for XF31-32N, described single kernel deformation. Meanwhile, bulk soybean load-deformation was described by first- or second-order tangent curve models. The force coefficient of the tangent curve model increased with loading rate, while the deformation coefficient decreased with initial height. Moreover, the findings highlighted a viscoelastic behavior in soybeans, which diminishes as loading rates increase. The relaxation behavior of bulk soybeans was best described by the five-element Maxwell model. Conclusion: This study emphasizes the importance of considering loading behavior, as well as the physical and gravimetric attributes of soybean grains, when devising energy-efficient techniques for soybean oil extraction.

## Advancing Great Plains Crops For Food Ingredients with Added Value Integrating Antioxidant Activity, Glycemic Control, and Abiotic Stress Tolerance

**KATLYN BALSTAD**
ENVIRONMENTAL CONSERVATION SCIENCE

**FACULTY MENTOR:** Kalidas Shetty, Ph.D. – Department of Plant Sciences

Chronic overnutrition of hyper processed, refined carbohydrates often leads to the development of noncommunicable diseases (NCDs) such as cardiovascular disease and type 2 diabetes. As NCDs remain the leading cause of global deaths and climate change continues to create difficulties for agricultural production, finding solutions that address both health of humans and the environment is vital. Phenolic compounds are secondary metabolites produced by plants as a response to counteract the effects of stresses such as heat, salinity, and disease. Phenolic compounds are also beneficial for human health as they act as antioxidants, have glycemic control properties, and have shown benefits for preventing cognitive degeneration. The Great Plains is an important agricultural region providing the global community with various products including corn and soybean. These two staple crops are common food ingredients that help structure our food system. The purpose of this research project is to use the proline-linked pentose phosphate pathway (PPP) model to see the effects of heat and cold stress on phenolic phytochemical production. Proline is an amino acid that is produced in larger quantities when a plant is under stress. Corn and soybean seeds were germinated at intervals of 3, 6, and 9 days after subjection to 24 hours of heat stress (37 °C) or cold stress (4 °C). Total soluble phenolics were measured in addition to antioxidant activity and glycemic control properties through ∝-glucosidase and ∝-amylase inhibition assays.

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

**PRATIK SUNILDATTA BANKAR**
HORTICULTURE

**FACULTY MENTOR:** Todd West, Ph.D. – Department of Plant Sciences

Background: *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 the viable seed is potentially invasive. One method to deal with this problem is to produce a sterile triploid cultivar through ploidy manipulation. Methods: 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. Conclusion: The advantages of a sterile *P. ussuriensis* would potentially have 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*.

## Variation of Organic and Inorganic Carbon Stocks with Depth under Three Land Management Systems in North-Central South Dakota.

**MARIA BATOOL**
SOIL SCIENCE

**FACULTY MENTOR:** Larry Cihacek, Ph.D. – Soil Science

Background: Carbon (C) is stored in soils as organic carbon (SOC) and inorganic carbon (SIC). Most research focuses on SOC which is widely accepted as a repository for soil sequestered C. However, the role of SIC (lithogenic and pedogenic carbonates) is often ignored and research focused on it as an important repository of sequestered C is generally neglected. Methods: A study was conducted on a north-central South Dakota landscape to determine the SOC and SIC differences due to land management as well as to investigate the variation of depth to carbonate concretions in three different land management systems. Three replicate cores were collected to a depth of 1 m, where possible, on a transect from a wetland border to an interfluve position at 10-meter spacing for each land management. The three transects were on similar landscape slopes surrounding a common wetland marsh so that position relative to the wetland should not play a major role in the carbon fluctuation at differing depths. Carbonate concretions were collected separately during the processing of the soil cores and weighed before soil grinding. Soil total carbon (STC), SOC, and SIC of both soil and carbonate concretions were measured separately using a carbon analyzer. Statistical analysis was performed by a three-way interaction between Land Management, Depths, and slope Positions on the amount of stored C. Results: In general, SIC accumulates greater in the mid-depths of the soil profile while SOC is highest in the surface soil zone. Conclusion: The contribution of carbonate concretions to STC, SOC, and SIC as well as the importance of SIC's role in evaluating C sequestration in lower rainfall areas of the US Great Plains will be discussed. Keywords: SOC, SIC, STC, NG, CF, and C.

## The application of machine learning, image processing, and ArcGIS for the yield estimation of sunflower

**ALIASHGAR BAZRAFKAN**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**FACULTY MENTOR:** Paolo Flores, Ph.D. – Department of Agricultural and Biosystems Engineering

Background: This study presents a comprehensive precision agriculture approach, integrating shape metrics, ArcGIS, and machine learning for yield estimation of sunflower. Methods and Results: It operates on a trained Random Forest model using a dataset consisting of over 140,000 polygons representing sunflower seeds and leaves. There is a tool developed in ARCGIS PRO that anyone can use, even without any programming skills. This tool looks at the picture and tells you where it thinks the seeds are in the sunflower image. It utilizes a combination of image processing and machine learning techniques to detect sunflower seeds representing sunflowers in RGB images. This tool goes through several steps to analyze an image and predict where the seeds are. First, the RGB image is split into different parts – Red, Green, and Blue. After that, it uses a method called ISO clustering to break down the image, focusing mainly on the green part. This process separates the image into clear sections. Then, it calculates various measurements for each section, including circularity, compactness, area, perimeter, length, width, and shape index. These measurements give important details about each section. Next, it uses a trained random forest, to take those measurements and guess where the seeds are in the picture with an overall accuracy of 89%. Conclusion: With this tool, farmers, plant breeders, and researchers can save time by obtaining a reliable and fast estimation of sunflower yield, even using RGB images captured by their cellphones. Keywords: Random forest, Shape metrics, Classification, ArcGIS pro, Modeling.

## Cold Hardiness Evaluation

**HAVA DELAVAR**
PLANT SCIENCES

**FACULTY MENTOR:** Harlene Hatterman-Valenti, Ph.D. – Plant Sciences

Background: Cold hardiness is an economically important trait that can significantly affect grape production and quality. Until now, there have been no reports on identifying effective quantitative trait loci (QTL) for cold hardiness in grapevines. The bottleneck of QTL mapping of cold hardiness in grapes and other fruit trees is field evaluation, due to the fact that vulnerable plants to cold often die in their first year of planting. To address this, our study focuses on developing a method that involves acclimating the entire mapping population in the greenhouse with controlled photoperiod and temperature, allowing for a comprehensive assessment of both cold-susceptible genotypes and cold-hardy ones by using differential thermal analysis. Methods: For this purpose, a mapping population resulting from a cross between Vitis riparia and Vitis vinifera underwent cold hardiness evaluations under three distinct environments: 1) acclimated in a cold region of North Dakota that experiences temperatures as low as -35 C during winter 2) acclimated in a greenhouse, where photoperiod and temperature were controlled; and 3) acclimated in the temperate climate of California, devoid of any cold stress. This research can speed up the breeding processes, as evaluation in the greenhouse can be done at any time of the year and will not be limited to the winter season. Results: Data analysis for the study is ongoing, and thus, the findings have not been disclosed at this stage. Conclusion: We anticipate completing the requisite analyses and presenting the results by the time of the Conference.

Hava Delavar, Ozkan Kaya, Harlene Hatterman-Valenti

## Co-Occurrence Network Analysis Displays Decreased Connectivity Across Increasing Salinity Gradient.

**RYLIE ELVERS**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Samiran Banerjee, Ph.D. – Microbiological Sciences

Background: Salinity in soil is becoming increasingly an issue not only along coastal regions and naturally saline environments but also due to secondary salinization. Secondary salinization is caused by agriculture intensification via poor drainage and poor water quality. Salinity can impact soil and plant growth, and water quality (1)namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan (Figure 1. There have been many salinity studies investigating the salinity in coastal areas sediments and different habitats, but less investigating a salinity gradient in agriculture soil (2, 3)a previously uncharacterized, hypersaline lake located in southern Texas, USA, were surveyed to characterize the structure and diversity of their microbial communities. Samples were collected along a transect that spanned vegetated uplands, exposed lakebed sediments, and water-logged locations, capturing a wide range of environments and physical and chemical gradients. Community quantitative PCR (qPCR. Due to this we asked the question: how microbial communities differ across salinity levels? We hypothesized that high salinity levels would have the lowest diversity levels and the least connectivity communities with low having the highest connectivity. Methods: We sampled low, moderate, and high saline soil from NDSU Langdon Research Extension Center and analyzed soil properties, co-occurrence networks, and diversity indices Results: Our results showed no apparent differences in Shannon diversity across treatments but Bray-Curtis dissimilarity for both bacteria and fungi across treatments while fungal beta diversity showed tighter clustering and lower alpha diversity. Soil properties showed increasing $Na^{+}$, phosphorus, and salts, but decreasing organic matter as salinity increased. In our co-occurrence networks, low salinity had the highest average degree of 27 and most edges with high having an average degree of 8 and fewest edges. Conclusions: Overall, this analysis shows that differences in salinity levels alter the microbial communities, decreasing connectivity with increasing salinity. Our future directions are to conduct further analyses on these soils to further understand how the microbiome varies under different salinity levels.

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## Functional Analysis of Polyketide Synthesis-1 Gene Using Crispr-Cas9 Technique

**CARLY GEORGE**
PLANT SCIENCES

**FACULTY MENTOR:** Zhaoliu Liu, Ph.D. – Department of Plant Pathology

Background: Tan spot of wheat caused by the ascomycete fungal pathogen Pyrenophora tritici-repentis (Ptr), is an economically important disease in almost all wheat (Triticum spp.) growing regions, including North Dakota. The fungal pathogen is known to produce three necrotrophic effectors (NEs), including Ptr ToxA, Ptr ToxB, and Ptr ToxC, that cause disease. Ptr ToxC has been partially characterized as a secondary metabolite, but its production in the fungal pathogen is unknown. Polyketide synthase (PKS) genes are important enzymes required for the production of secondary metabolites in the fungi and have been shown in many fungal pathogens to be involved in fungal virulence and other morphology. The objective of this research was to determine the role of PKS1 in the production of Ptr ToxC production and virulence. Methods: CRISPR-Cas9 technology was used to mutate the gene and the mutants were characterized for their morphology and inoculated onto Ptr ToxC sensitive lines. Results: The results showed that PKS1 mutants lost the ability to produce melanin, forming white colonies, but maintained their ability to produce Ptr ToxC and full virulence to the sensitive lines and other susceptible wheat lines. Conclusion: This work demonstrates that PKS1 is not involved in Ptr ToxC production and does not contribute to virulence of the fungal pathogen.

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## Tracking the development of early die disease complex in potato

**DANIEL GILL**
PLANT PATHOLOGY

**FACULTY MENTOR:** Julia Pasche, Ph.D. – Department of Plant Pathology

Background: The early die disease complex causing premature senescence of potato, is an endemic affliction of the crop throughout the world. Verticillium spp., Colletotrichum coccodes, and Pratylenchus penetrans all contribute to the development and severity of the disease. Management options are limited due to pathogen biology, large scale feasibility, and government regulation. With few control options available, disease detection can have an important role in improving management. Advancements in remote sensing technology and machine learning have allowed companies to market early disease detection services to potato growers. There is a need to begin validating the use of these technologies in accurately and efficiently identifying disease development. The goal of this research is to determine the viability of color imaging technology from Prospera mounted to center pivot irrigation systems for early detection of early die disease. Methods: Validation of the camera technology will be guided by data collected from in-season field observations and sampling along with molecular techniques for quantifying changes in pathogen levels over time. In addition to exploring the use of imagery for early die detection, a disease risk factor for production fields, referred to as the disease fingerprint, will be developed. Conclusion: Maximizing limited potato acreage in rotation by ranking field risk to early die will allow informed agronomic decisions to limit disease escalation for future seasons.

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## Planting Dates Effect on the Tuber Bulking Rate and Verticillium Accumulation of Russet Burbank, Dakota Russet, and Bannock

**JED GROW**
PLANT SCIENCES

**FACULTY MENTOR:** Andrew Robinson, Ph.D. – Department of Plant Sciences

Background: Large potato (*Solanum tuberosum L.*) yields are often associated with long growing seasons and high yielding varieties. Earlier planting dates can extend a growing season, but there is little research on if planting early in the Upper Midwest results in higher yields. Growing potatoes in a region with a short production season can be challenging, especially with the potential for premature vine death caused by Verticillium wilt and the early die complex. The objective of this study was to determine the effect of planting date on the bulking patterns, yield, and V. dahliae colonization of stems of three russet cultivars. Methods: In 2021 and 2022, field experiments using a randomized complete block design with a factorial arrangement of treatments were set up in Larimore, ND and Perham, MN. Treatments included cultivar (Russet Burbank, Dakota Russet, and Bannock Russet) and three planting dates (representing an early, average, and late planting). Tubers were harvested from subplots and weighed individually, starting at tuber initiation and throughout the growing season on a two-week interval. At harvest, tubers were collected, graded based on size, and measured for specific gravity, fry quality, and internal physiological disorders. Stems from every plant in a subplot were collected and processed to determine pathogen colonization. These samples were dried and ground for DNA extraction and qPCR analysis. Results: Data is being analyzed using mixed models and ANOVA to identify any differences in *V. dahliae* colonization among cultivar or planting date Bulking rates for each cultivar will be calculated using a mixed model across years and locations. A Time-series model will also be fit to the data and aid in the prediction of optimal harvest dates to minimize *V. dahliae* accumulation in plants and is the amount of pathogen returned to the soil. Conclusion: This experiment will aid in harvest date decisions for growers across the region.

## VIP Mice Party: When the Gut Throws a Vitamin K Bash Without Its Main Guest

**KELL HELMUTH**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Glenn Dorsam, Ph.D. – Microbiological Sciences

Background: The intricate ecosystem of the mammalian gut microbiota plays a pivotal role in host health, involving key biochemical pathways such as the synthesis of quinol and quinone, essential for vitamin K production and crucial for blood clotting. This study investigates the role of the vasoactive intestinal peptide (VIP), which regulates physiological functions including circadian rhythms and metabolism, on these synthesis pathways. Utilizing VIP knockout mice, we have published predictive results suggesting deficient levels of quinol and quinone biosynthesis by the gut microbiota (GMB), thereby impacting vitamin K synthesis. Therefore, we hypothesized that VIP knockout mice would present with a blot clotting defect (e.g., anemic) due to reduced GMB vitamin K production. Methods: To this end, blood samples were collected and analyzed for both fibrinogen clotting rates and platelet cell counts – a red blood cell derivative that plays a pivotal role in coagulation. Conclusion: This research is expected to advance our understanding of the gut microbiota's biochemical interactions and their implications for host physiology, particularly in vitamin K metabolism and blood clotting, underscoring the need for further investigation into these critical pathways.

## Starch and protein physicochemical study under nitrogen fertilization in US hard red spring wheat

**NAJMOL HOQUE**
PLANT SCIENCES

**FACULTY MENTOR:** Shahidul Islam, Ph.D. – Department of Plant Sciences

Background: The Hard Red Spring (HRS) wheat, the most prized and protein-rich class of wheat, is grown in the northern Great Plains region of the United States. To utilize the benefits of HRS, it is often blended with other types of wheat. Nitrogen, which is essential for protein structure, plays a crucial role in affecting the properties of HRS wheat, particularly its baking characteristics. This study aimed to analyze the starch and protein composition of HRS wheat under different N treatments to understand how they affect the quality of the final product. Methods: The experiment involved testing three N rates (50, 100, and 200 lb acre-1) and a control group on three HRS wheat varieties in different location of North Dakota and Minnesota, USA. Protein properties were characterized using size exclusion high-performance liquid chromatography (SEC-HPLC), reverse phase high-performance liquid chromatography (RP-HPLC), Glutopeak, FT-IR and solvent retention capacity test. Results: The results of this study showed an increase in 12 to 15% ($p<0.05$) of total protein content, with significant genetic interactions for N treatment. This prediction was reflected in Glutopeak and SRC test, which are specific to protein strength and quality. Further, HPLC analysis confirmed significant improvement in high molecular weight glutenin subunits (HMW-GS) and γ-gliadin fractions, indicating a strong gluten composition and positive correlation with the N treatment. Starch characteristics were analyzed through scanning electron microscopy for imaging, biochemical tests for composition, Rapid Visco Analyzer for viscosity and differential scanning calorimetry for thermal properties, while X-ray diffraction was used to examine starch crystallinity. SEM results revealed that nitrogen fertilizer had a significant effect on starch granule sizes, shapes and distribution along with indicating a high level of starch-protein interaction. Biochemical studies showed up to 20% reduction in starch damage with higher amylopectin contents from 71% to 75% at increased N rates. The consequences of these results were also reflected in DSC and XRD showed higher gelatinization temperature and crystallinity ($p<0.05$). Conclusion: Overall, this study showed that higher N fertilizer application positively impacted the protein content of HRS wheat, but the quality was found to be strongly responsive only up to a certain rate. These findings will contribute to identifying improved N management techniques that ensure the high-quality production of HRS wheat.

# Screening for *Fusarium* Effectors that Play a Role During Root Rot Infection on Dry Bean

**RUBYLYN INFANTE**
PLANT PATHOLOGY

**FACULTY MENTOR:** Malaika Ebert, Ph.D. – Department of Plant Pathology

Background: Dry bean production faces significant challenges from diseases like root rot, caused by a complex of pathogens including *Aphanomyces euteiches*, *Pythium* spp., *Rhizoctonia solani*, and *Fusarium* species, with *Fusarium* being the most prevalent. During infection, these pathogens release small molecules called effectors, which can impact their ability to cause disease, compete with other microbes, or obtain nutrients. Previous research in the *F. oxysporum* - tomato pathosystem identified 14 secreted in xylem (SIX) effectors during infection using xylem sap analysis. Methods: Our lab aims to employ a similar method to identify effectors secreted by *Fusarium* spp. during dry bean infection. To identify effectors during Fusarium-dry bean interactions, we assessed *Fusarium* spp. collected during dry bean survey in 2022 to determine the level of virulence and used amplification with a translation elongation factor alpha 1 (TEF-1α) primer set to see which *Fusarium* strains could travel from roots to leaves during infection. We found that *Fusarium* strain 10-1 was present in leaves and displayed high level of virulence. Therefore, we chose this *Fusarium* strain for Nanopore sequencing with subsequent genome assembly, and annotation. Whole-genome sequencing of *Fusarium* strains 10-1 yielded a 50x coverage of the genome, which has a size of 60.68 Mb. Using long-read genome assembly, 17 contigs were produced, with an N50 length of 4.3 Mb. Comparisons between *Fusarium* strain 10-1 and the *F. solani* Fusso1 genome revealed high similarity across chromosomes 2 to 13. However, chromosomes 14 to 17 of *Fusarium* strain 10-1 exhibited decreased similarity, suggesting that they may represent accessory chromosomes. Notably, chromosome 1 of *Fusarium* strain 10-1 displayed markedly low similarity to the F. solani Fusso1 genome. Based on these findings, we propose that Fusarium strain 10-1 is a member of the *F. solani* species complex. However, we are currently not able to assign it to a specific *Fusarium* species. Additionally, we collected xylem sap from healthy and *Fusarium* strain 10-1-inoculated plants, extracted the whole proteome and analyzed it using mass spectrometry to screen for the presence of secreted fungal proteins. Results: This analysis yielded 60 putative fungal candidate proteins, of which three are showing predicted signal peptides. We are currently in the process to design and develop knockout mutants for these three candidate genes in *Fusarium* strain 10-1 for in planta testing to assess their impact on fungal virulence. Conclusion: Understanding the molecular dynamics of the *Fusarium*-dry bean interaction will aid in breeding dry bean varieties resilient to Fusarium root rot.

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## Integrating Alfalfa and Sainfoin with Sunflower Through Intercropping: Enhancing Forage Production, Soil Health, and Biodiversity

**SHAZZADUL ISLAM**
PLANT SCIENCES

**FACULTY MENTOR:** Marisol Berti, Ph.D. – Department of Plant Sciences

Background: Increasing challenges in soil health, food security, and environmental sustainability call for the adoption of sustainable agricultural methodologies. Pressed by economic, environmental, and biological demands, the exploration of innovative agronomic techniques becomes imperative. Intercropping systems, notably the combination of alfalfa (*Medicago sativa* L.) and sainfoin (*Onobrychis viciifolia* Scop.) with sunflower (*Helianthus annuus* L.), offer a valuable solution. This strategy not only boosts crop yields but also capitalizes on the deep-rooting abilities of alfalfa and sainfoin to scavenge nitrates, effectively minimizing nitrate leaching into the groundwater. Additionally, their comprehensive root systems play a crucial role in soil stabilization, markedly diminishing soil erosion and overall health. This study aimed to assess the viability of cultivating alfalfa and sainfoin alongside sunflower through intercropping, in comparison to traditional standalone crops, evaluating the impact on subsequent cash crop yields and the forage production of alfalfa or sainfoin in the following year. Methods: Conducted between May 2023 and 2024 in Hickson and Prosper, ND, USA, employing a randomized complete block design with four replicates, the experiment explored various treatments: (1) solo alfalfa, (2) alfalfa intercropped with sunflower at 40 kg N/ha, (3) alfalfa intercropped with sunflower at 80 kg N/ha, (4) solo sainfoin, (5) sainfoin intercropped with sunflower at 40 kg N/ha, (6) sainfoin intercropped with sunflower at 80 kg N/ha, and (7) sunflower alone. Results: Findings revealed that intercropping alfalfa with sunflower did not significantly alter sunflower grain yields (average yield of 2302 kg/ha) or the forage and nutritive quality of alfalfa, whereas sainfoin intercropped scenarios exhibited a decrease in forage yield. Interestingly, the intercropped plots had an upsurge in beneficial insect populations, indicating an enhancement in biodiversity. Conclusions: Hence, in the upper Midwest, the integration of sunflowers with either alfalfa or sainfoin emerges as a forward-thinking approach to concurrently produce valuable forage while cultivating sunflowers, mitigating soil erosion, enhancing groundwater quality through reduced nitrate leaching, and bolstering agrobiodiversity through increased beneficial insect populations. This intercropping system thus presents a multifaceted solution to sustainable agriculture, promising not only soil conservation but also ecological balance and improved crop yields.

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## Real-Time Uav Image Stitching using Raspberry Pi for Agricultural Field Applications

**ASTINA JOICE**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**FACULTY MENTOR:** Igathiathane Cannayen, Ph.D. – Department of Agricultural and Biosystems Engineering

Background: Precision agriculture (PA) uses unmanned aerial vehicles (UAVs) for remote sensing applications, allowing farmers to assess crop growth and health, deliver spatially targeted inputs, and monitor livestock. UAV orthomosaic image, stitched output of the whole field, creation involves setting coordinates, flying, marking points, and stitching captured individual images using software or cloud platforms, and generating a prescription map. Such conventional stitching methods are time-consuming, may have security and privacy risks, and are unable to make real-time decisions in the field. Methods: Automatic real-time image stitching and generating the prescription map by the user on-demand help make decisions in the field without delay. Single board computers (SBC) are credit card-sized, cost-effective, and energy-efficient computers built on a single circuit board, featuring all the necessary components to run the software and perform tasks. Raspberry Pi (RPi) is one of the SBCs commonly used in PA applications such as crop growth monitoring, and automatic spraying. Therefore, this research work focused on using RPi for automatic real-time image stitching and prescription map generation. The UAV-collected images are uploaded and processed using the ImageJ, OpenCV library, and Python software installed on RPi. Results: The novelty of the developed image stitching algorithm lies in the simplicity of handling the images in the simpler SBC. After determining the overlap (forward and side), UAV flight path, and profiles of images, it is possible to perform stitching efficiently with fewer images. This simpler method will not be memory intensive and can be easily handled by RPi. Conclusion: The proposed solution for image stitching followed by map generating for site-specific PA operations like stand count, disease control, weed management, nitrogen side-dressing, fertigation, and yield estimation will be useful for crop producers to make real-time decisions effectively at reduced cost and time. The methodology improves data security as the data stays with the farmers and empowers the farmers as they need not rely on third-party services to generate stitched images and prescription maps. The developed algorithm and associated software can be extended to other fields (e.g., horticulture, forestry, grazing, livestock production) where UAV is used in general.

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## Development of placental vasculature throughout gestation in beef heifers

**CHUTIKUN KANJANARUCH**
ANIMAL SCIENCES

**FACULTY MENTOR:** Lawrence Reynolds, Ph.D. – Animal Sciences

Abstract: Background: Placental vascular development is crucial for nutrient exchange between maternal and fetal systems, ensuring optimal fetal growth. While studied in various species, research on cattle is scarce. Methods: We localized CD31 and CD34 to understand placental vascular development in beef heifers. The study included 36 primiparous, pregnant, crossbred Angus beef heifers. Placental samples were collected at six gestational time points: days 34 (n=5), 50 (n=5), 63 (n=6), 83 (n=6), 161 (n=7), and 250 (n=7) (length of gestation approx. 280 days). Placental samples were processed, fixed, embedded, and sectioned at 5 µm. Immunofluorescence staining for CD31 and CD34 was performed, and Image-Pro Premier software was used for quantification. Vascularity was evaluated as capillary area density (CAD) and capillary number density (CND) in fetal placental (cotyledon; COT) and maternal placental (caruncle; CAR) regions. CAD reflects placental blood flow capacity and CND branching of blood vessels and are expressed as a % of total tissue volume. Data analysis utilized PROC GLM and PROC REG of SAS, with significance at $P \leq 0.05$. Results: Both CAD and CND differed across gestational time points ($P < 0.01$). In early pregnancy (days 34, 50, and 63), CAR exhibited greater CAD and CND than COT ($P < 0.01$). At day 250, CAD and CND of COT exceeded those of CAR (CAD: 11.528±0.403 vs. 8.373±0.155, $P < 0.05$; CND: 0.512±0.013 vs. 0.323±0.005, $P < 0.01$). Moreover, CAD exhibited cubic increases for both CAR and COT throughout gestation ($R^2 = 0.736$ and 0.886, respectively, $P < 0.01$), with COT showing a greater proportional rate of increase (11.5-fold) compared to CAR (2.2-fold). The CND of CAR also displayed a cubic increase ($R^2 = 0.796$; $P < 0.01$) with again a smaller increase (3.9-fold) compared with COT (9.3-fold), which also increased cubically throughout gestation ($R^2 = 0.934$; $P < 0.01$). In summary, in CAR both CAD and CND increased primarily during early pregnancy, with a more gradual rise in late pregnancy. Conversely, COT exhibited a pronounced increase in CAD and CND during late pregnancy. Conclusion: This study provides foundational insights into placental vascular development in beef heifers, enhancing our understanding of this critical process.

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## Bud break in grape cuttings is affected by cultivar, but not number of nodes or rooting hormone treatment

**ELIZABETH KRAUSE**
PLANT SCIENCES

**FACULTY MENTOR:** Avery Shikanai, Ph.D. - Department of Plant Sciences

Background: In grape breeding, it is necessary to use cuttings for propagation, but cuttings may also be used for bud break measurements to understand dormancy. Due to having limited plant material for cuttings, it would be valuable to use the same cuttings for bud break measurement and propagation. However, it is not well-known how rooting treatments affect bud break in grapes. Methods: We compared cuttings of 4 cultivars, of 1 or 2 nodes in length, and with or without rooting hormone powder (0.8% indole-butyric acid) grown in Oasis® Rootcubes in a misting chamber. Cuttings were in the misting chamber for 20 days and were observed every 3-4 days to record the BBCH growth stage of the buds. Each treatment combination was replicated 8 times. Results: Rooting hormone treatment did not affect bud break of any cultivar or node number. The node number was statistically significant ($p<0.0121$). However, its effect size was 0.05511, which means that an average 2-node cutting developed only 0.05 BBCH stages ahead of a 1-node cutting. Out of the four cultivars ('Frontenac Blanc', 'Adalmina', 'Kay Gray', and 'Petite Pearl'), apical buds of 'Kay Gray' developed the most rapidly, followed by 'Frontenac Blanc'. The basal buds of 'Kay Gray' also developed the most rapidly of the basal buds, although all of the basal buds developed several BBCH stages slower than apical buds. In fact, many basal buds of 'Adalmina' remained at the same BBCH over the duration of the experiment. This demonstrates that grape cuttings have apical dominance. Overall, the most important differences in bud break are due to cultivar and not node number or rooting hormone. The cuttings still do not have roots, so we will continue to collect data for any potential effects on rooting. Conclusion: The results of this experiment will inform the methods of other projects that require rooting and bud break of grape cuttings.

## Integrating alfalfa and winter camelina into wheat-sunflower-soybean rotations

**ANASTASIA KURTH**
PLANT SCIENCES

**FACULTY MENTOR:** Harlene Hatterman-Valenti, Ph.D. - Department of Plant Sciences

Background: Across the United States, particularly the Midwest, traditional cropping systems are designed as annual rotations that focus on one main cash crop and leave the soil bare for up to eight months of the year. Annual systems offer many challenges in terms of biodiversity and environmental impact, especially with shifting climate and increased demand for food and fuel. Methods: This study was conducted to determine if the addition of alfalfa (Medicago sativa L.) and winter camelina (Camelina sativa (L.) Crantz) to annual crop rotations would increase cropping system biodiversity and offer solutions to the challenges of traditional annual systems including sunflower (Helianthus annus L.), wheat (Triticum aestivum L.), or soybean [Glycine max (L.) Merr.]. Evaluations of agronomics, biodiversity, and nutritive value were investigated in Prosper and Hickson, ND for ten crop rotations. These evaluations were performed through yield measurement, pitfall and sticky trap arthropod sampling, and forage nutritive value analysis. Additionally, analysis through life cycle assessment (LCA) was completed. The LCA quantifies the carbon intensity (CI) of cropping systems in terms of greenhouse gas emissions based on inputs, activities and field emissions from 'cradle to gate'. Results: It was found that fall-planted alfalfa is difficult to establish in northern climates; however, despite a yield drag in the first cut, it was able to achieve similar yield to spring-planted alfalfa in subsequent cuts. Planting soybean in relay with winter camelina achieved lower total yield than monocrop soybean; however, the double crop with sunflower and winter camelina yielded 320 kg ha-1 more than the sunflower monocrop. The winter camelina-soybean relay had an average of 5.6 beneficial arthropod families per sticky trap, where the winter camelina monocrop averaged 4 families. Alfalfa had the lowest CI value. Continuous alfalfa had a CI of 11 g $CO_{2e}$ $MJ^{-1}$, where winter camelina monocrop had a CI of 1525 g $CO_{2e}$ $MJ^{-1}$. The high CI of winter camelina was due to the low average seed yield, 351 kg $ha^{-1}$, and long fallow period. Conclusion: Incorporating winter camelina and alfalfa into wheat, sunflower, and soybean annual rotations can be a solution to increasing biodiversity and cropping system resilience for the Midwest. Acknowledgement: This research is supported by USDA/NIFA/AFRI Sustainable Agricultural A.Kurth[1] , M.T. Berti[2] , H. Mosqueda, H. Lindell, S. Islam, F. Omeye

## Genomic characterization and antimicrobial resistance of Trueperella pyogenes isolated from domestic and wild animals

**GABRIELA MAGOSSI**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Samat Amat, Ph.D. – Department of Microbiological Sciences

Background: *Trueperella pyogenes* is an important pathogen implicated in infections such as mastitis, metritis, pneumonia, and liver abscesses in both domestic and wild animals as well as endocarditis and prosthetic joint infections in humans. Understanding the genomic features that enable *T. pyogenes* to colonize different anatomical sites within a host and to transmit between different host species is important for controlling its spread and dissemination. Methods: Here, we used comparative genomics to identify the host- and niche-specificity of *T. pyogenes* and its antimicrobial resistance (AMR) gene profile. *T. pyogenes* (n = 60) was isolated from 6 different animal hosts, and 11 body sites. A subset of these isolates (n = 49) was also assessed for susceptibility to 9 different antibiotics using disk diffusion. Results: Analysis of the 60 *T. pyogenes* genomes from this study plus 24 publicly available genomes, originating from 11 animal species and 16 different sample types, revealed phylogenetic clustering of bovine and swine isolates, but not by body site. The 83 genomes were grouped into 23 genotypes and the virulence genes *plo* and *fimA* were contained in almost all genomes (≥ 98.9%). Of the 19 ARGs identified, genes encoding resistance to tetracyclines (69%), lincosamides, macrolides, and streptogramin B (31%), glycopeptides (25%), and sulfonamides (21%) were most prevalent. Phenotypically, isolates were resistant to tetracycline (75%), clindamycin (38%), and erythromycin (25%). Conclusion: In summary, our results suggest that *T. pyogenes* strains are not specific to a particular host or body site. The presence of conserved virulence genes (*plo* and *fimA*), as well as genotypic and phenotypic AMR may contribute to infections in livestock, wildlife, and pets.

Gabriela Magossi[1], Katherine E. Gzyl[2], Devin B. Holman[2], and Samat Amat[1]

## Colonization and impact of arbuscular mycorrhizal fungi and pea aphids on a diverse panel of field pea genotypes

**RAMAN MOHANPURIA**
ENTOMOLOGY

**FACULTY MENTOR:** Deirdre Prischman-Volseth, Ph.D. – School of Natural Resource Sciences

Background: The use of mycorrhizae is a promising approach for developing resource-efficient and sustainable agricultural systems. Arbuscular mycorrhizal fungi (AMF) colonize plant roots and benefit plants by enhancing phosphorus availability and indirectly influencing densities of insect pests. Although the plant-AMF association can improve plant growth, neutral or negative effects can also occur depending on the AMF and the plant species involved. Methods: We conducted a greenhouse experiment to investigate the impact of AMF on growth and health of 20 diverse genotypes of field peas (Pisum sativum L.) within four groups (organic, modern, historically important, and protein-rich lines) and how susceptible the genotypes were to pea aphids (Acyrthosiphon pisum Harris). In the first greenhouse study, half of the plants were inoculated with AMF while the other half were non-inoculated controls, with all grown in a sterilized, low-phosphorus medium. Half of the plants were sampled at flowering to assess percent AMF root colonization and effects of AMF on leaf chlorophyll, plant vigor, and plant biomass. The second greenhouse experiment investigated pea aphid population growth on the same field pea genotypes, with half of plants receiving extra phosphorus in the growing medium. Two weeks after planting, each plant was inoculated with three female adult aphids and aphid densities and plant weight were assessed after ten days. Results: AMF root colonization and effects of AMF on plant vigor, leaf chlorophyll, and shoot weight varied according to genotype. Plant genotypes and additional phosphorus had no effect on the pea aphid density. Conclusion: This research emphasizes the importance of considering the interactions between plant genotype and AMF or insect pests and helps optimize the use of mycorrhizal symbionts in agricultural systems. Keywords: arbuscular mycorrhizal fungi, field peas, plant genotypes, phosphorus, pea aphids

Raman Mohanpuria[1*], Deirdre Prischmann-Voldseth[1], Laura Aldrich-Wolfe[2], Nonoy Bandillo[3]

## Enhancing Insect Diversity and Successful Establishment of Alfalfa by Intercropping with Forage Sorghum or Corn

**HALEY MOSQUEDA**
ENVIRONMENTAL AND CONSERVATION SCIENCES

**FACULTY MENTOR:** Marisol Berti, Ph.D. – Department of Plant Sciences

Background: Diversifying cropping systems by including perennial legumes such as alfalfa (Medicago sativa L.) to improve crop yield and quality as well as the soil microbiome and physiochemical properties of cropland is crucial for continued future production of agricultural products. However, despite the benefits it can have on soil quality, alfalfa production is declining because its establishment year is less productive. The objectives of this study are to 1) reduce economic loss in the seeding year, 2) determine whether intercropping corn (Zea mays L.) or forage sorghum (Sorghum bicolor (L.) Moench) with alfalfa can increase overall yield and quality of the perennial system, and 3) determine changes in soil health and ecosystem services of including perennials in cropping systems. Methods: Corn (C), sorghum (S), and alfalfa (A), alone or intercropped, (corn (CA) or sorghum (SA) + alfalfa) were planted under different management strategies: conventional and with 0.6-m gaps every 1.8-m within corn rows (G, corn gaps; GA, corn gaps + alfalfa) or a two-harvest system of sorghum 45 and 90 days after planting (S2, two-harvest sorghum; SA2, two-harvest sorghum + alfalfa). Results: Sorghum biomass was similar across all treatments, and corn grain yield in G and GA were similar to CA. Alfalfa failed to establish under SA (<20 plants m-1), however, it maintained similar stands in CA (42 plants m-1), GA (39 plants m-1), and SA2 (41 plants m-1) compared with alfalfa alone (44 plants m-1). Alfalfa forage yield in Year 2 were similar across CA and GA when compared with alfalfa alone. Alfalfa yields for SA2 were similar to CA and GA. Forage quality was similar across all treatments. Including alfalfa in the system increased arthropod diversity in the establishment year. Soil physiochemical characteristics and microbial diversity are expected to improve during the establishment of alfalfa intercropped with corn compared with a continuous annual corn system. Conclusion: The cost comparison of the three-year alfalfa system is expected to show most profitable when established as an intercrop compared with alfalfa alone or continuous corn/sorghum.

H. M. Mosqueda, M. T. Berti, A. Kurth, S. Bibby, and H. Lindell

## Screening for resistant canola lines against Leptosphaeria maculans infection

**JANNATUN NAHER**
PLANT SCIENCES

**FACULTY MENTOR:** Mukhlesur Rahman, Ph.D. – Department of Plant Sciences

Background: Canola, *Brassica napus* L., is one of the healthiest oil crops in the world, and it has the potential to promote brain development in infants and prevent heart disease and cancer in adults. *L. maculans*, a highly virulent fungus, causes more than 50% yield loss in canola worldwide. Continuous cultivation of the same resistant cultivar triggers the emergence of more virulent races of the pathogen, which in turn breaks down canola resistance to *L. maculans*. Hence, screening for improved resistance is necessary to develop durable blackleg-resistant canola cultivars. Our objectives were to know the reaction of canola lines to the virulent races of *L.maculans*, and screen out the resistant line(s) from their interaction. Methods: We inoculated 80 canola lines (including two resistant and one susceptible check) at cotyledon leaf stage (two cotyledons/plant) with 15 replications by ten microliters spore suspension (One lac spore/cotyledon) of the virulent races of the fungus in the greenhouse 12 days after sowing. After inoculation, we kept the plants in the misting chamber for 24 hours. The lesion size on the cotyledon leaf was categorized into 1 to 5 rating scales (1 = the smallest lesion size, and 5 = the largest lesion size). We recorded the data at 7, 10, 14, and 20 days after inoculation (DAI). Results: We have found a few highly resistant canola lines from our screening experiment. Conclusion: The identified resistant lines will be a valuable resource for developing high-yielding and durable blackleg-resistant canola cultivars in the future.

Jannatun Naher[1], Md Zahangir Alam[1], Duaa Al Islam, Luis E. del Rio Mendoza[2] and Mukhlesur Rahman[1]

## Effect of salinity on PFAS Uptake by Lettuce

**TAJRIN ALOM NIZHUM**
CIVIL ENGINEERING

**FACULTY MENTOR:** Jiale Xu, Ph.D. – Department of Civil, Construction, and Environmental Engineering

Background: Per- and polyfluoroalkyl substances (PFASs) are persistent organic compounds that have raised growing concern due to their ubiquitous presence in the environment, resistance to decomposition, capacity for bioaccumulation. PFAS have been found to be accumulated in agricultural products. The accumulation of PFASs in plants is generally dominated by root uptake, which can be translocated to edible parts. Methods: In our study, we examined the effect of salinity on Lettuce (*Lactuca sativa*) uptake of PFAS. We used a mixture of 10 PFAS to spike promix, the medium used for growing the lettuce. Varying concentrations of salt solution ($NO_3^-$, $NH_4^+$) were applied in the lettuce to examine the effect of salinity on PFAS uptake. After extracting the PFAS from the hydroponically grown dried lettuce samples, we will use Triple Quad Mass Spectrometer to analyze the PFAS by LC-MS/MS method. Results and Conclusion: The focus of our study is to understand how PFAS uptake is affected by salinity gradient in the root and understand the translocation of PFAS in different parts of lettuce plants.

## Establishing Alfalfa or Sainfoin in an Intercropping System with Sorghum

**FRANKLIN OMEYE**
PLANT SCIENCES

**FACULTY MENTOR:** Marisol Berti, Ph.D. - Department of Plant Sciences

Background: High yields and positive impacts to the ecosystem are necessary for forage production in order to preserve global systems and reduce production costs per unit of forage. Certain annual crops allow more environmental degradation yet have more production potential than perennial legume crops. The purpose of this study is to determine whether intercropping sorghum (*Sorghum bicolor* L.) with alfalfa (*Medicago sativa* L.) or sainfoin (*Onobrychis viciifolia*) could alter the yields of forages especially during the establishment year, could solve environmental challenges while increasing biomass yields relative to sorghum grown alone as well as successfully establishing its legume counterpart. Methods: This experiment was conducted in Fargo and Prosper, ND, USA in 2023-2024. The design of the experiment was a randomized complete block and four replicates. The treatments for this study included (1) alfalfa alone, (2) alfalfa-forage sorghum at 40 kg N/ha (40N), (3) alfalfa- forage sorghum at 80 kg N/ha (80N), (4) sainfoin alone, (5) sainfoin-forage sorghum at 40N, (6) sainfoin-forage sorghum at 80N, and (7) forage sorghum alone. The overall scale of success within these treatments is measured in sorghum forage yield and impact of alfalfa in the intercropped plots in the first year and subsequent years. Results: Alfalfa at different N rates was not significantly different from the alfalfa alone. In Fargo forage sorghum only had one cut in the season and the forage nutritive value was the same across all treatments. In the first cut from Prosper, forage sorghum total digestible nutrients (TDN) was highest when intercropped with alfalfa and sainfoin at 80 kg N/ha. Overall high presence of beneficial insects in the plots intercropped with alfalfa was observed which is evidence of healthy soil and rich ecological niche. Conclusion: Optimizing this cutting-edge cropping method could increase crop productivity and benefit farmers, protect the soil from erosion, reduce nitrogen fertilizer applications to the cash crop, and reduce nitrogen losses to air and water.

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F. Omeye, M.T. Berti, Md S. Islam, A. Kurth, H. Mosqueda, H. Lindell, M. Morocho-Lema, and O. Igboke

## Root Exudates of Peas, Tomatoes, and Cucumbers Can Sustain the Growth and Migration of Plant-Growth Promoting Bacteria, *Rhizobium Leguminosarum* Bv. *viciae* 3841 and *Azospirillum brasilense* Sp7.

**JANICE TAGOE**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Birgit Pruess, Ph.D. – Department of Microbiological Sciences

Background: Plant root exudates, according to numerous studies, have indicated benefits in plant growth and productivity by playing a significant role in the recruitment of plant growth-promoting rhizobacteria (PGPR). We studied the ability of two PGPRs, *Rhizobium leguminosarum* bv. *viciae* 3841 and *Azospirillum brasilense* Sp7 to grow and migrate in the exudates of pea (*Pisum sativum* L.), tomato (*Solanum lycopersicon* L.), and cucumber (*Cucumis melo* L). Methods: Exudates were collected after overnight incubation of germinated seedlings in distilled $H_2O$ and filter sterilized. Migration experiment was performed by inoculating 1µL of the respective bacteria standardized at $OD_{600}$ 1, to the center of semi-solid agar plates containing 1:1 dilutions of seedling exudate. The diameter of migration rings was measured over 24 to 72 h periodically. Migration rates from each plate were determined in mm/h. For bacterial growth, the two respective bacteria were inoculated in 1:1, 1:5, and 1:10 dilutions of filter-sterilized exudates in $H_2O$. All exudate inoculations were at an approximate starting $OD_{600}$ of 0.03. The cultures were incubated at 30°C and the $OD_{600}$ was determined every 4 h for up to 72 h and growth curves were generated. Results: Our results show that both PGPB migrated and grew on each of the three exudates. The highest migration rate was seen for *A. brasilense* SP7 on pea at 1.3 mm/h and tomato at 0.87 mm/h. *R. leguminosarum* bv. *viciae* 3841 migrated best on pea exudate at 0.54 mm/h. A. brasilense Sp7 grew best on undiluted tomato exudate with a growth rate of $0.54 \pm 0.027$ and the highest growth rate for R. *leguminosarum* bv. *viciae* 3841 was seen on undiluted pea exudate at $0.33 \pm 0.009$ gen/h. Both growth and migration rates of the two bacteria were lowest in cucumber exudate. Conclusion: Our study is evident that the PGPB studied could be recruited by the exudates of pea, tomato, and cucumber in the rhizosphere since they can sustain their growth and migration.

J.N.A. Tagoe, A.B. Pease, F.A. Nisha, S.M. Horne, and B.M. Pruess

## Analysis of the Function of an Uncharacterized Gene Present in *phb* Gene Cluster Found in *Rhizobium Leguminosarum bv. viciae*

**NATALIE VISICH**
MICROBIOLOGICAL SCIENCES

**FACULTY MENTOR:** Barney Geddes, Ph.D. – Department of Microbiological Sciences

Background: *Rhizobium leguminosarum* bv. *viciae* and *Sinorhizobium meliloti* are species of soil bacteria capable of nitrogen fixation in symbiosis with legumes. Poly-3-hydroxybutyrate (PHB) is one of the major carbon storage compounds found in *S. meliloti.* However, previous research has shown that plants inoculated with strains containing a *phb* gene cluster have a significantly decreased symbiotic effectiveness, illustrated by a decreased shoot dry weight. In the *R. leguminosarum phb* gene cluster, there is a small, previously uncharacterized gene which encodes a protein similar to necrosis-induing *Phytophthora* protein (NPP1). NPP1 has been previously known to cause lesions and cell death within plants, and may be the cause of the decreased shoot dry weight. Methods: To investigate if *NPP1* has a negative impact on symbiotic effectiveness and shoot dry weight, three plasmids were constructed: a suicide plasmid, an expression plasmid, and a protein purification plasmid. The suicide plasmid contained an internal portion of the *NPP1* gene, and was used to remove NPP1 from strains with the gene through homologous recombination. This plasmid was transformed into *Escherichia coli* ST18, then conjugated into native North Dakota *R. leguminosarum* strains. The expression plasmid contained *NPP1* along with its promoter, and was used to insert *NPP1* into strains that did not have it. The plasmid was transformed into *E. coli* DH5-alpha, then conjugated into highly studied strains, *R. leguminosarum* Rm3841 and *S. meliloti* Rmp110. The protein purification plasmid contained the open reading frame of NPP1, and was used to express and purify the *NPP1* protein. The plasmid was transformed into *E. coli* BL21.Following successful conjugation, plant assays occurred. Results: The suicide and expression strains were used as inoculants, alongside their wildtype counterparts. This was to determine if the presence of *NPP1* within the rhizobia inoculants was resulting in a decreased symbiotic effectiveness. The purified NPP1 protein was applied directly to the leaves of plants, in order to determine if the protein itself can cause cell death, resulting in a reduced shoot dry weight.

N. Visich, G. Levin, and B. Geddes

## Implementation of Automated Drip Irrigation System for Tomato and Pepper Cultivation Inside and Outside The High Tunnel in North Dakota

**SAI SRI SRAVYA VISHNUMOLAKALA**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**FACULTY MENTOR:** Xinhua Jia, Ph.D. – Department of Agricultural and Biosystems Engineering

Background: In North Dakota, vegetable production is limited due to cold weather and a short growing season. High tunnels, also called unheated greenhouses, are commonly used to increase air temperature and extend the growing season. Inside high tunnels, irrigation is a must; scheduling and water volume levels are key to high yields. Irrigation scheduling can be automated by using a soil potential sensor-based and remotely controlled drip irrigation system with real time data. Methods: In this 2022-2023 study, eight tomato (*Solanum lycopersicon* L.) and pepper (*Capsicum annuum* L.) cultivars were compared inside and outside a high tunnel at Absaraka, ND. We designed irrigation treatments using management allowable depletion (MAD) at 10%, MAD 30%, and time based (TB) with three replicates and installed inside and outside the high tunnel. Results: MAD 10% treatment showed competitive results especially for tomato both inside (241 kg $ha^{-1}$) and outside (103 kg $ha^{-1}$) conditions in 2023. MAD 30% treatment, while not consistently highest, still yielded respectable results especially for peppers inside (149 kg $ha^{-1}$) in 2022. The results also showed that the average diameter and weight were significantly higher under MAD 30% for tomatoes and MAD 10% for green peppers both inside and outside the high tunnel, respectively. Conclusions: Our research demonstrated that peppers and tomatoes required specific water management practices, while optimal yields were obtained under 30% MAD and TB for both pepper and tomato.

S.S.S. Vishnumolakala1, X. Jia1, and H. Hatterman-Valenti2

## Increasing Soybean Yield under Drought through Enhanced Symbiotic Nitrogen Fixation in North Dakota

**COLE WILLIAMS**
CROP AND WEED SCIENCES

**FACULTY MENTOR:** Carrie Miranda, Ph.D. – Department of Plant Sciences

Background: Low water conditions are a major yield limiting factor in western North Dakota, with the average yield between 15-20 bushels per acre. While there are several traits that can help mitigate the negative yield effects of low water, many come with an initial yield potential loss. One low water mitigation trait that does not compromise yield potential is sustained symbiotic nitrogen fixation (SNF). Methods and Results: With low soil water content, soybean symbiotic $N_2$ fixation rates decline in advance of other physiological processes. A greater ability to sustain SNF under low water conditions results in higher yields in low water conditions without sacrificing yield potential in well-watered conditions. The ability to sustain SNF in soybeans has been shown to have a genetic basis, and the trait has been observed in the U.S. germplasm collection. The University of Arkansas successfully created two elite lines containing the SNF trait. Our goal is to incorporate SNF into NDSU germplasm using the Arkansas cultivars R01-416F and R01-581F. Conclusion: If the trait proves to be useful in the western North Dakota environment, it could have significant economic impact for the state. Acknowledgements: North Dakota Soybean Council; United Soybean Board

Cole Williams, Barney Geddes, Kelsey Griesheim, Felix Fritschi and Carrie Miranda

## Mapping of novel QTL associated with crown rust resistance in oats (*Avena sativa* L.)

**CERLY RINI YERUVA**
PLANT SCIENCES

**FACULTY MENTOR:** Michael McMullen, Ph.D. - Department of Plant Sciences

Background: Crown rust caused by *Puccinia coronata* f.sp. *avenae* is the most destructive fungal disease threatening oat production worldwide. Therefore, a search for novel sources of genetic resistance is considered essential to combat the evolving races of pathogen. Methods: The objectives of this study were (i) to develop two $F_{5:6}$ recombinant inbred lines(RILs) from the crosses ND141862(resistant) ×ND141087(susceptible), ND130020(resistant)×ND130182(susceptible) respectively and (ii) to identify and map QTL conferring disease resistance in field and greenhouse conditions under randomized complete block experimental designs with two replications. Urediniospores were collected from the field to inoculate the plants in the greenhouse, whereas natural infection was allowed to study the disease severity in the field conditions. USDA_SoyWheOatBar_3K platform was used for genotyping the DNA of 108 and 112 RILs, to generate the SNP markers. Of the SNP markers generated, the polymorphic markers were identified using the Genome Studio v2.0.5 software. Linkage analysis of the polymorphic markers was performed using JMP Genomics v.10.2. software to develop linkage maps. The final linkage maps were drawn using the QTL ICiMapping v.4.2 software and the flanking markers underlying the QTL were identified using the ICIM-ADD effect. The identified flanking markers were used as cofactors in the QGene v.4.4.0 software to determine the LOD threshold and identify the significant QTL. Results and Conclusion: Two novel QTL were identified that showed consistency across all the tested locations and appear to be useful for marker-assisted selection in oat breeding programs.

C.R. Yeruva, S.M. Naraghi, M. McMullen

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# thank you!

## Semaglutide Use Associated with Gastrointestinal Adverse Events: Analysis of US FDA Data

**EDWIN AKOMANING**
PUBLIC HEALTH
**ADVISOR:** Akshaya Bahgavathula, Ph.D.

Background: Semaglutide is presently being misused due to its capacity to induce weight loss and can have the potential to cause adverse events including gastrointestinal events. This research investigated the gastrointestinal safety profile of semaglutide using the US FDA Adverse Event Reporting System (FAERS) database. Methods: A retrospective cross-sectional analysis of FAERS data from 2018-2023 was examined to assess the extent of GI adverse events associated with semaglutide. Adverse events and their outcomes reported among US adults were considered. Reported Odds ratios (ROR) with 95% confidence intervals were calculated. Results: A total of 3,966 adverse events were reported with semaglutide, with the majority (24.3%) in 2023. Females (60.5%), with a median age of 64 years (IQR 25-75 years) used semaglutide to manage diabetes (88.6%), weight loss (12.2%), and obesity (3.7%), and reported GI adverse events such as nausea (50.3%), vomiting (30.2%), diarrhea (25.7%), gastroparesis (8.2%), acute pancreatitis (7.2%), and GI bleeding (1.1%). Hospitalization occurred in 12.5%, disability in 0.6%, and mortality in 0.4%. Semaglutide use was significantly associated with acute pancreatitis (ROR: 2.78, 95% CI: 1.26–6.18) and diarrhea (1.7 times higher odds), but not with adverse outcomes. Conclusion: The use of semaglutide was associated with acute pancreatitis and diarrhea. Physicians should be cautious while prescribing semaglutide to prioritize patient safety and outcomes.

## Edible Wild Fruits, Velvet Apple (Diospyros discolor Willd.) and May-nuh (Meyna spinosa Roxb. Ex.), have Antioxidant and Enzyme Inhibitory Activities

**MOHAMMAD KHAIRUL ALAM**
CEREAL SCIENCE

**ADVISOR:** Shahidul Islam, Ph.D.

Wild edible fruits (WEFs) are becoming increasingly valuable because of their nutritional significance, which not only has favorable health effects but also presents novel applications in the food industry. Importantly, these WEFs are a very good source of phytochemicals and bioactive compounds that might be specific for preventing oxidative stress-related diseases. Thus, the present study was to evaluate the nutritional potential of the five selected WEFs native to Bangladesh, collected from local markets. In this study, these fruits were tested for total phenolics (TPC), total flavonoids (TFC), polyphenolic profile, and antioxidant and enzyme inhibitory activities, as well as ascorbic acid, proximate, and mineral composition. Polyphenolic profile, and proximate and mineral composition were determined using HPLC-DAD and AOAC method, respectively. The fruits studied had a high content of specific nutrients, such as protein, fiber, carbohydrates, Fe, Zn, Mg, K, and ascorbic acid. Moreover, they were found to have a low content of fat. The findings also indicated that velvet apple (Diospyros discolor Willd.) had significantly (p < 0.05) higher contents of TPC (143.4 ± 2.8 mg GAE/g), TFC (80.3 ± 0.5 mg QE/g), antioxidant activities, as documented by radical scavenging (84% inhibition) and higher ferric reducing capacities (815 μmol Fe(II)/g), and enzymes inhibitory activity, as evidenced by α-amylase (57% inhibition) and α-glucosidase (63% inhibition), than other fruits. The polyphenolic profile content varied between 0.25 to 98.44 mg/100g among the studied fruits. In addition, the principal component analysis indicated a clear separation among the fruits. Therefore, it is apparent from the investigation that the WEFs are nutrient-dense, rich in antioxidant molecules, and hence, can confer health benefits and serve as raw material for the food industry.

## Mechanisms of RAGE Dependent Drug Resistance in Melanoma

**YOUSUF ALAM**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Estelle Leclerc, Ph.D.

Background: Melanoma is a cancer of skin melanocytes and can be very difficult to treat once it has metastasized. According to the American Cancer Society, in 2024, in the USA, around 100,640 new patients will be diagnosed with melanoma and around 8,290 people are expected to die of this cancer. Vemurafenib is a selective inhibitor of mutant forms of the B-RAF kinase and is a standard of care for melanoma patients who carry B-RAF mutations. We hypothesize that RAGE inhibition can enhance the efficacy of vemurafenib by blocking the interaction between cell surface RAGE and its HMGB1 ligand. Method: We used immunohistochemistry and immunofluorescence techniques to determine the localization of RAGE in melanoma cells grown as 2D monolayers, 3D spheroids or within tumors generated in mice. We used different combinations of vemurafenib and of the small molecule RAGE inhibitor FPS-ZM1 to assess possible synergistic effects between the two drugs using the Combenefit software. Difference in cell growth in the presence of the drugs was determined using the metabolic dye Alamar Blue. Results: Different localizations (intracellular/cell surface) for RAGE were observed in melanoma cells grown as monolayers or as 3D spheroids. We observed a synergistic effect at 15uM vemurafenib and 10uM FPS.ZM1 in the melanoma cell lines that were investigated. Our data suggest that the RAGE inhibitor FPS-ZM1 could sensitize melanoma cells to vemurafenib. We are currently performing additional experiments to determine if RAGE inhibition blocks the interaction of cell surface RAGE with HMGB1.

## Targeted Combination Drug Therapy for Triple-Negative Breast Cancer Employing Hypoxia-Responsive Polymer Nanoparticles

**SHUBHASHRI AMBHORE**
CELLULAR AND MOLECULAR BIOLOGICAL SCIENCE

**ADVISOR:** Sanku Mallik, Ph.D.

Background: Triple-negative breast cancer (TNBC) accounts for 15% of diagnosed breast malignancy and lacks the expression of the hormone receptors and HER2. The diseases have a poor prognosis with high rates of relapses and metastases. Additionally, uncontrolled cell proliferation and insufficient blood supply leads to low oxygen level or hypoxia in the core of the tumors. Hypoxia increases cancer cell survival through aggressiveness, metastasis, and resistance to chemotherapy, leading to poor therapeutic effects. We hypothesized that a STAT-3 inhibitor (Napabucasin, NAPA) would decrease the stemness and increases the effectiveness of the anticancer drug doxorubicin (Dox) in killing TNBC cells under hypoxia condition. Methods: By utilizing MDA-MB-231 cells, we found a prominent synergistic effect of NAPA and DOX in regulating cell proliferation in both Normoxia (21% oxygen) and hypoxia (0.2% oxygen). Subsequently, we prepared targeted, iRGD peptide-conjugated, hypoxia-responsive polymersomes (Ps) containing NAPA and Dox. We performed the immunofluorescence imaging of neuropilin-1 (NRP-1) receptor on MDA-MB-231 and patient-derived (PDX) TNBC cells in Normoxia and hypoxia. We have established TNBC PDX mouse model and utilized F3-F6 generations (TNBC tumor samples received from Sanford Broadway Clinic, Fargo, IRB approved). PDX tumor-bearing female NSG mice were administered various drug formulations by intravenous injection biweekly for 4 weeks. The percentage of tumor volume growth was monitored on these treatment groups and compared to vehicle. Results: We observed a synergistic effect of NAPA and Dox in regulating cell proliferation under Normoxia (21% oxygen) and hypoxia (0.2% oxygen). Interestingly, the synergistic effect was higher in hypoxia compared to Normoxia. We observed increased NRP-1 receptor expression on MDA-MB-231 and PDX-TNBC cells under hypoxia. Further, in animal studies by using TNBC PDX mice model we observed reduction in tumor size with targeted combination therapy compared to vehicle. Conclusion: The combination of NAPA and Dox has shown promising results in controlling the growth of MD-MB-231 cells. Our proposal is to create NRP-1 targeted hypoxia-responsive polymersomes that can selectively deliver NAPA and Dox to hypoxic TNBC cells. Encapsulation of NAPA and Dox has been shown to enhance the release of drugs in hypoxic conditions, thereby precipitating the death of cancer cells.

## Targeting Purinergic Signaling Improves Sepsis-Induced Lung Injury by Modulating the Expression of P2Y12 Receptor

**EMMANUEL AMOAFO**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Elisabetta Liverani, Ph.D.

Sepsis is a severe and potentially deadly response of the body to infection, often leading to organ dysfunction, tissue injury, and, in extreme cases, death. . In sepsis-induced lung injury, purinergic signaling pathways through P2Y12 are activated, and their modulation can ameliorate lung damage. P2Y12 is widely expressed in immune cells and plays an important role in platelet ADP-activation. Our group has shown that antiplatelet drug therapies targeting P2Y12 or P2Y1 are organo-protective and may improve the outcome of sepsis in male but not female mice. Currently, we seek to investigate the mechanism through which blocking P2Y12 receptors improves sepsis-induced lung injury in both sexes. Male and female mice underwent sham surgery or cecal ligation and puncture (CLP) to induce sepsis. After surgery, mice received intraperitoneal injection of 30mg/kg ticagrelor (P2Y12 antagonist). Twenty-four hours post-surgery, whole blood was collected via cardiac puncture, bronchoalveolar lavage (BAL) fluid was collected and lungs were harvested. Plasma chemokine levels were analyzed by EveTechnology, immune cell count in the BAL fluid was determined using Hemavet and P2Y12 in the lung was determined using Western blot. Male and female CLP mice treated with Ticagrelor had significantly reduced levels of Lipopolysaccharide-induced CXC chemokine (LIX) (p £ 0.05, n=5). Platelet count in the BAL fluid of male and female septic mice was significantly increased compared with sham (*p £ 0.05, n=5). However, platelet count was significantly higher in septic males than in septic females. Platelet count was significantly reduced in male and female CLP mice treated with Ticagrelor (*p £ 0.05, n=5). P2Y12 protein levels in the lung were significantly increased in the lungs of septic male or female mice as compared with sham (*p £ 0.05, n=3). P2Y12 protein levels were decreased in male CLP mice treated with Ticagrelor. No change was noted in treated Female CLP mice. Blocking p2y12 receptors appears to decrease platelet and neutrophil infiltration in the lungs and reduces the expression of these receptors. These data suggest that antiplatelet therapy could provide a potential alternative/adjunctive treatment for sepsis-induced lung injury in a sex-related manner.

## Short Chain Fatty Acids Produced After Bariatric Surgery May Be Associated with Weight Outcomes Over Two Years Following the Procedure

**THERESAH AMPONSAH**

PHARMACEUTICAL SCIENCES

**ADVISOR:** Kristine Steffen, Ph.D.

Dietary fiber, abundant in plant-based foods, contains microbiota-accessible carbohydrates (MACs) metabolized by gut microbiota into short-chain fatty acids (SCFAs), influencing gut health and physiological processes. The interplay between gut bacteria and MAC byproducts is crucial for health and weight management. Increased fiber intake post-bariatric surgery may boost weight loss beyond reduced calorie intake. In this study, we investigated prospective, longitudinal relationships between SCFAs produced by gut microbiota and how they contribute to weight loss over 24 months post Roux-en-Y Gastric Bypass (RYGB) and Sleeve Gastrectomy (SG). Participants (n = 124) were assessed pre-surgery and at 1, 6-, 12-, 18-, and 24-months post-surgery. y. Height and weight of participants were recorded to calculate BMI. Dietary fiber intake was recorded using a validated 24-h dietary recall method (the Automated Self-Administered 24-hour [ASA-24] Dietary Assessment Tool). Changes in gut microbiota post-surgery were analyzed using shotgun metagenomic sequencing. Weight significantly decreased by the first month for RYGB (p < 0.001) and SG (p = 0.014), with another significant decrease from one to six months (RYGB, p < 0.001; SG, p = 0.027). RYGB maintained significant weight loss from six months to one year (p = 0.026), unlike SG. Dietary fiber intake recorded was below the average daily intake for all timepoints, with the lowest recorded one-month post-surgery (4.91 ± 3.70). Pre-surgical gut microbial diversity didn't differ between RYGB and SG. Participants' microbiota communities clustered according to surgery type with the most distinct cluster separation occurring 12 months after surgery. Post-surgery, Proteobacteria, Bacteroidetes, and Fusobacteria levels increased significantly. Bifidobacteria, Ruminococcus and Faecalibacterium decreased significantly from baseline to one month after surgery followed by an increase in abundance after the first month that remained steady over time. In conclusion, although lower concentrations of dietary fiber were consumed, gut microbes involved in their fermentation increased in abundance after surgery. Gas chromatograph will be used to measure the concentrations of SCFAs produced after gut fermentation of the ingested dietary fiber, and their correlation with weight loss will be determined using simple Pearson correlations. Findings will be used to optimize future bariatric surgery outcomes.

## Molecular Approaches to Identify Ascochyta Rabiei Effectors

**AMLAN ARMAN**
PLANT PATHOLOGY

**ADVISOR:** Malaika Ebert, Ph.D.

Amlan Arman1, Michael F. Seidl2, and Malaika K. Ebert1 1North Dakota State University, Department of Plant Pathology, Fargo, ND, 2 Utrecht University, Department of Biology, Theoretical Biology and Bioinformatics, Utrecht, the Netherlands North Dakota ranks 4th of the highest chickpea producing states in the US. One of the yield limiting factor affecting chickpea production is Ascochyta Blight, caused by the necrotrophic fungus Ascochyta rabiei. Ascochyta Blight is a seed borne disease of the above-ground parts of the chickpea plant. Plant pathogens deploy a range of secreted molecules, collectively known as effectors to colonise the host. These effectors aid the pathogen in virulence, competition among other microbes, and/or nutrient acquisition. To identify effectors of A. rabiei, we are using whole genome sequencing data of our most virulent A. rabiei strain, APNS4. The APNS4 genome assembly reveals the genome to be of about 41mb in 48 contigs. Additionally, we will pair our whole genome sequencing with an RNA sequencing experiment, where we use different time points (3DPI, 6DPI, 9DPI, and 14DPI) to study differential gene expression throughout the infection progress. By Identifying fungal effector molecules, we will get a better understanding of the infection mechanism of this economically important pathogen and will ultimately help with the development of resistant varieties of chickpea and broaden our understanding of the A. rabiei-chickpea pathosystem.

## Additive Manufacture of Advanced Composites using Reactive Resin.

**BIBEK ARYAL**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

Reactive Extrusion Additive Manufacturing (REAM), also known as a two-part reactive additive manufacturing system, is an efficient technique for printing thermoset polymeric materials by mixing two components (i.e resin and amine or hardener) within the mixing chamber before deposition on the print bed. The REAM process was developed to overcome significant limitations such as slow processing times and substantial energy needs of conventional additive manufacturing technology. In this study, pentaerythritol was utilized as a reactive resin and M-xylendiamine as an amine. The objective of this study is to enhance the mechanical properties of the reactive resin by creating a thermoset composite. Continuous carbon fiber was chosen as the reinforcement to increase the mechanical properties of the printed composites. The mechanical properties of the printed continuous carbon fiber-reinforced composites were compared with those of the printed neat resin samples. The mechanical properties of carbon fiber reinforced PX (Pentaerythritol Xylendiamine) composites were found to be increased significantly when compared with samples printed without fiber reinforcement. Keywords: Additive Manufacturing, 3D printing, Reactive resins, continuous carbon fiber, thermoset.

## Advanced Machine Learning Models and Explainable AI for Predicting and Understanding Emergency Shutdown Durations Level of Pipeline Incidents

**LEMLEM ABEBAW**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Chau Le, Ph.D.

Pipeline incidents pose significant concerns due to potential environmental, economic, and safety risks, emphasizing the critical need to understand and manage this vital infrastructure effectively. While existing studies predominantly focus on the causes of incidents and pipeline failures, only a few studies have investigated the consequences of pipeline incidents, such as shutdown duration. Additionally, these studies fail to capture nonlinear relationships, assume independent and identical failure events, and do not consistently align with the complex dynamics of pipeline incidents. Previous studies lack comprehensive models capable of accurately predicting and providing insights into the factors influencing the shutdown duration of pipeline incidents. This study bridges this gap by employing Machine Learning techniques such as random forest for classifying pipeline incidents' emergency shutdown duration levels. These techniques excel in capturing complex patterns and dependencies within the data. The proposed model was augmented with explainable AI techniques to enhance the model's interpretability and transparency, providing insights into the diverse factors influencing shutdown durations. This study leverages historical incident data collected from the Pipeline and Hazardous Materials Safety Administration (PHMSA) from 2010 to 2022 and examines various variables. K-Fold Cross-Validation was employed to ensure robustness and accuracy in classifying shutdown duration levels. The proposed model can assist pipeline operators, emergency responders, and regulatory authorities in categorizing the levels of shutdown durations, enabling better decision-making in emergencies to optimize resource allocation and minimize impacts on safety, the environment, and the economy.

## Numerical Features Development for Machine Learning to Describe Complex Materials

**RAHIL ASHTARI MAHINI**
COMPUTER SCIENCE

**ADVISOR:** Simone Ludwig, Ph.D.

Multi-component materials/compounds and polymeric/composite systems pose structural complexity that challenges the conventional methods of molecular representation in cheminformatics, which have limited applicability in such cases. Therefore, we have introduced an innovative structural representation technique tailored for complex materials. We implemented different metrics based on linear relationships' additive effect and the possible interactions between different components in reaction treating each multi-component material as a mixture system. We developed and improved mixture descriptors that are based on 13 different metrics and are divided into four categories including property-based descriptors, concentration-weighted descriptors, deviation-combination descriptors, and combinatorial descriptors. Two main packages were developed for this purpose and that allows users to compute 13 different mixture descriptors to use as input for the generation of machine learning-based Quantitative Structure-Activity/Property Relationship (mxb-QSAR/QSPR) models for predicting a range of chemical and physical properties across various complex systems.

## Efficacy of Herbicide Use on Three Prominent Invasive Species in an Invaded Rangeland

**ANNIE BAHE**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Shawn DeKeyser, Ph.D.

Grassland ecosystems are one of the fastest declining ecosystems in the United States. The introduction of invasive species is a primary driver of this decline. In the Northern Great Plains, three of the most prominent invaders in rangelands are Kentucky bluegrass, smooth brome, and leafy spurge due to their rapid reproduction and spread. A common way to treat these invasive species is through the use of herbicide applications. There have been few published articles within the last few years studying the efficacy of newly formulated herbicides used on these species, creating a gap in the literature. This study aims to discover how new herbicides, herbicide mixes, and different herbicide concentrations aid in the control of Kentucky bluegrass, smooth brome, and leafy spurge while limiting the harm to native plants. This study is conducted within a rangeland at the Albert K. Ekre Grassland Preserve in southeastern North Dakota. Four different herbicides were used to treat Kentucky bluegrass and smooth brome, and six different herbicides were used to treat leafy spurge. Each herbicide treatment was applied once in June of 2023 in spring only plots and once in September of 2023 in fall only plots within a randomized complete block design. Ideally, these herbicide treatments will help prepare pastures and rangelands for restoration by effectively reducing the cover and seedbank of invasive species as well as allowing for native species to expand. Cover data for each plot will be collected 3, 12, 15, and 24 months after spring treatments and 9, 12, 18, and 24 months after fall treatments. The results of this study will hopefully provide new guidelines for herbicide use in Kentucky bluegrass, smooth brome, and/or leafy spurge dominated rangelands as a pretreatment for restoration.

## The Application of Machine Learning, Image Processing, and ArcGIS for the Yield Estimation of Sunflower

**ALIASGHAR BAZRAFKAN**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Paulo Flores, Ph.D.

This study presents a comprehensive precision agriculture approach, integrating shape metrics, ArcGIS, and machine learning for yield estimation of sunflower. It operates on a trained Random Forest model using a dataset consisting of over 140,000 polygons representing sunflower seeds and leaves. There is a tool developed in ARCGIS PRO that anyone can use, even without any programming skills. This tool looks at the picture and tells you where it thinks the seeds are in the sunflower image. It utilizes a combination of image processing and machine learning techniques to detect sunflower seeds representing sunflowers in RGB images. This tool goes through several steps to analyze an image and predict where the seeds are. First, the RGB image is split into different parts – Red, Green, and Blue. After that, it uses a method called ISO clustering to break down the image, focusing mainly on the green part. This process separates the image into clear sections. Then, it calculates various measurements for each section, including circularity, compactness, area, perimeter, length, width, and shape index. These measurements give important details about each section. Next, it uses a trained random forest, to take those measurements and guess where the seeds are in the picture with an overall accuracy of 89%. With this tool, farmers, plant breeders, and researchers can save time by obtaining a reliable and fast estimation of sunflower yield, even using RGB images captured by their cellphones.

## Analyzing Trust Dynamics in Human-Robot Collaboration through Psychophysiological Responses in an Immersive Virtual Construction Environment

**HARDIK CHAUHAN**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Youjin Jang, Ph.D.

Human-robot collaboration (HRC) has emerged as a promising frontier within the construction industry, offering the potential to enhance productivity, safety, and efficiency. The effectiveness of HRC critically depends on the degree of trust that workers place in these robots and establishing a seamless level of trust in robots is essential to realize the full benefits. Despite the extensive exploration of trust dynamics in various industries, a notable research gap exists regarding trust in construction robots that possess distinctive characteristics in terms of appearance, capabilities, and interaction compared to robots in other sectors. Therefore, this study aims to analyze trust dynamics within the context of HRC during construction tasks. Both subjective survey data and objective psychophysiological data, including heart rate variability (HRV), electrodermal activity (EDA), and electroencephalogram (EEG)-based emotional valence and arousal, were employed as human trust measures. This study conducted experiments for bricklaying tasks in an immersive virtual construction environment and analyzes the multifaceted robot factors, including workspace environment, level of interaction, robot speed, proximity, and angle of approach, and their relationships with human trust measures using statistical analysis, such as t-test, two-way ANOVA, Spearman's rank correlation, and moderation analysis. The results demonstrated workspace environment and level of interaction are the most significant robot factors affecting human trust. Whereas EDA exhibited the most sensitivity to robot factor variation. It was also observed that the effect of speed, proximity, and angle of approach were also dependent on the level of interaction and the type of workspace environment. A significant positive correlation between proximity and perceived trust was observed. The findings of this study contribute to optimizing robot design and interaction protocols for construction tasks, fostering greater worker trust, and enhancing project productivity and efficiency.

## An Experimental Study of Fluid-Structure Interaction in a Thin-Walled Collapsible Vessel

**SIFAT KARIM CHOWDHURY**
MECHANICAL ENGINEERING

**ADVISOR:** Yan Zhang, Ph.D.

Microgravity during space travel associates physiological challenges, as it alters hydrostatic pressure gradients, causing a significant blood shift from lower to upper body circulations. Recent studies have revealed irregular blood flow in internal jugular veins, posing health risks such as venous thrombosis and emphasizing concerns for long-term space travel. An experimental study was conducted to investigate the complex fluid-structure interaction in a collapsible tube under both steady and pulsatile flow conditions. The study employed quantitative analysis of structural deformation and flow fields analysis utilizing optical image analysis and Particle Image Velocimetry (PIV). Tube wall deformation followed Shapior's tube law under static condition and conformed under steady flow conditions. However, as flow magnitude increased, self-excited oscillations occurred with an irregular pattern within specific ranges of negative transmural pressures. These oscillations became regular with increased frequency as transmural pressure became more negative. During pulsatile flow, positive and neutral transmural pressures led to symmetrical vuckling of the collapsible tube. Under highly negative transmural pressures, the tube collapsed, and self-excited oscillations were observed towards the end of systolic phases. Though the average flow rate became limited under such conditions, self-excited oscillations enhanced the peak flow rates within a pulsating cycle. The study suggests that negative transmural pressure aids in maintaining positive pressure gradients during pulsatile flow cycles, acting similarly to vein valves to prevent flow reversal.

## Exploring Novel Genetic Resources: Evaluating Effectiveness of Culling to Manage CWD in Endemic Areas

**ALEC CHRISTENSEN**
ENVIRONMENTAL AND CONSERVATION SCIENCES

**ADVISOR:** Travis Seaborn, Ph.D.

Chronic Wasting Disease (CWD) is an emerging prion disease causing neurodegeneration and death. Effective management tools are necessary for combating CWD outbreaks, which can lead to population declines in wild cervid populations. The use of agency culling is used in reducing population densities in CWD high-risk areas to reduce disease prevalence and transmission. Hunting pressure has also been used as a tool to reduce disease transmission by targeting individuals in high-risk areas, such as those with high population densities and prevalence. The relatedness of removed individuals during these two management actions could impact the average susceptibility of individuals in the population, yet it has not been assessed. Integrating genetic approaches to evaluate the effectiveness of management strategies to understand the susceptibility of wild cervids to CWD will provide valuable insights for management strategies. We will utilize microsatellites and multiple panels of differing numbers of single-nucleotide polymorphisms to explore relatedness and susceptibility among culled and hunted deer to determine the best number of genetic markers. We will then use the best panel to determine the relative impacts of culling and hunting on relatedness and susceptibility to CWD. We hypothesize temporal patterns of relatedness and genomic susceptibility over multiple years will demonstrate a concurrent decline, illustrating a reduction in genetic susceptibility and relatedness over time that will be differently reduced depending on the management strategy. Our findings will impact future management activities in controlling CWD.

## Student Satisfaction and Perceived Learning Related to Course Organization, Learner Interaction, Student Engagement, and Instructor Presence in Fully Online RN-To-BSN Courses

**COLLETTE CHRISTOFFERS**
ADULT AND COMMUNITY EDUCATION

**ADVISOR:** Florin Salajan, Ph.D.

Nursing programs have used current and emerging technologies to plan, deliver, and evaluate nursing education. As online distance education grew in the 1990s and proliferated in the early 2000s with advancement of the internet, in 2023 the Association of American Colleges of Nursing (AACN) reported more than 650 of the 747 RN-to-BSN programs across the United States were offered at least partially online.1 Nursing students completing an RN-to-BSN program are considered adult learners according to andragogy assumptions.2 Using the Expectancy Value Theory,3 understanding the factors impacting student satisfaction and perceived learning in the fully online RN-to-BSN environment can aid instructors with implementation of constructivist teaching-learning practices enhancing the learning experience. Evaluating the relationship between two dependent variables (student satisfaction and perceived learning) and four independent variables (course organization, learner interaction, student engagement, and instructor presence) in fully online RN-to-BSN courses using the Student Learning and Satisfaction in Online Learning Environments Instrument (SLS-OLE)4 can determine if there is a significant relationship between student satisfaction or perceived learning and course organization, learner interaction, student engagement, and instructor presence in fully online RN-to-BSN courses. Preliminary data alludes to relationships between factors. The factors that impact student perceived learning and expectations in online RN-to-BSN courses should be evaluated to assist online instructors implement learner-centered teaching strategies that enhance perceived learning and meet student expectations. References 1. American Association of Colleges of Nursing (AACN). (2023). Fact Sheet: Degree Completion Programs for Registered Nurses: RN to Master's Degree and RN to Baccalaureate Programs. Retrieved from: https://www.aacnnursing.org/Portals/0/PDFs/Fact-Sheets/Degree-Completion-Factsheet.pdf?ver=WFkXWp3oYafYuwAIK24igA%3d%3d 2. Merriam, S. B., & Baumgartner, L. M. (2020). Learning in adulthood: A comprehensive guide (4th edition). John Wiley & Sons. 3. Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. Annual Review of Psychology, 53(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153 4. Gray, G. & DiLoreto, M. (2016). The effects of student engagement, student satisfaction, and perceived learning in online learning environments. NCPEA International Journal of Educational Leadership Preparation, 11(1). ISSN: 2155-9635

## Rising Temperatures: Influences of a Reduced Snowpack on Kentucky Bluegrass

**BAILEY COFFELT**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Kevin Sedivec, Ph.D.

Global temperatures are expected to rise between 1.7 °C and 4.8 °C by the end of the 21st century. The rise in temperatures will reduce the impacts of the winter season, extent, and duration of snowpack in the Northern Plains. Because snowpack acts as an insulator, reductions in snowpack could expose plants to extreme temperature conditions, which could decrease the possibility of overwinter plant survival, leading to changes in plant community composition. Kentucky bluegrass (Poa pratensis L.) has invaded the Northern Plains and much of the United States, resulting in the decline of plant and animal diversity, ultimately lowering biotic integrity of the resource, but it is unknown how the expected temperature variation will impact its survival. We hypothesize that a reduced snowpack will lower Kentucky bluegrass cover. We established 10 plots (10 x 19m) each containing three treatments including: (1) snow reduction all winter, (2) snow reduction mimicking a false spring (snow reduction 2 weeks following first snowfall and after March 30th), and (3) no snow removal as the control. In the first year after treatments, we found overall plant communities within the treatments had not changed (p>0.05). However, the percent of Kentucky bluegrass cover declined (p<0.05) in the snow reduction mimicking the false spring treatment while the snow reduction all winter and control treatments did not change (p>0.05). Our preliminary data suggests that reducing snowpack by multiple weeks could potentially lower Kentucky bluegrass cover. If reducing the snowpack lowers Kentucky bluegrass cover other plant species will fill in the niche created. This information will help improve our understanding of how climate change might impact bluegrass and the overall plant community enabling us to better prepare and create more effective management decisions in a changing climate.

## Characterization of Novel Antibodies Targeting the Receptor for Advanced Glycation End-products (RAGE)

**KAYLEN CROSS**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Estelle Leclerc, Ph.D.

The Receptor for Advanced Glycation End-products (RAGE) is a transmembrane receptor that has been implicated in many types of cancer and autoimmune diseases. It consists of three extracellular domains that serve as ligand binding sites, which can initiate the intracellular signal cascade contributing to disease progression. Therefore, identifying antibodies that can target RAGE may have significant therapeutic and diagnostic potential. 254 novel antibodies were manufactured and characterized in collaboration with Genovac, a Fargo-based biotechnology company. The binding affinity of each antibody was quantified using indirect ELISA. In order to assist in selecting optimal antibody pairs for a sandwich ELISA, dot blot was used to identify the binding domains of each antibody. To assess the ability of these antibodies to bind to RAGE in human tissue, three high-affinity antibodies were selected for immunofluorescent staining of human lung tissue. Images were taken using confocal microscopy.

## Virtual Library Design of Single-Walled Carbon Nanotubes and Predicting Photoluminescence Properties by Combined Quantum-Chemical and Machine Learning Approach

**AMIRREZA DAGHIGHI**
BIOMEDICAL ENGINEERING

**ADVISOR:** Bakhtiyor Rasulev, Ph.D.

Single-walled carbon nanotubes (SWCNTs) are nanomaterials widely used in industrial and quantum applications. In this study, we dive into the photoluminescence properties of sp3-hybridized defect SWCNTs. Our primary objective is developing Machine Learning-based (ML) Quantitative Structure-Activity Relationship (QSAR) model to predict photoluminescence properties of these functionalized SWCNTs. Using a novel technique for calculating descriptors, we generated 5,666 descriptors for a set of 85 SWCNTs to predict their wavelength and oscillator strength (OS) for the ground excitation state using ML/QSAR techniques. Our best model exhibited robust performance, with R2= 0.97 and R2¬ext= 0.99 for OS, and R2= 0.97 and R2-ext= 0.99 for wavelength (nm), respectively. This confirmed the reliability of our approach in predicting photoluminescence properties. For further design of SWCNT with superior wavelength and OS, we generated a comprehensive virtual library comprising 41,852 functionalized SWCNTs. The construction of this library was facilitated by the Chemically Reasonable Mutation (CReM) algorithm, which introduced various functional groups to SWCNTs, thereby expanding the scope of their potential applications. The 3D geometries of these structures were obtained by converting SMILES strings to 2D structures and subsequently optimizing them using the MMFF94 force field. The ultimate aim of this research is to predict wavelength and OS of the comprehensive library of SWCNTs via the developed ML/QSAR model which lays the foundation for high-throughput screening method of a large set of SWCNTs. The insight from this virtual library screening not only contributes to our fundamental understanding of SWCNTs but also holds promise for future applications, as it guides the quest for SWCNTs with enhanced photoluminescence properties.

## Smart Boundaries: Smart Cones for Accurate Detection of Intrusion Hazards in Highway Work Zones

**AYENEW DEMEKE**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Youjin Jang

This paper introduces a novel algorithm designed to accurately distinguish between true and false vehicle intrusion incidents in highway work zones. The core challenge addressed is the high rate of false alarms generated by existing sensor-based systems, which typically rely on traffic cones for monitoring intrusions. The study utilizes data from accelerometer and gyroscope sensors mounted on traffic cones to develop a rule-based algorithm to analyze the patterns of cone movements and differentiate between true vehicle intrusion incidents and false alarm scenarios. Through extensive simulations in Webots, a robot simulation software, various scenarios of vehicle intrusions and potential false alarm conditions were tested. The developed algorithm effectively differentiates between real hazards and harmless movements of cones, such as those caused by wind or manual handling.

## Targeting Purinergic Signaling in Platelets Ameliorates the Bacterial Burden and Reduces the Cytokine Storm in the Peritoneal Cavity During Intra-Abdominal Sepsis

**PHILOMENA ENTSIE**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Elisabetta Liverani, Ph.D.

Intra-abdominal sepsis is a complex syndrome of the host response to infection. To date there are no specific effective treatment against sepsis. Platelets express the purinergic receptors P2Y1 and P2Y12; once activated, these receptors mediate the secretion of pro-inflammatory mediators that contribute to organ damage. We hypothesize that blocking P2Y1 or P2Y12 activity will enhance pathogen clearance and alter inflammatory levels in the peritoneal cavity during intra-abdominal sepsis in a sex-specific manner. Male and female mice underwent sham surgery or cecal ligation and puncture (CLP) to induce intra-abdominal sepsis followed by intraperitoneal administration of ticagrelor (P2Y12 antagonist) or MRS2279 (P2Y1 antagonist). The peritoneal cavity fluid (PCF) was collected 24 hours post-surgery by peritoneal lavage. To assess cell recruitment in the cavity, we measured leukocyte and platelet counts using Hemavet® Multispecies Hematology System. To assess inflammation, we measured PCF levels of the cytokines MIP-1α and Rantes as well as bacterial clearance. The ileum of the small intestinal tissue samples were collected 24 hours post-surgery and platelet infiltration was measured by platelet factor 4 (PF4) content in the tissue using an ELISA kit. In response to the P2Y1 or P2Y12 blocker, we noted a significant reduction in the bacteria content in the PCF of CLP mice. Blocking P2Y12 but not P2Y1 reduced leukocyte recruitment, while platelet counts were reduced only with P2Y1 blockade in septic males. The level of MIP-1α reduced upon P2Y1 but not P2Y12 blockage in the PCF of septic males. However, Rantes levels in the PCF were reduced for either treatment in males compared to the untreated CLP. The platelet marker PF4 in the ileum was reduced after either treatment in both sexes as compared to the untreated CLP. In female CLP mice, bacterial burden in the PCF in response to the P2Y1 but not the P2Y12 blocker was reduced. Blocking P2Y1 or P2Y12 reduced leukocyte recruitment and platelet counts in female CLP mice. No change was noted for MIP-1α or Rantes levels in the females among all the septic groups. Our data indicate that blocking purinergic signaling is a promising sex-specific therapeutic strategy for sepsis.

## The "Supercool" Freeze Tolerant Maggot, *Tetanops myopaeformis*

**MADISON FLODEN**
BIOLOGICAL SCIENCES

**ADVISOR:** Kendra Greenle, Ph.D.

Of the 5.5 million insect species, under 300 are freeze tolerant. Freeze tolerance allows insects to survive extreme winter temperatures, but the underlying mechanisms have been determined in few species. Thus, to better understand the mechanisms of freeze tolerance, we need to diversify the species and methods used in such studies. In this study, the sugarbeet root maggot, (SBRM), a freeze tolerant species able to successfully pupate after five years of storage at 6°±1°C, was used. We hypothesized that diapausing SBRM use cryoprotectants and control location of freezing initiation to prevent the presence, or uncontrolled formation, of intracellular ice. We measured amounts of the cryoprotectants proline and alanine using GC:MS. We will be comparing freezing initiation location and cold acclimation in field-relevant temperatures between diapausing and non-diapausing SBRM. Levels of proline, a known cryoprotectant, doubled in diapausing individuals. We anticipate a significant difference in the freezing initiation location and duration to complete freezing between diapausing and non-diapausing SBRMs. Diapausing individuals took an average of 1.5 seconds to complete freezing. We expect to see a dramatic decrease in mass and an increased freezing point when SBRM are kept in conditions simulating the field over a 20-week period. Increasing our knowledge of the SBRM and its freeze tolerance could lead to improved pest management strategies and demonstrate the value of non-model species for understanding freeze tolerance mechanisms.

## A Novel Liposome Co-Delivery Adavosertib and Paclitaxel for the Treatment Of Ovarian Cancer

**ARPITA GHOSAL**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Buddhadev Layek, Ph.D.

Ovarian cancer is the most lethal gynecological cancers. It is considered to be the second leading cause of death among gynecological malignancies with 5-year survival rate is only 30%. Ovarian cancer is a heterogeneous collection of malignancies among which the most common type is high grade serous ovarian cancer which comprises of 75% of the cases. It is been observed that in monotherapy the chemotherapeutic dose required for significant tumor inhibition is higher which causes serious side effects like bone marrow suppression, neural toxicity etc. Due to different tumor counteracting mechanism the combined therapy produces synergistic anti-tumor effect and helps in curbing the side effects while maintaining high drug concentration at tumor site with low amount of drug. The biodistribution of chemotherapeutic agent to tumor site as a free solution is less effective. So, to overcome this issue, nanocarriers were formulated for enhanced delivery of the chemotherapeutics to tumor site through enhanced permeability and retention effect exhibited by nanocarriers. Liposome is one of the first class of therapeutic nanocarriers to be approved clinically for its proven biocompatibility, biodegradability and low toxicity. In this study, we designed a novel combinational liposome (L-ADA/PTX) loaded with two drugs adavosertib (ADA) a Wee1 inhibitor and paclitaxel (PTX) taxane based chemotherapy which blocks cell division by inhibiting microtubule. L-ADA/PTX containing ADA and PTX was prepared by thin film hydration method. The mean particle size and polydispersity index (PDI) of liposome were 149.2 nm and 0.034, respectively. Encapsulation efficiency (EE) were determined by HPLC method with the results of 41.79% for ADA and 60.44% for PTX. In vitro tests like cell cytotoxicity assay of liposome L-ADA/PTX was done against high grade serous ovarian cancer cell line SKOV-3. In future, we will be performing in vivo study regarding the effectiveness of liposome in ovarian cancer mouse model.

## Monitoring the Dynamics of Potato Early Die

**DANIEL GILL**
PLANT PATHOLOGY

**ADVISOR:** Julie Pasche, Ph.D.

The early die disease complex causing premature senescence of potato, is an endemic affliction of the crop throughout the world. Verticillium spp., Colletotrichum coccodes, and Pratylenchus penetrans all contribute to the development and severity of the disease. Management options are limited due to pathogen biology, large scale feasibility, and government regulation. With few control options available, disease detection can have an important role in improving management. Advancements in remote sensing technology and machine learning have allowed companies to market early disease detection services to potato growers. There is a need to begin validating the use of these technologies in accurately and efficiently identifying disease development. The goal of this research is to determine the viability of color imaging technology from Prospera mounted to center pivot irrigation systems for early detection of early die disease. Validation of the camera technology will be guided by data collected from in-season field observations and sampling along with molecular techniques for quantifying changes in pathogen levels over time. In addition to exploring the use of imagery for early die detection, a disease risk factor for production fields, referred to as the disease fingerprint, will be developed. Maximizing limited potato acreage in rotation by ranking field risk to early die will allow informed agronomic decisions to limit disease escalation for future seasons.

## Low-Temp Interlaminar Bonding in AM Polymer Parts

**ANGELA GRABOWSKI**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

Additive manufacturing is a type of manufacturing that works from the ground up to create a part instead of carving away stock material as in conventional manufacturing. There are many types of additive manufacturing that use different orientations and mediums for part creation, such as resin pools, powders, sheets of material, or extrusion of filament. 3D printing is a common name for additive manufacturing and is usually understood as extruding plasticized polymer from a nozzle and depositing it into a print plate in layers to form the desired part. This technique has been revolutionary in creating precise parts and geometries that would be extremely difficult to create with conventional techniques. One of the main challenges with this method is the weak interlaminar bonding that causes the layers of the part to peel off of one another before the stresses reach the material failure point. When printed poorly, the layers can even peel off from purely internal stresses. The objective of this project is to observe interlaminar bonding at ambient and sub-ambient temperatures. To help enable this, unique print geometries and methods are being developed that emphasize failure between print layers. This can determine the best print techniques and allow for better optimization in parts used in industry. By developing test methods for characterization of printed material properties, print parameters can be qualified for structural components that need to meet performance criteria.

## Earthquake-Induced Inelastic Displacement Ratio in Bridges

**BIGYA GYAWALI**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Mijia Yang, Ph.D.

Most bridges behave nonlinearly when subjected to strong earthquake ground motion. In conventionally designed bridges, this nonlinear effect is considered following the design specification of AASHTO (Guide Specifications for LRFD Seismic Bridge Design). The specification relies on an amplification factor (R_d) to estimate inelastic displacement. A variety of research has been performed in the Single Degree of Freedom (SDOF) system to determine this amplification factor, however, no study has been conducted on bridges, considering the wide range of bridge types, bridge layouts, and their connections with soil supports. It is necessary to develop a simple and reliable adjustment factor or expression that can better predict the real inelastic displacement response in bridges. The presented work models the complete nonlinear behavior in different components of bridges and performs nonlinear time history analysis and linear time history analysis using CSI Bridge, a commercial design software for bridges, to determine the maximum inelastic and elastic displacement demands. The derived R_ds match well with the AASHTO equation in the transverse direction of bridges, however, AASHTO significantly underpredicts the inelastic displacements in the longitudinal direction of bridges. This result highlights the necessity of modification of R_d in the AASHTO specification and helps the Civil Engineering industry to provide better bridges for society.

## Buzzing Through Change: Using Landscape Ecology to Unravel Bumble Bee Dynamics in the Northern Great Plains

**RHIANNON HALL**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Travis Seaborn, Ph.D.

Pollinators are vital for both ecosystem health and agricultural productivity. One crucial group of pollinators are bumble bees of which there are approximately 250 known species. Bumble bees have a special pollination technique called buzz pollination that is critical for about 6% of plants including both wildflowers and major commercial crops such as tomatoes, peppers, and potatoes. However, they face multifaceted challenges including habitat loss, climate change, and pesticide exposure, leading to a decline in about one-fourth of IUCN Red List species. Given their ecological and economic significance, it is imperative to understand bumble bees' population dynamics and adaptive responses to changing environments for effective conservation strategies. This study uses landscape genomic techniques to understand the intricate relationships between environmental factors and the ecology of bumble bees in the Northern Great Plains. A total of 381 bumble bees were sampled between 2017 and 2020 across North Dakota at 13 and 17 survey sites for Bombus ternarius and B. griseocollis, respectively to better understand their population structure and response to their habitat. Basic measures of genetic diversity and structure will be analyzed to understand the current state of these bumble bee populations. We will look for any relationships between environmental factors and the population genetics of these species. Here we present the initial stages of our analysis, which utilizes GIS data to characterize the environmental conditions both within and among survey sites. Anticipated outcomes include insights into how landscape features such as land cover types, habitat fragmentation, and temperature gradients influence bumble bee genetic diversity and connectivity. These influences could include acting as barriers to dispersal or otherwise creating resistance on the landscape. Our study's findings will inform conservation strategies and contribute to understanding bumble bee ecology in dynamic landscapes. Moreover, the insights garnered from this study are anticipated to enrich our broader understanding of bumble bee ecology and inform targeted interventions aimed at mitigating the threats posed by anthropogenic activities and environmental changes.

## Predicting the Tofu Quality Based on Protein Subunit Profiles using Machine Learning

**MENGLIN HAN**
PLANT SCIENCES

**ADVISOR:** Minwei Xu, Ph.D.

Tofu is widely recognized as a prevalent source of plant-based protein globally. The quality of protein plays a crucial role in determining the overall quality of tofu. Specifically, the protein subunits within tofu are integral to its quality. Understanding the relationship between these protein subunits and tofu quality is of paramount importance, as it can furnish soybean breeders with valuable insights. This research investigates the effect of protein subunits on soybean seed quality metrics and resultant tofu characteristics, focusing on the role of soybean protein composition, especially the 11S/7S ratios, in determining tofu's texture and taste. In a comprehensive exploration, 172 varieties of soybean seeds from East Asia and North America were processed into tofu. Parameters such as water uptake capacity, tofu and soymilk yield, moisture, crude protein, and texture profiles were scrutinized. High-resolution sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and machine learning were used to detail the profiles of 11S and 7S protein subunits. The findings highlighted significant variations in tofu quality based on the seeds' geographic origins. Notably, tofu made with the soybean seeds from North America showed lower protein content (52.10%), but higher moisture content (69.66%), alongside enhanced yield, firmness, and gelatinization. SDS-PAGE analysis confirmed the clear distinction of eleven protein subunits, effectively differentiating 7S and 11S proteins. A K-Nearest Neighbors (KNN) model shows the highest accuracy at 83%, which will transcend geographical boundaries, unlocking the potential of high-quality soybeans for tofu production. This study can guide the selection and breeding of soybean varieties optimized for producing tofu of superior quality, thereby enhancing the food's appeal and nutritional profile.

## Genetic Diversity in the North Dakota State University Soybean Breeding Program

**FORREST HANSON**
PLANT SCIENCES

**ADVISOR:** Carrie Miranda, Ph.D.

Soybean [Glycine max (L.) Merr.] is a relatively new crop in North Dakota. Despite this, it has become one of the leading crops for acres planted and production value within the state. However, in terms of soybean yield averages, North Dakota falls behind compared to other midwestern states. Public breeding efforts began in 1986 through North Dakota State University, and during this time, 40 cultivars in maturity groups 00 and 0 have been released (1994 – 2021). Although yields have increased during this time, the yield gains and genetic diversity of the program had not been previously studied. The objective of this study was to determine the parentage of NDSU cultivars dating back to founders, as well as utilize genotype data to display genetic relatedness and assess genetic diversity among released NDSU cultivars. To address this, ancestral pedigree records were collected for all released NDSU cultivars dating back to the original North American soybean founders. In constructing the parental pedigree, lineage traced back to the original founders encompassed a total of 443 pedigree-related accessions, 49 of which are founders. For genetic analyses, 11 NDSU cultivars were left out of the analysis due to lack of available seed and genotype data. Coefficient of parentage was determined through use of pedigree information and by calculating average contribution between: founders and NDSU cultivars, founders and NDSU experimental lines, first progeny and NDSU cultivars, and first progeny and NDSU experimental lines. Results show that only 10 founders help contribute over 70% of all germplasm within NDSU released soybean, with Mandarin (Ottawa), A.K. (Harrow), and Strain 171 contributing 24.19%, 9.88%, and 6.43%, respectively. Genotype data (50K) was used to create the heatmap and population structure bar plot. Genotype data was imputated and filtered at MAF < 0.1, resulting in 20K SNPs. Heatmap and population structure bar plot analyses both display regions where heightened levels of relatedness occur among NDSU cultivars. Analysis of genetic relatedness revealed that high levels of genetic relatedness are present within current released NDSU cultivars, and utilization of unused elite germplasm will help expand diversity moving forward.

## Impact of RAGE Inhibition on Melanoma Cell Response to Chemotherapy

**MD ZAHIDUL HASAN**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Estelle Leclerc, Ph.D.

Background: Melanoma is a frightening form of skin cancer because of its aggressiveness and poor therapeutic response. The Receptor for Advanced Glycation End-products (RAGE) has been recognized as a significant factor in the progression of melanoma, making it a potential therapeutic target. The purpose of this research is to explore the complex association between RAGE and melanoma by studying the impact of inhibiting RAGE on the responsiveness of melanoma cells to two chemotherapeutic agents: the BRAF mutant inhibitor drug vemurafenib and the DNA alkylating agent temozolomide. Methods: Human A375 melanoma cells were used for the study. RAGE was silenced using RAGE specific shRNAs. Western blotting, immunoprecipitation, and ELISA assays were performed to confirm RAGE silencing at the protein level. Quantitative PCR (qPCR) was performed to assess changes in RAGE mRNAs after silencing. Alamar Blue assay was utilized for assessing the effect of vemurafenib and temozolomide on the metabolic activity of A375 cells. Results: The A375 cells were successfully transfected with RAGE-specific shRNA. Single-cell clonal selection of transfected A375 cells generated a more homogeneous population with consistent gene expression by minimizing cell-to-cell variation. The results of this study will determine if RAGE inhibition influences chemotherapy response in A375 human melanoma cells. Conclusion: This research could shed light on the complicated relationship between RAGE and the chemotherapeutic agents, understanding ways to improve melanoma chemotherapeutic outcomes.

## Buzzing Amidst the Heavy Metals: The Toxicity Effects of Heavy Metals on Survival and Performance in Alfalfa Leaf Cutting Bee

**JACKIE HUMBLE**
BIOLOGICAL SCIENCES

**ADVISOR:** Giancarlo López-Martínez, Ph.D.

The alfalfa leaf-cutting bee is one if not the most important solitary bee and is second behind honeybees for their importance and management to agricultural practices (Pitts-Singer & Cane, 2010). The environment has changed as humans have expanded their infrastructure of mining and drilling causing negative impacts to the water and land. North Dakota is one example where there has been an increase in heavy metal pollution over the years due to brine water spills (Lauer et al., 2016). These spills indicate there is concern for the organisms that live in these environments. This is why we will be testing alfalfa leaf-cutting bees' performance (longevity, survivability, flight performance, and activity) in response to heavy metal exposure. The bees will be given food tainted with LD50 doses of selected metals and spill-relevant doses in North Dakota. We are using cadmium and lead for our experiments because of their brine spill doses and the effects they have on honeybees. Longevity experiments will inform timepoints for the flight and activity experiments. Activity experiments will be done using DAMs, and flight experiments will be conducted using a large cylinder where the bee will be dropped. We expect the results to show certain negative effects of the heavy metals and here we present preliminary experiments showing promising results. Due to the importance of pollinators and the pollution that is affecting their environment, there is the potential for heavy metals to have dire consequences for the survival and performance of the alfalfa leaf-cutting bee. References Lauer, N. E., Harkness, J. S., & Vengosh, A. (2016). Brine Spills Associated with Unconventional Oil Development in North Dakota. Environmental science & technology, 50(10), 5389–5397. Pitts-Singer, Theresa & Cane, Jim. (2011). The Alfalfa Leafcutting Bee, Megachile rotundata: The World's Most Intensively Managed Solitary Bee*. Annual review of entomology. 56. 221-37. 10.1146/annurev-ento-120709-144836.

## Measurement of Optimum Laser Energy Required to 3D Print Continuous Fiber Reinforced Composites Using Photo-Curable Thermoset Resin

**MD ZAHIRUL ISLAM**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

Continuous carbon fiber (CCF) reinforcement has garnered significant attention in 3D printing due to its ability to impart exceptional mechanical performance characteristics to polymer composites. Light-assisted 3D printing of thermoset resin with CCF reinforcement enables the scalable production of complex structures using additive manufacturing. However, the opaqueness of carbon fiber poses challenges to the curing process of thermoset resins during printing with CCF reinforcement. Therefore, knowledge on the minimum light energy required to continue printing while retaining the desired print shape is crucial for designing energy-efficient and successful manufacturing systems. The primary objective of this study was to measure and compare the minimum energy required to continue light-assisted 3D printing of thermoset resin with CCF reinforcement. The study specifically investigated the minimum light energy needed for printing with both an acrylate-based thermoset resin and an epoxy-acrylate resin. Optimized laser irradiation with the appropriate light energy is imperative for achieving scalable production of CCF reinforced composites with minimum energy consumption.

## Nanomechanics of Actin Filament Deformation and Fracture: A Steered Molecular Dynamics Approach

**SHARAD JASWANDKAR**
MATERIALS AND NANOTECHNOLOGY

**ADVISOR:** Dinesh Katti, Ph.D.

In eukaryotic cells, the cytoskeleton is a three-dimensional dynamic structure that helps cells retain their form, internal organization, and mechanical rigidity. The polymer biomolecules in eukaryotic cells that function as structural elements of the cytoskeleton are the actin microfilaments, microtubules, and intermediate filaments. The diseases like cancer transform the cell's cytoskeletal structure. Altered cytoskeletal structures modify cancer cells' ability to contract or stretch by affecting their deformation mechanics. The abnormal cellular motility is a signature characteristic of metastatic cancer cells, promoting tumor cells' spread to both local and distant locations in the body. The dynamic reorganization of the actin cytoskeleton is a fundamental requirement of this process. We have also shown that the cancer cells' altered mechanical properties during disease progression are connected with the actin reorganization. In actin assembly dynamics, actin filaments are severed constitutively by an essential regulatory protein, ADF/Cofilin. Therefore, several studies were performed to examine the mechanical properties of F-actins. However, the fundamental mechanism that controls F-actin's response to deformation is not understood. The present study uses the steered molecular dynamics (SMD) simulation approach to understand actin filament mechanics. The work was performed in four computational sets of experiments, namely bending, compression, tension, and torsion simulations. Our findings demonstrate that F-actin's deformation response is regulated by the dissociation pattern of conformational locks at intra-strand and inter-strand G-actin interfaces. F-actin elongation enabled salt bridge formation at the inter-strand interfaces, improving the G-actin-G-actin bond strength. Furthermore, we noticed an inter-strand serrated locking pattern connecting G-actin subunits, restricting their relative movement, thus enabling F-actin's ability to resist deformation. Additionally, we found ADF/Cofilin to cause structural transmutations in f-actin, thus altering their physical properties. The F-actin mechanics described here are vital for constructing a mechanobiological eukaryotic cell model that mimics cell mechanics with disease progression.

## Involvement of Cerebellar Vermis in the Perception of Depth from Motion Explored with Transcranial Magnetic Stimulation

**EMILY JOHNSON**
PSYCHOLOGY

**ADVISOR:** Mark Nawrot, Ph.D.

Current models suggest that the unambiguous perception of depth from motion parallax (MP) relies on the integration of retinal image motion with a pursuit eye movement signal, which previous work has suggested may be generated by the frontal eye fields (FEF). In the present study, we used Transcranial Magnetic Stimulation (TMS) to explore a possible role of the Cerebellar vermis (CV) in these computations. Both physical lesions to and TMS of the CV, but not the cerebellar hemispheres, have been found to disrupt motion perception and produce smooth pursuit deficits. However, a possible role of the CV in the computation of depth from MP has not been explored. In the present study, we used TMS to investigate this possibility. Triple-pulse (33 hz) TMS was applied to mid-line CV (1 cm below the inion) at the time of visual stimulus onset (0 msec ISI) during three tasks: i) pursuit, ii) motion perception, and iii) MP depth perception. The pursuit task was a step-ramp. Psychophysical tasks required the observer to report perceived depth or perceived motion direction (2AFC) of a computer-generated random-dot stimulus making a single translation, leftward or rightward, of duration (t). Between trials, t varied in two interleaved staircases, one for each direction of stimulus translation. Average performance from 35 participants indicates that TMS of CV produced an overall decrease in pursuit latency (13 msec for leftward and 11 msec for rightward translation). Similarly, for depth perception, TMS produced a decrease in pursuit latency in both directions (25 msec for leftward and 18 msec for rightward translation). TMS produced no change in motion perception latency for either direction of stimulus translation. These results suggest that cerebellar vermis may play a role in the integration of the pursuit signal needed for the unambiguous perception of depth from MP.

## The Processing Effects on Crystallinity in Thick Section Compression Molded Comingled PET/ E-Glass Composites

**AVERY JORGENSEN**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

As the world moves rapidly towards sustainable technology, the need for recyclable high-performance materials is at an all-time high. Fiber-reinforced composites (FRCs) are materials that use fiber, such as carbon fiber or glass, to augment the mechanical properties of another material, known as the matrix. For high-performance applications, the most common matrix materials are high-strength epoxy resins that, once solidified, are extremely difficult to recycle. One new option being investigated is creating these composites using readily available and recyclable polymers such as Polyethylene terephthalate (PET). PET is the most recycled polymer on the planet and is most commonly seen in water bottles. Because of this, PET has the potential to be used as a matrix material for FRCs. Until recently, PET was not considered for thick composite sections because it can present different properties based on its cooling rate due to crystallinity. As PET cools, molecular chains form ordered groups and create small crystals, while most of the polymer remains unordered or amorphous. The mass ratio of these two areas is considered crystallinity. Crystallinity must also be characterized to characterize PET composites fully. This study aims to relate thickness, peak processing temperature, and hold time at PET's crystallization temperature to the final crystallinity of a specimen. To do this, a fabric made of E-glass and PET fibers was heated in a steel mold under high pressure in a process known as compression molding. Compression-molded parts were processed at three peak temperatures, thicknesses, and hold times. Through this process, an optimized process can be created to produce a composite that can be used for many generations to come.

## Investigation of the Crosstalk Between Platelets, Cancer Cells, and Immune Cells in Pancreatic Cancer

**YING KANG**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Elisabetta Liverani, Ph.D.

Background: With the incidence rising at a rate of 0.5% to 1.0% per year, pancreatic cancer is projected to become the second-leading cause of cancer death by 2030 in the US. Pancreatic cancer has the lowest survival rates, where approximately 9% of patients survive five years after diagnosis. It is recognized that the progression of tumors in pancreatic cancer patients is accompanied by an increased risk of thrombotic episodes, which suggests the important role of platelets in pancreatic cancer. Solid tumors secrete more ADP than normal tissues, especially under hypoxia, which often occurs in solid tumors as they outgrow their blood supply. ADP is an important platelet agonist. It activates platelets through Gq-coupled P2Y1 and Gi-coupled P2Y12 receptors. Apart from hemostasis and thrombosis, platelets also play an important role in immune activities. However, the crosstalk between platelets, cancer cells, and immune cells has not been fully explored. In this study, we aim to explore the stimulation of platelets in pancreatic cancer, the effects of platelets on pancreatic cancer cells, and platelet-associated inflammation and immune responses. Methods and Results: We measured platelet activation by pancreatic ductal adenocarcinoma (PDAC) cells and in cancer patient blood. We found that ADP-induced platelet aggregation seems to be amplified by exposure to PDAC cells and p-selectin surface expression is higher in blood samples of cancer patients as compared to healthy individuals. We confirmed the expression of P2Y12 in PDAC cells. Next, we co-cultured platelets and PDAC cells and performed proliferation and migration assays. We found that PDAC cell proliferation was not affected by platelet exposure. However, platelets promoted the migration of PDAC cells most likely through the ADP-P2Y12 axis. We also measured the levels of platelet-derived inflammatory cytokines in pancreatic cancer patient plasma. We found that levels of platelet-derived inflammatory cytokines are higher in pancreatic cancer patients' plasma than in healthy donors. Lastly, we performed platelet-PDAC cell-peripheral blood mononuclear cell (PBMC) co-culture to detect PDAC cell survival. Exposure to PBMC and platelets could decrease cancer cell growth. Conclusion: Overall, our data suggest that platelets play a complex role in the regulation of pancreatic cancer.

## Exercise Motivation Does Not Affect Critical Speed in Army ROTC Cadets

**JOE KETTERLING**
Exercise Science and Nutrition

**ADVISOR:** Nathan Dicks, Ph.D.

Background: This study investigated whether exercise motivation influences critical speed performance in Army Reserve Officers' Training Corps (ROTC) cadets. Critical speed (CS) is theorized as the physiological upper limit of effort that can be maintained for an extended period. Meanwhile, D' (pronounced "distance prime") represents the work above CS before fatigue sets in. Sprinting speed during all-out effort will typically regress toward CS within 90 to 150 seconds. Thus, a 3-minute all-out test (3MT) will produce D' and critical speed parameters. Performing at these high levels of intensity results in substantial displeasure and requires psychological resources (e.g., motivation) to overcome these feelings of discomfort. Understanding the psychological determinates of critical speed and D' will help practitioners develop exercise interventions for tactical populations. Methods / Procedure We recruited 33 Army ROTC cadets for a two-day visit. During the first visit, researchers collected demographic information, body composition measurements, and administered the Behavioral Regulations in Exercise Questionnaire (BREQ-3). During their second visit, the cadets completed a 3MT on an indoor 200 m track, where speed, power, and heart rate were measured. Relative Autonomy Index (RAI) was determined by summing the weighted (-3 to +3) mean scores of the BREQ-3 subscales. We calculated Pearson correlation coefficients to determine the strength and direction of association between D', CS, RAI, age, height, and body fat percentage. Results Twenty-six subjects (21 males) completed the 3MT. Our analysis revealed no significant relationships between exercise motivation (RAI) and critical speed (CS), with correlation coefficients ranging from 0.06 to -0.28 (p>0.05). There was a significant correlation between body fat percentage and CS (r=-0.50, p< 0.05), but not D' (r=-0.06, p=0.77). No significant correlation was found for height and age for either CS or D'. Conclusion / Significance Our findings indicate that exercise motivation does not significantly impact CS performance among Army ROTC cadets. Due to the limited sample size in our study, further validation of these results is recommended in larger population samples. Additionally, future research could explore how these findings compare with the CS performance of tactical athletes at later stages of their careers.

## Impact of Location and Planting Dates on Stem Solidity Expression for Wheat Stem Sawfly Resistance in Spring Wheat (Durum And Bread)

**BASANTA KHANAL**
ENTOMOLOGY

**ADVISOR:** Deirdre Voldseth, Ph.D.

Wheat stem sawfly (WSS, Cephus cinctus Norton) is a major threat to wheat in the Northern Great Plain for several decades and is expanding its range. Host plant resistance, using wheat lines with solid stems, is primary means of managing WSS over decades, as other management practices are less effective. Solid stems act as a mechanical barrier to inhibit oviposition, larval emergence, feeding and movement. Stem solidity is primarily controlled by genes on quantitative trait loci (QTL), Qss.msub-3BL on chromosome 3B, with some other minor loci on chromosomes 2A,2D, 3A, 3D, 4A and 5A. Expression of stem solidness can be affected by environmental and plant growth factors. There is lack of information on how the expression of solidity is affected by environmental condition. The major objective of the study was to evaluate the expression of stem solidity at multiple location and planting dates of 13 wheat genotypes with four different genetic bases for stem solidity: 1) the Rescue allele on chromosome 3B, hexaploid 2) the Conan allele associated with "early solidity"- hexaploid 3B, 3) Goldenball derived genetic base, fully solid-dosage tetraploid on 3B, and 4) susceptible hollow-stemmed hexaploid checks. We conducted the field experiment at two locations, one with a single planting date (early) and another with three planting dates (early, recommended and late) arranged in an RCBD with three replications. Experiments are ongoing. The outcome of this study will help in understanding how the expression of stem solidity with different genetic bases will be expressed under multiple environmental conditions.

## Biomass Waste as Green and Sustainable Corrosion Inhibitors for Reducing Corrosion Caused by De-Icing Salt

**TAEHYUN KIM**
COATINGS AND POLYMERIC MATERIALS

**ADVISOR:** Xiaoning Qi, Ph.D.

Corrosion, especially transportation-related corrosion is problematic with significant societal impacts on economy, environment, and safety. De-icing salts, as one of the major culprits of corrosion of roads, bridges, and vehicles, are still widely used in northern states in the U.S. In 2023, U.S. applied approximately 20 million tons of sodium chloride de-icing salts, which is about 42% of total sodium chloride consumption [1]. Substantial efforts are put into studies and practices to reduce de-icing salt caused corrosion. Here we propose to use widely available oil-rich biomass wastes during the vegetable oil production as green and sustainable corrosion inhibitors. This approach will add value to biomass waste, as well as provide economical viable solutions for reducing the corrosivity of de-icing salts. Specifically, we report the effects of commonly used sodium chloride de-icing salt induced corrosion and the performance of the green corrosion inhibitors on galvanized steel and rebar steel, commonly used in vehicles and reinforced concrete. The effect of green corrosion inhibitors was investigated using several electrochemical methods: potentiodynamic polarization (PDS), and electrochemical impedance spectroscopy (EIS), with the goal to understand the corrosion mechanism and inhibition efficiency of the newly developed green corrosion inhibitors.

## Tackling the Weedy First Years of Prairie Reconstructions with Spike Seeding and Herbicide Pretreatments

**THEO KNOWLES**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Shawn DeKeyser, Ph.D.

The first two years of prairie reconstructions are generally dominated by weedy species. These weedy years can hinder the progress of prairie reconstructions since they can slow the establishment and reduce the diversity of the sought after native plant community. To try and limit the initial weed pressure in prairie reconstructions, we are testing a method called spike seeding, which adds four native forbs at double the seeding rate to a diverse seed mix. In addition, we aim to test different herbicide pretreatments that target leafy spurge, a common weedy species in our reconstruction site located within the Albert K. Ekre Grassland Preserve. Over the next two years, we will be sampling the plant community of the spike seeding method and comparing it to a non-spiked seeding method, within each herbicide pretreatment. We will use this data to assess three questions: 1) Does the spike seeding method limit the presence of weedy species in the first two years of prairie reconstructions? 2) Which herbicide pretreatment is most effective at controlling leafy spurge in leafy spurge infested reconstructions? 3) Which combination of herbicide and seeding method yields the most diverse plant community? We hope that these results can provide methods to limit the weedy first years of prairie reconstructions and provide insight on effective reconstruction pretreatments in leafy spurge infested areas.

## Development of a Four-Axis 3D Printer for Continuous Fiber-Reinforced Composite

**PRASHANT LAKHEMARU**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

Additive Manufacturing, also commonly known as 3D printing, has gained significant popularity in recent years due to its increased design freedom, lower cost, reduced material wastage, rapid prototyping capabilities and improved material properties. It is a revolutionary technology that builds objects from digital designs by adding-up layers. This study proposes the development of a novel 4-axis 3D printer with fixed printhead for precise continuous fiber placement in additive manufacturing of fiber reinforced composites and a custom controller software to control the printer. Unlike conventional 3-axis 3D printers that move along X, Y and Z axes, a 4-axis 3D printer has a rotating build platform as an additional axis to enable intricate layering and more flexible orientation of reinforcing fibers. The objectives of this study are to achieve better fiber alignment and improved print quality, leading to higher mechanical properties of the printed composites and improving overall performance compared to the conventional printers. The proposed research includes designing and building the 4-axis 3D printer, development of the controller software, optimizing the printing parameters, conducting mechanical tests, and finding new possibilities for creating complex geometries without the limitations of traditional 3D printers.

## Tolpyralate and Bromoxynil Efficacy on Green Foxtail in Small Grains

**HAYDEN LEE**
PLANT SCIENCES

**ADVISOR:** Kirk Howatt, Ph.D.

In small grains, post emergence grass weed control is limited to ACCase- (Group 1) and ALS- (Group 2) inhibiting herbicides. Green foxtail (Setaria viridus) has developed resistance to these sites of action and an additional mode of action is necessary for green foxtail control. Tolpyralate (Group 27) mixed with bromoxynil (Group 6) has shown activity on foxtails but is primarily used for broadleaf control. To further investigate grass activity, field experiments in 2023 were conducted at three locations to determine the effect of application timing (1-leaf, 3-leaf, and tillering) on foxtail control. Treatments were arranged in a randomized complete block design with four replicates, comparing tolpyralate and bromoxynil to industry standards. Visual evaluations for foxtail control and wheat response were performed at 7, 14, and 21 days after treatment (DAT). Foxtail biomass and wheat grain yield were measured at the end of the season. Green foxtail at Prosper showed resistance to Group 1 herbicides, observed as less than 3% control (21 DAT) when sprayed with an ACCase herbicide. At the same location greater than 91% foxtail control (21 DAT) was observed with tolpyralate and bromoxynil. Application timing did not significantly affect visible control with tolpyralate and bromoxynil. However, the biomass accumulation following the 1-leaf timing was significantly greater than the other timings. This was consistent at all locations and likely the effect of new foxtail flushes throughout the growing season. Spraying tolpyralate and bromoxynil at the 3-leaf timing provided at least 90% control of green foxtail while avoiding post application emergence following the 1-leaf timing. In resistant foxtail populations, tolpyralate and bromoxynil offers an additional mode of action for post emergence control.

## Harmony and Discord: Exploring the Intersections between Science Communication and Culture

**MARLEY LUND-PETERSON**
MICROBIOLOGICAL SCIENCES – DISCIPLINE-BASED EDUCATION RESEARCH

**ADVISOR:** Danielle Condry, Ph.D.

The interplay between science communication and political and religious identity constitutes a dynamic and multifaceted connection at the core of modern societal discourse. This narrative literature review uses the Sense of Community Theory and the Moral Foundation Theory to examine the intricate relationships between science communication and political and religious identities. This literature review explores their historical foundations, present complexities, and profound implications for public understanding, policy, and the collective pursuit of societal progress via science. Scopus and Web of Science databases were used to find appropriate literature for this review since they encompassed the most results with keyword searches. Implications of this narrative literature review include building a sense of community in science and effective, evidence-based science communication. Building a sense of community in science is pivotal in building scientific identity, facilitating dialogue across diverse peoples, and addressing conflicts that impact the future. These future impacts could be driven by informed decision-making of individuals or large-scale policy decisions that affect communities or entire countries. Establishing effective, evidence-based science communication is a pivotal skill that any individual entering a STEM career should be trained in to leverage the impacts of community engagement to bring about positive change in the world.

## The MTNA Piano Teacher Certification Workbook: Asking Questions that Better Reveal the Pedagogical Knowledge of Potential Certified Teachers

**GUILHERME MONTENEGRO**
MUSIC

**ADVISOR:** Tyler Wottrich, D.M.A.

In general terms, actions in music education require critical self-reflection, with the goal of improving teaching skills. Regarding instrumental teaching, the Music Teachers National Association (MTNA) holds a certification annually to those individuals who are not collegiate faculty members and instead teach in other contexts. Certification candidates must submit a teacher profile, and detailed explanation is provided in the 2023 revised MTNA workbook. Five projects integrate this document: a teaching philosophy statement; a musical analysis of four contrasting pieces; a self-reflection of their own teaching; a description of the physical learning environment; and a discussion of the studio business ethics and policies. According to an analysis of the referred workbook, the teaching profile document has important, general content for the evaluation of one's teaching skills. Specifically, the teaching self-reflection project portion of the document provides questions to instigate the reflection. However, most questions are based on the teachers' subjective opinions at the piano lessons, and they are limited to whether communication is clear to students. These inquiries hardly ever dig further into the realm of teachers' pedagogical knowledge in music education. For instance, what musical goals do teachers have in mind when teaching? What is the relation between these goals and teaching procedures in the piano studio? What type of repertoire is selected and why? What are the musical contents approached, and to what extent are these related to the lessons' goals? When do teachers "transfer" knowledge, and when do they allow the students to discover "the new" by themselves? In a broader sense, how do the instructors assure that they are teaching music musically, i.e., providing the direct musical experience to the pupils (performing, listening, or composing)? These sorts of questions, driven off from one's individual opinion, have the potential to enhance the quality of the teachers' self-reflection. Thus, a re-evaluation of the workbook's content will provide cues to coherently validate the certification, boosting the pedagogical knowledge of potential certified teachers. Lastly, answers originated from appropriate questions will reveal concepts, behaviors, procedures, beliefs, and actions of piano teachers in detail.

## Determining Genetic Mechanisms of Maturity in North Dakota: Expanding the Molecular Model for Early Maturity Groups (MG 00 And 0) in Soybean

**CLARA MVUTA**
PLANT SCIENCES

**ADVISOR:** Carrie Miranda, Ph.D.

Production areas of soybean (Glycine max (L.) Merr.) have expanded in North Dakota to make it the one of the most grown crops in the state. However state yield averages are among the lowest in the Midwest, but the reason is not understood. Maturity is one of the most important agronomic traits impacting yield potential. North Dakota is characterized by having a short season length due to frost risk and it is necessary to have early maturing soybean cultivars. The predominate maturity groups grown in North Dakota are MG 00 and 0. It is possible to "fine tune" maturity to a region/environment to maximize yield potential. The major genetic mechanisms of soybean maturity are well characterized. E1, E2, and E3 genes have the largest effect on soybean maturity in other maturity groups, where the functional allele of these genes condition for late maturity and the null or semi-functional alleles condition for early maturity. It has been determined that variations of the non-functional or semi-functional alleles of these three genes create the MG 00 or MG 0 phenotype. However, it is not understood which combination of alleles is most favored for breeding purposes that can potentially affect yield. The goal of this research is to determine which maturity alleles are utilized in the North Dakota State University soybean breeding program. This will be accomplished by exploring characterized maturity gene alleles in the NDSU soybean breeding program. A GWAS will be conducted separately for MG 00 and 0 lines from the soybean germplasm collection, to determine if minor effect maturity genes are affecting this maturity group. If new maturity genes are discovered to have an effect, the NDSU soybean germplasm collection will be screened for these genes. Finally, a prediction model for MG 00 and 0 will be created to facilitate breeding efforts. These results will enrich knowledge of the maturity molecular model necessary to create an MG 00 and 0 cultivar and could possibly identify new genetic mechanisms for yield gains.

## Identifying Common Misconceptions in Undergraduate Microbiology Students Using the Microbiology Concept Inventory

**JOHNNY NGUYEN**
MICROBIOLOGICAL SCIENCE – DISCIPLINE-BASED EDUCATION RESEARCH

**ADVISOR:** Danielle Condry, Ph.D.

The Microbiology Concept Inventory (MCI) is a two-tiered (multiple-choice answer plus rationale), 23 question assessment tool that was developed with the American Society for Microbiology Curriculum Guidelines for Undergraduate Microbiology in mind. The rationale's open-ended nature allows for a greater level of insight into students' thought processes and levels of comprehension. Thus, close analysis of student responses may reveal commonly held microbiology misconceptions in the undergraduate population. We distributed the MCI to undergraduate microbiology students at a rural midwestern university at three different points in their careers (freshman, sophomore, and senior). Utilizing qualitative thematic analysis, we coded student responses and uncovered various misconceptions commonly held by students that were spread across several microbiology concept areas. Of those misconceptions, a few notable examples include students asserting that membrane-bound organelles are characteristic of prokaryotic cells or that bacterial cells do not process eukaryotic genes due to a lack of necessity of the genes rather than the lack of necessary cellular processes (i.e., intron splicing). Identifying common misconceptions in any discipline is vital to the integrity of an academic program because it can inform instructors of possible holes in the curriculum where students may be falling short or missing the mark conceptually. Once these holes are brought to light, the foundation is set for future remedial action to be taken that can supplement or improve courses and, ultimately, student learning.

## Graduate International Students' Perception of Support from their Universities: A Qualitative Study

**OBEHIOYE OMOKHUALE**
COMMUNICATION

**ADVISOR:** Laura Parson, Ph.D.

**FRANCISCA NYARKO**
COMMUNICATION

**ADVISOR:** Justin Walden, Ph.D.

This qualitative study examines international students' perceptions regarding the support they receive from their universities in meeting their basic needs. The study addresses the gap in research on basic needs insecurity among international students and explores their experiences to understand their challenges comprehensively. To capture the perspectives of international students, qualitative methods, particularly interviews, were employed. A total of 12 international graduate students from a mid-sized Midwestern University participated in the study. The data analysis used was in-vivo coding and focused coding methods. The research used narrative inquiry as a research design to analyze how international students perceive institutional support in areas such as food, housing, financial security, transportation, hygiene, and overall well-being. The results of the study showed that graduate international students define basic needs in various ways that have not been supported by existing Literature. They also showed that Doctoral students and students in the STEM fields expressed feeling financially supported by their departments specifically and not their university whereas non-Doctoral students and students in non-STEM fields expressed little feelings of support from their department or their university. The findings shed light on the challenges faced by international students in meeting their basic needs and their perceptions of the support provided by their institutions. The study reveals that while institutions offer resources to address basic needs, departmental support is instrumental in meeting the basic needs of international students. As departmental support differs, there is often a disparity between various graduate international students feeling like they are supported. The disconnect between the support provided and its perception by students highlights the need for more understanding of the experiences of this group to create equitable and inclusive policies and practices within higher education institutions.

## North Dakota's Sex-Specific Coronary Heart Disease Mortality Trajectories from 2000-2020: Progress and Pitfalls

**SAMUEL OSEI**
PUBLIC HEALTH

**ADVISOR:** Akshaya Bahgavathula, Ph.D.

Background: Coronary heart disease (CHD) remains the foremost cause of mortality in the United States. Reducing CHD deaths and elucidating sex disparities in outcomes are objectives within the Healthy People 2030 recommendations. This study analyzed sex differences in long-term CHD mortality rates in North Dakota from 2000-2020. Methods: This study utilized data from the ongoing Healthy People 2030 initiative, drawing from national census data such as the National Vital Statistics System and nationally representative survey data like the National Health Interview Survey. To analyze CHD mortality trends, we employed cause-of-death modeling and statistical analysis to compare crude and age-adjusted CHD mortality rates (ASR) between men and women and examine changes in CHD mortality over time in North Dakota in relation to national estimates. Joinpoint regression analysis was used to evaluate trends in the age-standardized CHD mortality rates, reporting annual percentage changes (APC) and average APC (AAPC) with accompanying 95% confidence intervals (CI). Results: From 2000 to 2020, the ASR of CHD decreased by an AAPC of -3.9% (95% CI: -4.4% to -3.5) in North Dakota compared to national estimates (-3.7%, 95% CI: -4.0% to -3.6%). However, North Dakota showed a significant reduction in the ASR of CHD observed only during 2003–2016 by an APC of -5.2% (95% CI: -8.6% to -4.9%). North Dakota showed a consistent reduction in ASR of CHD only in women by APC of -5.3%, 95% CI: -14.5% to -4.9% from 2003–2020. On the other hand, CHD mortality decreased by -4.7% (95% CI: -6.5% to -4.2%) from 2000–2017, but no progress in ASR was observed after this period. Conclusions: While North Dakota demonstrated an overall decline in age-standardized CHD mortality from 2000-2020, the reductions were inconsistent over time and disparate between sexes. Women exhibited steady CHD mortality improvements annually, aligning with national Healthy People 2030 objectives. However, stagnating CHD mortality rates after 2017 in North Dakota men highlight concerning deviations from the downward trajectories expected. Renewed efforts are warranted to equitably achieve optimal, sustained declines in CHD mortality across all populations in North Dakota.

## Prescribing High-Intensity Interval Training using the Critical Power Model with Rowing Exercise

**PATHOMPONG PHUAKLEE**
EXERCISE SCIENCE AND NUTRITION

**ADVISOR:** Nathan Dicks, Ph.D.

Background: This study aimed to verify the effectiveness of the 3-minute all-out exercise test in rowing to determine critical power (CP) and work prime (W'). Critical power is the intensity level associated with a maximum metabolic steady state for continuous exercise. W' is the work performed primarily from non-aerobic energy sources such as phosphocreatine and fast glycolysis above CP. Practitioners can use these parameters to prescribe high-intensity interval training. Methods: Six subjects (2 = females) will have completed the study. The subjects completed four visits to the Human Performance Laboratory. During the first visit, subjects performed a 1-repetition maximum with the leg press exercise to assess lower body muscle strength and a graded exercise test on the rowing ergometer to determine power output at maximal oxygen consumption. During all rowing testing, researchers collected the volume of oxygen (VO2), heart rate, and skeletal muscle oxygen of the upper leg. During the second visit, the subject will perform a rowing three-minute all-out exercise test to determine their CP and W'. The critical power model uses the individual's CP and W' along with time duration (i.e., 3-5 minutes) and depletion of W' (i.e., 60-80%) to prescribe high-intensity interval training (HIIT). In the last two sessions, participants will perform two different HIIT regiments counterbalanced at 60 and 80% depletion of W, completing 3 and 4 intervals, respectively. Results: End-exercise VO2 and HR values for each bout will be evaluated using an analysis of variance, and p < 0.05 will be set as the limit for rejecting the null hypothesis. We will also compare end-interval values with the graded exercise test. Conclusion: We hypothesize that the CP model will effectively prescribe proportional intervals for rowing exercise. (Note: We are still collecting this data but will have finished the data collection in time to present results for the Symposium).

## Fluctuating Thermal Regime Preserves Longevity and Physiological Condition in the Pollinator, Megachile Rotundata

**JACOB PITHAN**
BIOLOGICAL SCIENCES

**ADVISOR:** Kendra Greenlee

Insect cold storage is commonly used to extend dormancy and improve synchronization of development. Cold storage is generally implemented using a static thermal regime (STR) at a constant low temperature because of its simplicity; however, this has been shown to be detrimental to pollinator performance and longevity. Using a fluctuating thermal regime (FTR) during storage reduces cold-induced mortality and improves longevity in insects. Although FTR seems inherently better than STR, there are possible fitness and energy costs. We predict that FTR treated bees will experience improved longevity and survival compared to STR, but will decline in performance and reproduction with time. To explore potential tradeoffs, we conducted a study where post-diapause quiescent alfalfa leafcutting bees were stored under STR at a constant 6°C and compared with bees given a daily 1-hour pulse of 20°C (FTR). Over several months, emergence, longevity, locomotion, and reproduction were measured. Initially, emergence between STR and FTR was similar, but over time bees stored in FTR experienced faster development rates and reduced cold-induced mortality with no effect on individual mass. Similarly, longevity diverged over time with FTR bees living longer than STR bees. Flight performance and walking performances did not differ with treatment or time. Contrary to our prediction, these results suggest that FTR can improve survivorship and longevity without physiological conditions suffering in bees.

## Recurrent Selection to Improve Fusarium Head Blight Resistance in a Durum Wheat Population

**HARIKA POTHULA**
PLANT SCIENCES

**ADVISOR:** Xuehui Li, Ph.D.

Fusarium Head Blight (FHB) is a destructive fungal disease poses a significant threat to durum wheat, a crucial crop for pasta production in the Northern Great Plains, due to limited resistant resources. Historically, incorporating resistant genes from wild tetraploid wheat or hexaploid bread wheat has enhanced durum germplasm's FHB resistance. Given the complex genetic nature of FHB resistance in wheat, recurrent selection could be an effective method to increase frequency of favorable alleles and to develop germplasm with high and durable resistance. A durum recurrent selection population was developed by using 10 FHB resistant lines and five elite durum wheat breeding lines or cultivars as founders. Four cycles of phenotypic selection were conducted from 2019 to 2023 and several FHB resistant lines with lower FHB disease index than 'Riveland' were obtained. To explore the implementation of genome-wide markers to speed up FHB resistance improvement in the durum wheat population, a genomic prediction model was developed using 318 breeding lines from the NDSU durum wheat breeding program and 256 S0:1 lines from the recurrent selection Cycle3 and Cycle4 populations. The prediction accuracies for FHB disease index, plant height, and days-to-flowering were 0.51, 0.53 and 0.79, respectively, based on ten-fold cross-validation. Forward prediction for the Cycle4 population by using the 318 breeding lines and Cycle 3 population as training population, prediction accuracies were 0.27, 0.39, and 0.63, respectively. Our results indicate that recurrent phenotypic selection can improve FHB resistance in durum wheat. Introducing genomic selection into recurrent selection is a feasible approach to further augment genetic advancement in durum wheat population.

## A Systematic Literature Review on Rural Veterans Utilization of Telehealth.

**BRIGHT QUAYSON**
TRANSPORTATION AND LOGISTICS

**ADVISOR:** Jeremy Mattson, Ph.D.

Introduction: Veterans residing in rural areas in the US are faced with various health conditions that require swift attention to care to improve their well-being and quality of life. Telehealth which is the use of technology to deliver healthcare remotely via video conferencing and remote monitoring can connect rural veterans to their care providers without needing to commute for long distances to access care. This has made it possible to bridge the accessibility gap for veterans who are limited by vehicle ownership, income, and geographic location, and specialist. Objectives: The purpose of this study is to comprehensively examine the literature on veterans' use of telehealth three years before and after the pandemic (2017-2023). The objectives were; 1. to examine the medical conditions that rural veterans mostly prioritized telehealth to meet their healthcare needs, 2. literature on transportation cost savings associated with the adoption of this innovative technology will be explored. Methods: A Systematic Literature Review (SLR) was conducted following strictly the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Relevant articles were gathered from three databases- Google Scholar, PubMed, and Scopus. The final studies for analysis were 26 comprising veterans' medical conditions (n = 20), telehealth use during COVID-19 (n = 6), and transportation cost savings (n = 2). Results: The evidence suggests that Telehealth has been effective in addressing rural veterans' medical needs, especially chronic conditions before the global pandemic. Telehealth use was much higher during the pandemic than before the pandemic. Telehealth was also found to be cost-efficient for veterans when compared with traditional transportation. Internet access and high network connection were found to be a major challenge for rural veterans. Conclusion: Telehealth use in offering medical support to veterans residing in rural areas of the United States was found to help bridge the healthcare gap faced by rural veterans. However, the many challenges warrant further studies, and the little literature on the economic or cost-benefit analysis of telehealth use by rural veterans must be explored further.

## Phytochemical-Enriched Plant Extracts as Therapies for Bone Metastasis of Breast Cancer

**PREETHAM RAVI**
MATERIALS AND NANOTECHNOLOGY

**ADVISOR:** Kalpana Katti, Ph.D.

Among all types of cancer, breast cancer is one of the most diagnosed types among women. At a particular stage, breast cancer prefers to travel from its initial site to a secondary site like the bone. Bone metastatic breast cancer is poorly understood and lacks effective treatment options due to limitations in current drug-screening cancer models. In recent years, our group has developed a unique 3D in vitro bone-mimetic testbed with human mesenchymal stem cells (hMSCs) and human breast cancer cells to accurately recapitulate bone metastatic breast cancer. The scaffolds achieve bone-like tissue formation via the vesicular delivery of osteogenically differentiated hMSCs and in vitro tumor growth.1-2 This testbed can be used to identify different anticancer therapies.3 The present study evaluated the cytotoxicity of three phytochemical-enriched plant extracts, Rhodiola Crenulata, Origanum vulgare, and Vaccinium Macrocarpon, on bone metastatic (BM) breast cancer. To assess the cytotoxicity of these extracts, we evaluated the cell viability of metastatic and non-metastatic breast cancer to determine their respective IC50 concentrations. Additionally, we assessed the response from bone cells against these three compounds. We also evaluated apoptotic response from metastatic and non-metastatic breast cancer cells through annexin V apoptosis via flow cytometry. We further quantified the mRNA levels of genes related to cancer resistance and apoptosis. Human breast cancer cells grown on a BM testbed needed higher IC50 concentration than 2D cultures for all three extracts. MDA-MB-231 required a higher dosage of all three compounds in 2D and 3D cultures than MCF-7. This study reports the successful utilization of a BM in vitro bone-mimetic testbed as a viable screening tool for potentially new anti-cancer drugs (R. Crenulata, O. vulgare, and V. Macrocarpon) against bone metastatic breast cancer. Overall, this BM testbed can be utilized as a reliable screening tool to identify new potential anti-cancer therapies.
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## Synthesis of Novel Waterborne PVA Coatings Protecting Steel from Crevice Corrosion

**IRAM RIAZ**
COATINGS AND POLYMERIC MATERIALS

**ADVISOR:** Xiaoning Qi, Ph.D.

Crevice corrosion can compromise the structure of an entire system even with minimal material loss, making it unfeasible to use steel joints in chloride contaminated surroundings, especially in construction like bridges. In this study, we develop and study an environment-friendly anti-corrosive coating based on polyvinyl alcohol (PVA). The new PVA coating has water-based PVA as the resin, aldehyde the cross-linker, and H2SO4 the catalyst; Cellulose nanofibril (CNF) and calcium-based pigments (Ca) are also used to enhance mechanical strength, barrier performance and active corrosion inhibition. The new PVA coatings are compared with a commercial water-based epoxy coating. Coatings were applied on the steel substrates using a drawdown applicator at 8 mils. Surface morphology, topography and roughness of the coated layers are studied using scanning electron microscopy (SEM) and atomic force microscopy (AFM). Structural characterizations of PVA and coatings were performed using FTIR. Adhesion and wettability of the films were evaluated by crosshatch adhesion test and contact angle measurement, respectively. The anti-corrosive performance of the coatings was evaluated using electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization (PDP). The PVA coating developed will serve as a platform for further testing active green corrosion inhibitors providing long-term protection to steel substrates.

## Low-Temp Impact Characterization in AM Polymer Parts

**NATHAN RONS**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

With the rise in popularity of additive manufacturing, specifically rapid prototyping technology commonly referred to as 3-D printing, it is becoming necessary to develop printing and testing standards for different test conditions. Without test standards and having predictable performances of printed components it is difficult to expand printed parts into many industries. Composite processes such as injection molding and sheet molding have processing and material testing standards that allow for predictable properties and that can be transferred to part designs. 3-D printing however, has many user defined process parameters that greatly affect the component performance. Impact performance and characterization is very difficult as the material properties, part geometry, and print quality have affect on the performance. An impact test in varying environments ranging from room temp to -60F conditions along with short fiber carbon-fiber and polypropylene was used to examine how print orientation, raster angle and other printing variables affect the impact performance. With the new standards, parts could be designed and printed using specific patterns to have predictable impact ratings.

## Investigating Plastic Pollution: A Model System Approach to Assess the Size-Dependence for Interaction of Polystyrene Particles with Model Human Biological Systems

**KATERYNA RUDICH**
COATINGS AND POLYMERIC MATERIALS

**ADVISOR:** Andriy Voronov, Ph.D.

Environmental pollution, driven by the widespread use of plastic-based consumer goods has become a critical issue due to plastics resistance to decomposition. Their residues of various chemical structures, dimensions, and sizes (micro- and nano-) are formed over the years through the breakdown of consumer goods and pose health risks to humans. Nanoplastics, being of nano size, have higher bioavailability and longer retention times and potentially could affect human health. Human Serum Albumin (HAS), is one of the most abundant blood proteins in the circulatory system. HSA faces immediate exposure to any foreign compounds entering the circulatory system and can reversibly bind with a number of molecules in the plasma through various interactions, resulting in conformational changes of HSA and loss of its biological activity. Understanding how plastics residues interact with proteins is crucial for assessing the structural and functional damage they may inflict on human health. This study investigates the size-dependence of the interaction between model polystyrene particles of different sizes and human serum albumin through fluorescence quenching experimentation. For this purpose, polystyrene particles of different diameters were synthesized using a surfactant-free emulsion polymerization and purified from unreacted monomer to model plastic particles, originating from contamination after degradation and perform a systematic study of the effect of material surface area on the human serum albumin/particles interaction mechanism. High-Performance Liquid Chromatography (HPLC) method was developed to determine monomer conversion, and residual styrene content in latex samples after purification.

## Integrating Machine Learning in Experimental and Computational Research to Assess the Performance of Organic Corrosion Inhibitors

**CHAMELI SAMARAWICKREMA**
COATINGS AND POLYMERIC MATERIALS

**ADVISOR:** Bakhtiyor Rasulev, Ph.D.

Organic corrosion inhibitors play a crucial role in many industries by significantly enhancing the durability of coatings, thus providing materials with superior protection against corrosion and environmental damage. They act as a protective barrier against the corrosive environment and the material body, thereby improving material performance and reducing maintenance costs over time. In many industries, application of machine learning tools such as Quantitative Structure-Activity Relationship (ML/QSAR) modeling to generate predictive models to predict the corrosion inhibition efficiency of organic compounds emerges as a crucial strategy in the development and optimization of corrosion resistant coatings. These models can predict the corrosion inhibitory performance of organic compounds without even physically synthesizing or testing them, which saves a lot of resources and experimental costs. Predictive ML/QSAR model generation requires meticulous data curation to assure the precision and dependability of the models to be developed, with the acquisition of high-quality input data, which is the principal challenge for QSAR modelers. The integrity of data significantly dictates the accuracy and predictive capability of the resulting models. This study explores the challenges and importance of securing reliable experimental data on corrosion inhibition efficiency of organic compounds pertinent to QSAR modeling. It highlights how data variability, experimental protocols, and testing methods & conditions can profoundly influence model outcomes. By analyzing corrosion inhibition efficiency data from diverse public sources collected under various experimental conditions, this study employs machine learning techniques to transform these data into one set of controlled experimental conditions, creating a consistent dataset to overcome the outlined challenges. The extrapolation was performed using linear regression, and the resulting dataset was used in the construction of a predictive QSAR model aimed at evaluating the corrosion inhibition efficiency of three organic classes (pyridines, quinolines, and imidazoles). The corrosion rate of these compounds on mild steel was determined experimentally through the electrochemical method, linear polarization resistance test (LPR). The findings of this research show that the corrosion inhibitory performance depends on several important physicochemical and structural parameters of organic compounds.

## Thermal Stability of Composites with PCM Inclusions in Radiation Cured Additive Manufacturing

**ABIGAIL SAYLER**
MECHANICAL ENGINEERING

**ADVISOR:** Chad Ulven, Ph.D.

Manufacturing is vital to the engineering design process, and additive manufacturing (AM) methods have been developed in recent years to increase efficiency and automation in manufacturing. Fiber reinforcement of the polymers typically used in additive manufacturing has been a key step forward in the development of design components that require better properties than neat polymers. In some applications, other properties such as thermal conductivity and stability will need to be optimized. Additives may be introduced to these fiber reinforced composites, and this project aims at examining the property enhancement from the inclusion of phase change materials (PCMs). In environmental conditions where there may be a large temperature swing, these PCMs provide stability for the overall structure. A 3D printer was constructed and calibrated to additively manufacture specimens with continuous fiber, a UV-cured thermoset resin, and PCM inclusions. The continuous fiber used was basalt fiber. The resin was cured with a 405 nm laser as the print head was moving and was post cured at 140°C for 2 hours. Testing was done to characterize the crystallinity, mechanical properties, thermal shock properties, and environmental weathering. The results inform the further utilization of PCMs in applications where thermal stability is important.

## Tillage Alters Microbial Functional Group Abundances Across Soil Depths

**ALAN SNAVELY**
MICROBIOLOGICAL SCIENCES

**ADVISOR:** Samiran Banerjee

Soil hosts a complex microbiome vital to agriculture. Differing soil depths may harbor unique microbiomes, in terms of both taxonomic composition and functional capability. While previous research has identified general taxonomic differences between topsoil and subsoil microbiomes, a more detailed phylogenetic and network-based analysis is needed to dissect these interactions. We hypothesize that topsoil harbors distinct microbiomes in terms of taxonomic composition and function, and that management practices such as tillage disrupts the available niches. We collected topsoil (0-6cm) and subsoil (6-24 cm) samples from an agroecosystem trial growing either corn or soybeans across three tillage regimes (no-till, minimal-till, and conventional-tillage). We then characterized microbial communities by utilizing Illumina MiSeq amplicon sequencing of the bacterial16S rRNA and fungal ITS regions. Our results show that the topsoil harbors increased richness (p < 0.001) of both fungi and bacteria, while neither tillage nor crop type had an impact. Microbiome structure was influenced by depth, tillage, and crop type (p < 0.01), with ordination displaying distinct clustering between topsoil and subsoil communities. Differential abundance analysis revealed that specific ASVs and OTUs enriched in a specific soil depth, indicating niche partitioning at fine taxonomic scales. For instance, phylotypes assigned to Parafilimonas, Halangium, and Spizellomycetales were less abundant in subsoils than topsoil, and are also more abundant in no-till systems than minimal-till systems. Network analysis showed that the subsoil community has increased average betweenness, transitivity, and closeness than the topsoil community but lower average degree connectivity (p < 0.001). Bacterial ASVs assigned to Microvirga, Sphingomonas, and Rubrobacter were identified as keystone taxa in the subsoil using co-occurrence networks, while the fungus Syncephalis was found to be the only keystone in the topsoil. Bacterial functional groups were greatly impacted by tillage practices and soil depth. Notably, predatory and exoparasitic bacteria were nearly absent in the no-till treatment but enriched in the other tillage regimes. Furthermore, nitrogen fixation and cellulolysis functional groups were only present in the subsoil of the no-till fields. Overall, this study reveals mechanistic insights into microbial niche partitioning across soil depth and demonstrates how tillage acts as a disturbance which alters microbiome functioning.

## Debranning and Tempering Affect Stone Milling and Durum Whole Wheat Flour Properties

**AISHWARYA SURESH**
PLANT SCIENCES

**ADVISOR:** Frank Manthey, Ph.D.

The stone milling process for durum wheat is considered to preserve the grain's natural nutrients and flavor. Durum flour is primarily used in pasta production. Its properties directly impact the texture, color, cooking behavior, and overall quality of pasta products. Flour properties such as protein content characteristics influence the firmness, elasticity, and cooking stability of pasta. The durum kernel is covered with a protective outer coat called bran. Outer bran layer can contain undesirable microorganism, mycotoxins, and pesticide residues. Many commercial mills employ debranning, the removal of the outer bran coat of the grain, as a pre-milling step, Thus, debranning can reduce the amount of bran needed to be removed from grain and reduce potential contamination in the flour. The debranning process involves the application of friction to remove the outer pericarp layer and abrasion forces on the kernel surface to remove inner bran and aleurone layers. This pre-treatment potentially improves flour and pasta quality. The goal of this study was to determine the impact of debranning and grain tempering on stone milled durum wheat flour properties, and to compare these properties with those of non-debranned samples. A commercial bulk sample of durum wheat was tempered to 12%, 14%, and 16% moisture content for 48 hours and was milled on a stone mill while maintaining consistent gap settings and feed rates. Whole wheat flour brightness, particle size, ash and protein contents, and starch damage were determined. Debranning had significant effects on flour brightness, particle size, and ash content. The flour brightness increased with the debranning process. With regards to the tempering, significant differences were observed in the particle size of the flour, ash and protein contents, and starch damage as the tempering increased. These results indicate that for the stone milled whole wheat flour properties can vary greatly with tempering and the debranning process. Key Word: Durum wheat, Stone milling, debranning

## Root Exudates of Peas, Tomatoes, and Cucumbers can Sustain the Growth and Migration of Plant-Growth Promoting Bacteria, Rhizobium Leguminosarum Bv. Viciae 3841 and Azospirillum Brasilense Sp7

**JANICE TAGOE**
MICROBIOLOGICAL SCIENCES

**ADVISOR:** Birgit Pruess, Ph.D.

Plant root exudates, according to numerous studies, have indicated benefits in plant growth and productivity by playing a significant role in the recruitment of plant growth-promoting rhizobacteria(PGPR). We studied the ability of two PGPRs, Rhizobium leguminosarum bv. viciae 3841 and Azospirillum brasilense Sp7 to grow and migrate in the exudates of pea, tomato, and cucumber. Exudates were collected after overnight incubation of germinated seedlings in distilled H2O and filter sterilized. Migration experiment was performed by inoculating 1μL of the respective bacteria standardized at O.D600 1, to the center of semi-solid agar plates containing 1:1 dilutions of seedling exudate. The diameter of migration rings were measured over 24 to 72 hours periodically. Migration rates from each plate were determined in mm/h. For bacterial growth, the two respective bacteria were inoculated in 1:1, 1:5, and 1:10 dilutions of filter-sterilized exudates in H2O. All exudate inoculations were at an approximate starting OD600 of 0.03. The cultures were incubated at 30°C and the OD600 was determined every four hours for up to 72 hours and growth curves were generated. Our results show that both PGPB migrated and grew on each of the three exudates. The highest migration rate was seen for A. brasilense SP7 on pea at 1.3 mm/h and tomato at 0.87 mm/h. R. leguminosarum bv. viciae 3841 migrated best on pea exudate at 0.54 mm/h. A. brasilense Sp7 grew best on undiluted tomato exudate with a growth rate of 0.54 + 0.027 and the highest growth rate for R. leguminosarum bv. viciae 3841 was seen on undiluted pea exudate at 0.33 + 0.009 gen/h. Both growth and migration rates of the two bacteria were lowest in cucumber exudate. Our study is evident that the PGPB studied could be recruited by the exudates of pea, tomato, and cucumber in the rhizosphere since they can sustain their growth and migration.

## Application of Digital Image Processing for Color and Shape Changes in Jasmine Flowers

**HUMEERA TAZEEN**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**ADVISOR:** Igathinathane Cannayen, Ph.D.

Jasmine flowers are prized for their sweet and exotic scent, and their essential oils have a wide range of uses in industries such as perfume, food, pharmaceutical, and medicine. However, these flowers have a short shelf life. They are vulnerable to light, temperature, and humidity, which can cause photo-oxidative stress and lead to the breakdown of pigments and dehydration, resulting in petal browning and reduced visual appeal and overall value. To determine the proper shelf life for packing and storage of jasmine flowers, it is necessary to measure the temporal color variation and quantify the color degradation post-harvest. Manual methods of color measurement and variation over time are cumbersome and not feasible, therefore digital image capture, image processing, and analysis techniques were applied. An open-source java-based software called ImageJ, which can run programs in its integrated development environment, was employed to develop the necessary plugin program. Jasmine flowers were captured digitally on a black background at one-hour intervals for 26 hours using a smartphone camera under ambient conditions. The ImageJ plugin processes the image and analyzes the flower color variation and petals opening over time and models the kinetics. Image processing operations such as, image cropping, artifacts removal, thresholding for background extraction, petal color measurement, shape parameters evaluation, color and shape kinetics, visualization, and model fitting were followed. The results of this analysis provide insights into the color degradation of flower petals and flowering kinetics, which can influence the overall flower quality and customer acceptance. They can also be used to determine the useful shelf life of flowers stored in ambient conditions. Further research may be needed to investigate the effect of storage environment conditions, especially temperature, and relative humidity, and determine the optimal conditions for extending shelf life.

## KISS1R Activation Alters Intracellular Calcium in Airway Smooth Muscle During Inflammation: Th2 Biased Effect

**JACOB TESCH**
CELLULAR AND MOLECULAR SCIENCE

**ADVISOR:** Sathish Venkatachalem, Ph.D.

Rationale: Asthma is characterized as a chronic condition of the lungs that results in inflammation, airway remodeling and airway hyperresponsiveness (AHR). Airway Smooth Muscle (ASM) cells moderates airway tone and lung function through their intracellular calcium ([Ca2+]i) signaling. In asthma, exaggerated airway narrowing by ASM contributes towards airway hyperresponsiveness. As recent studies have shown, this pro-contractile phenotype is the result of Th1 and Th2 inflammation predisposing ASM cells towards a heightened [Ca2+]i release in agonist-induced responses. Kisspeptin (Kp) and KISS1R (Kp receptor) have been shown to be expressed in ASM cells and Kp/KISS1R signaling is observed to be repressed in asthmatic samples, implicating inflammation as a regulating interaction. In this study, we intend to investigate the effect of pro-inflammatory cytokines on the Kp/KISS1R expression and their intracellular calcium [Ca2+]i regulation in human ASM cells. Methods: Primary Human ASM cells maintained at <5th passage were used for all experiments as approved by Mayo IRB. RT-qPCR and Western blotting were used to quantify the expression of Kp and KISS1R after treatments of pro-inflammatory cytokines (TNFα, 20 ng/mL; IL-13, 50 ng/mL). Cells were treated with cytokines for 6 hours (RT-qPCR) or 24 hours (Western blot). Fura-2 AM loaded ASM cells were monitored to quantify the effects of inflammation and Kp treatments on ASM [Ca2+]i levels. For inflammation, cells were treated for 24 hours prior to calcium imaging. Results: IL-13 exposure significantly reduced the expression of Kp while TNFα did not impact Kp expression. Both TNFα and IL-13 exposures significantly reduced KISS1R expression levels. Kp-10 treatments did not elicit a detectable calcium response within ASM cells. Acute and chronic Kp-10 alone treatments did not affect [Ca2+]i responses to histamine, acetylcholine or bradykinin. Acute and chronic Kp treatments significantly reduced the IL-13 effects on [Ca2+]i. Acute Kp treatments reduced the effects of TNFα on [Ca2+]i, while the chronic time point showed no difference from TNFα exposure. Conclusions: Overall, these findings suggest that KISS1R activation regulates inflammation-induced increases in ASM [Ca2+]i and modifies airway contractility during inflammation and AHR. Thus, KISS1R activation may act as a therapeutic avenue for chronic lung diseases such as asthma.

## Idea Execution, Self-Determination, and Cheerfulness Predict Dementia Onset Over Nine Years

**YUFANG TU**
DEVELOPMENTAL SCIENCE

**ADVISOR:** Melissa O'Connor, Ph.D.

The prevalence of dementia and its negative effect on well-being has made it a global public health concern. It is essential to understand factors that predict the onset of dementia above and beyond age and physical health to aid in preventative efforts. The current study investigated idea-execution ability, self-determination, and cheerfulness as predictors of the onset of dementia across nine years. We used the longitudinal data from the first nine waves of the National Health and Aging Trends Study (NHATS). NHATS participants are nationally representative of Medicare recipients in the United States. Data were initially collected in 2011 and annually thereafter. The current study included 6780 participants; 678 participants reported having a diagnosis of dementia at either baseline or a follow-up visit. Cox regression was used to examine the following self-report items as predictors of months-to-dementia onset: idea execution ability ("when I really want to do something, I usually find a way to do it"); self-determination ("other people determine most of what I can and cannot do"); and cheerfulness ("how often I feel cheerful"). Each predictor was time-invariant and scored on a 3-point scale so that higher scores were more positive. Covariates included baseline age group (five-year groups), sex (dichotomized), education level, and self-rated overall health. Statistically significant results were shown for idea-execution (HR=0.79, p=0.008), self-determination (HR=0.69, p< 0.001), and cheerfulness (HR=0.91, p=0.047). These potentially modifiable variables were associated with reduced odds of developing dementia, above and beyond demographic and health factors. Increasing the level of idea execution, self-determination, and cheerfulness by 1 unit significantly decreased the onset of dementia or AD by 21%, 31%, and 9%, respectively. Being active in executing ideas, self-decision-making, and being happy could help protect against dementia in later life. Future research could investigate the relationship between these factors and cognitive reserve to decrease the risks of dementia incidence and cognitive aging.

## A Review of the Development and Exploration of Deep Learning Architectures for the Identification of Crop Diseases

**TALHA TUFAIQUE**
AGRICULTURE AND BIOSYSTEMS ENGINEERING

**ADVISOR:** Igathinathane Cannayen, Ph.D.

Crop diseases are a significant threat to food security globally. Hence, there is a need to develop efficient and accurate methods for identifying diseases in agriculture. Recently, deep learning (DL) architectures have emerged as promising tools for automated crop disease identification, which is a complex research problem to tackle, leveraging their ability to extract intricate patterns and features from large datasets of crop images. This review study explores various DL architectures tailored specifically for crop disease identification, aiming to enhance the effectiveness and efficiency of disease detection in agricultural practices. In this study, a systematic literature review was performed to obtain results for the research questions designed. The effectiveness of various DL models, such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and their modified versions, was examined in classifying crop diseases using visual symptoms captured in images. CNN has demonstrated remarkable accuracy in identifying crop diseases from images with high precision and recall rates. Popular CNN models such as AlexNet, GoogleNet, ResNet, and VGG (visual geometry group) performed better than traditional methods. Furthermore, transfer learning techniques and data augmentation strategies effectively improved model generalization and robustness to variations in environmental conditions and disease manifestations. These findings of the study comprehensively illustrate various methodologies available for the task and compare their performances. The results provide farmers and agricultural stakeholders with a digital methodology for early detection and mitigation of crop diseases. By enabling timely intervention and targeted treatments, DL-based crop disease identification systems have the potential to minimize yield losses, optimize resource allocation, and contribute to sustainable agricultural practices in general.

## Mapping the Path to Student Success: Integrating Systems Thinking into Higher Education Retention Research

**KAYLEE WEIGEL**
MICROBIOLOGICAL SCIENCES

**ADVISOR:** Danielle Condry, Ph.D.

Retention in higher education has been extensively studied over the years, with numerous theoretical models proposed, tested, and refined to understand its dynamics. While fundamental works by pioneers such as William Spady and Vincent Tinto have provided valuable frameworks, their longitudinal nature limits their adaptability to the evolving landscape of higher education retention research. Recognizing the inadequacy of a one-size-fits-all solution, there is a pressing need to address the multifaceted influences on retention more comprehensively. Drawing from the interdisciplinary framework of systems thinking, which has found wide application in STEM disciplines, this research advocates for systems thinking integration into the study of retention in higher education. Despite widespread use, systems thinking has yet to be applied to retention research. Leveraging insights from a comprehensive literature review, we have developed a systems map to elucidate the intricate web of factors influencing student retention within higher education institutions. By synthesizing these elements into a cohesive system, this novel approach provides a roadmap for researchers to pinpoint specific areas for intervention within their respective contexts and build evidenced-based strategies to approach retention. This holistic perspective also enables institutions, colleges, and departments to identify imbalances and implement targeted strategies to enhance student retention in higher education.

## Biomedical Data Science in Healthcare, Drug Discovery, and Precision Medicine

**QIANQIAN YAO**
STATISTICS

**ADVISOR:** Bong-Jin Choi, Ph.D.

Precision medicine is "an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person." The concept of precision medicine has been a part of healthcare for many years to allow doctors and researchers to predict more accurately which treatment and prevention strategies for a particular disease will work in which groups of people, which is an approach different to "one-size-fits-all". To apply data science in the areas of healthcare, drug discovery and precision medicine, we need first to model the tasks in such domain into well-defined computational tasks: 1) The background of healthcare, drug discovery and precision medicine; 2) some computational tasks in different phrases such as chemical screening, clinical trials, treatment effect evaluation in drug usage by survival analysis, and so on; 3) data visualization and feature selection and extraction; 4) classification or prediction tasks. After introduction of the processes, the use case of precision oncology will be analyzed to shed light on how data science can advance the area of healthcare, drug discovery and precision medicine.

## Utilizing Physiological Signals and Deep Learning for Construction Workers' Awkward Posture Recognition

**MOEIN YOUNESI HERAVI**
CONSTRUCTION MANAGEMENT

**ADVISOR:** Youjin Jang, Ph.D.

Construction workers frequently face the risk of adopting awkward work postures, which can lead to work-related musculoskeletal disorders. Many existing solutions using wearable sensors suffer from intrusiveness and the need for multiple sensor attachments. This study proposes a novel method for automatic recognition of awkward postures using wristband biosensors and deep learning algorithms. Physiological data from ten subjects was collected, processed, and used to train the models. Long Short-Term Memory (LSTM) and One-Dimensional Convolutional Neural Network (1D CNN) models were compared, with LSTM achieving superior accuracy at 97.28% compared to 1D CNN's 94.41%. The study also conducted a comprehensive analysis of the impact of diverse signal combinations and time windows on posture recognition, providing valuable insights. The findings expand the use of physiological signals for safety enhancement, specifically in recognizing awkward postures. This study contributes to wearable sensor-based posture recognition, ultimately enhancing the health and safety of construction workers.

## Discovering an Effective -Amylase Inhibitor via Machine Learning-based QSAR Approach.

**MARIAM ZAMANI**
BIOMEDICAL ENGINEERING

**ADVISOR:** Bakhtiyor Rasulev, Ph.D.

α-Amylase (1,4-α-d-glucan-glucanohydrolase, EC 3.2. 1.1) is one of the key enzymes that help digest complex carbohydrates and convert them into simple sugar in the gastrointestinal tract. This process contributes to post-prandial (post-meal) hyperglycemia. Inhibitors of α-amylase slow down the carbohydrate digestion process by inhibiting the enzyme. As a result, the entry of glucose into the circulation is controlled. Our focus in this project is an investigation of the structure-activity relationship for a series of small molecule amylase inhibitors using a computational approach, for further search and discovery of effective α-amylase inhibitors. Such effective inhibitors can help delay glucose absorption, control blood glucose, maintain glycemic levels, and minimize hypoglycemic risks.

## Regulation of Myocardial Lipid Accumulation in the Development of Obesity

**REDEMPTOR ZHOU**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Natasha Fillmore, Ph.D.

Background: Mitochondrial beta fatty acid oxidation is the major fuel that propels cardiac functioning. This is tightly regulated by intricate pathways that include inter-organelle signaling, storage, and trafficking of fatty acids. Metabolic syndromes such as obesity increase cardiac energy substrate supply deranging cardiac fatty acid signaling. Thus, the increasing insult by lipid accumulation leads to lipotoxicity, one of the drivers of cardiac remodeling and dysfunction. Our previous research on PPARα provided insight into how cardiac PPARα affects the heart lipidome. In the current study, we aim to understand the interplay between various cardiac fatty acid signaling molecules during the inception of obesity and how this regulates lipid accumulation in the myocardium. Methods: We generated a tamoxifen-inducible cardiac-specific PPARα knockout mouse (cPPAR-/-) model. Mice were fed with either a standard chow or a 60% high-fat diet (HFD) for 5 weeks. At the end of the diet treatment, the mice underwent transthoracic echocardiography (FujiFilm Visualsonics Vevo 3100) to assess cardiac function and hypertrophy. Western blot for the target proteins like Perilipins (PLINS), Diglyceride acyltransferases and CD36 were performed using the protein samples extracted from the heart tissue using RIPA buffer. Results: As expected, the HFD induced a significant increase in body weight. A similar rise in body was seen between Control and cPPAR-/- mice on the HFD. Also, blunting cardiac PPARα results in less cardiac lipid accumulation. The evidence indicates that this effect is mediated through the regulation of proteins involved in cardiac lipid homeostasis. Furthermore, there is a variability in the expression of the different PLINS in the hearts of cPPAR-/- mouse. Conclusion: This supports the concept that PPARα is essential as a regulator of myocardial fatty acid metabolism in the inception of obesity. However, regulation of myocardial lipid accumulation by PPARα may be more comprehensive than imagined, as it may also influence lipid droplet stability and trafficking. This is enlightening as it avails additional targets for pharmacological agents.

## Experimental Investigation of Erosion and Solid Particle Dynamics in Gas Gathering Pipeline Elbows

**IMTIAJ NAHIN AHMED**
MECHANICAL ENGINEERING

**ADVISOR:** Yan Zhang, Ph.D.

Solid particle erosion is a major cause of gas pipeline damage, increasing maintenance costs and shortening pipeline lifespan. Elbows, among pipeline components, are particularly vulnerable with shorter lifespans. This study used lab-scaled experiments to investigate large sand particles (≥;200 microns and ≥;800 microns) and airflow dynamics in horizontally oriented elbows (90 and 45 degrees), simulating gas-gathering pipeline conditions. High-speed video analysis helped understand the intricate dynamics of inertia-driven sand particles colliding with the elbow wall. Laser Doppler Anemometry measured sand particle velocities, especially near the wall where impacts occurred. Additionally, special paints were used to visualize the erosion pattern on the elbow's inner wall, and metal specimens were attached to critical locations for erosion rate analysis. Results revealed highly complex sand particle dynamics influenced by turbulence and particle-flow interactions. Asymmetric surface erosion patterns occurred due to gravity effects on inertial particles. Erosion rates on metal samples varied across elbow locations, correlating with the sand particle flow pattern. The region 30-45 degrees past the elbow experienced significant particle path changes, increasing susceptibility to erosion. In typical pipeline conditions with high air velocity and a large Stokes number, sedimentation was minimal, but low gas velocity conditions resulted in substantial sedimentation.

## Modeling Liquid-Solid Phase Transitions in Suspensions of Compressible Microgels

**OREOLUWA ALADE**
PHYSICS

**ADVISOR:** Alan Denton, Ph.D.

Microgels are soft colloidal particles, made of crosslinked polymer gels, whose internal degrees of freedom allow them to respond to external stimuli by changing size. Their sensitive responses to changes in temperature and concentration inspire practical applications, e.g., to drug delivery and photonic crystals. To explore the influence of particle compressibility on thermodynamic phase behavior, we modeled suspensions of microgels that interact via the Hertz pair potential and swell/deswell according to the Flory-Rehner theory of polymer networks. From extensive Monte Carlo simulations that incorporate novel trial changes in particle size [1], we determined the liquid-solid phase boundary (microgel density vs. crosslink density) by computing free energies, osmotic pressures, and chemical potentials of both liquid and solid phases via thermodynamic integration methods [2]. Our results significantly extend previous studies of the phase behavior of (incompressible) hertzian spheres [3]. We further computed latent heats of melting, radial distribution functions, and static structure factors. [1] M. Urich and A. R. Denton, Soft Matter 12, 9086 (2016). [2] C. Vega et al., J. Phys.: Condens. Matter 20, 153101 (2008). [3] J. C. Pàmies et al., J. Chem. Phys. 131, 044514 (2009). *Supported by National Science Foundation (DMR-1928073)

## From Pages to Places: Situating Kelly et al.'s the Robot Zoo in Real-Life Context

**NASIH ALAM**
ENGLISH

**ADVISOR:** Anastassiya Andrianova, Ph.D.

The Robot Zoo (1994) written by John Kelly, Dr. Philip Whitfield and Obin, consists of textual descriptions and visual images of sixteen robot animals. Among them, my discussion of Giraffe, Platypus and Rhino highlights the fact that they are endangered animals who are facing extinction due to climate change, human encroachment, poaching, illegal trade, and a lack of biodiversity. Although my other subjects of discussion such as House Fly, Grasshopper, Chameleon and Bat do not necessarily face any immediate extinction, this paper shows how scientists are using the heights and zips of these flying beings for wildlife conservation and construction engineering, even raising the possibilities of conserving real-life giraffes, rhinos and platypuses. Besides the option of preserving nature and animals, robot animals have interactive elements which inform children, young and aging adults more about the plight and suffering faced by wildlife animals. Therefore, in my paper, I prove that the more people watch and interact with electronic animatrons on display in robot zoo exhibitions, the more informed they will be about conservation, extinction, and the global climate crisis. Keywords: extinction, robot zoo exhibitions, wildlife conservation, construction engineering.

## Modeling the Response of Soft Microgels to Crowding by Nanoparticles

**MAHESH ARYAL**
PHYSICS

**ADVISOR:** Alan Denton, Ph.D.

The internal degrees of freedom of crosslinked polymer networks enable compressible microgels to swell or deswell by absorbing or expelling solvent in solution. The presence of cosolvents or other macromolecules (e.g., nanoparticles) can enrich the swelling response, facilitating applications of "smart" colloidal particles, e.g., as drug delivery vehicles and biosensors. We extend the mean-field Flory-Rehner theory of polymer networks to incorporate, as an implicit species, hard nanoparticles that perturb the polymer network through volume exclusion. Within the free energy landscape of these asymmetric ternary mixtures, we perform Monte Carlo simulations, including novel trial moves [1] that allow microgels to change size and nanoparticles to penetrate microgels. Within our coarse-grained model, we investigate how single-microgel properties (e.g., crosslink density) and solution properties (e.g., microgel and nanoparticle concentrations, solvent quality) influence (1) partitioning of nanoparticles inside and outside of microgels; (2) swelling of microgels; and (3) bulk structure of microgel solutions. Our results can guide experiments and applications by providing insights into how the response of soft (e.g., biological) materials to external stimuli can be tuned by adding nanoparticles.
[1] M. Urich and A. R. Denton, Soft Matter 12, 9086 (2016). *Supported by National Science Foundation (DMR-1928073).

## Preparation of Iron Coated Chitosan Beads for the Removal of Phosphate from Aqueous Environment

**UMER ASLAM**
ENVIRONMENTAL AND CONSERVATION SCIENCES

**ADVISOR:** Achintya Bezbaruah, Ph.D.

The urgent need for addressing water pollution and its detrimental effects on aquatic ecosystems has urged research into innovative water treatment solutions. This study focuses on using chitosan beads as potential adsorbents for the removal of phosphate ions, offering a promising strategy to combat environmental challenges associated with eutrophication. For efficient anion removal, two different types of beads were used. The initial category involved chitosan-based beads, while the second category was iron-doped chitosan beads. The chitosan-based beads demonstrated a modest phosphate removal efficiency of 40%. However, a significant increase in removal efficiency was achieved with the iron-doped chitosan beads, 98% removal. The adsorption of phosphate ions was most effective within a pH range up to 8 and gave adsorption capacity of 53 mg/g. Langmuir and Freundlich adsorption models were applied and in terms of kinetics, pseudo second order reaction was followed. Zeta potential analyses offered insights into the underlying removal mechanisms that was potentially guided by the electrostatic attraction between the positively charged bead surfaces and the negatively charged ions. Detailed characterization showed the introduction of additional functional groups following modification, increasing the potential for enhanced anion removal. Overall, this study highlights the potential of using chitosan beads with iron modification to remove phosphate from water. This approach has the potential to provide a simple and effective solution for tackling water pollution issues.

## Mathematical modeling, Rupture, and Relaxation Characteristics of Soybean under Compressive Loading

**EMMANUEL BAIDHE**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**ADVISOR:** Clairmont Clementson, Ph.D.

The mechanical properties of soybeans are crucial in determining the energy requirements for the oil extraction process. This study aimed to investigate the impact of initial pressing height (20, 30, 50 mm) and loading rate (20, 30, 50 mm min-1) on the rupture and relaxation behavior of three soybean varieties: P23A40E, XF31-32N, and EL30-33. The objective was to gain insights into optimizing the oil extraction process for efficient energy utilization. Standard methods were employed to determine the physical, gravimetric, and mechanical properties. Compression tests were conducted using a TestResources universal testing machine equipped with 5kN and 25kN load cells for single kernel and bulk soybeans, respectively. Mathematical models were utilized to characterize the load-deformation and relaxation properties of bulk soybeans under compression. Single kernel soybean mechanical properties exhibited significant variation based on variety ($p \leq 0.05$). In bulk soybeans, variety, initial height, and loading rate significantly impacted rupture energy and modulus of elasticity ($p \leq 0.05$), whereas only loading rate significantly affected rupture stress ($p \leq 0.05$). Rupture energy increased with higher initial height and loading rate. Generally, lower loading rates and initial heights tended to produce higher modulus of elasticity, though this was dependent on soybean variety. The study also identified that different mathematical models, such as third-order tangent curve models for P23A40E and EL30-33, and a second-order model for XF31-32N, described single kernel deformation. Meanwhile, bulk soybean load-deformation was described by first- or second-order tangent curve models. The force coefficient of the tangent curve model increased with loading rate, while the deformation coefficient decreased with initial height. Moreover, the findings highlighted a viscoelastic behavior in soybeans, which diminishes as loading rates increase. The relaxation behavior of bulk soybeans was best described by the five-element Maxwell model. This study emphasizes the importance of considering loading behavior, as well as the physical and gravimetric attributes of soybean grains, when devising energy-efficient techniques for soybean oil extraction.

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

**PRATIK BANKAR**
HORTICULTURE

**ADVISOR:** Todd West, Ph.D.

*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 the viable seed is potentially invasive. One method to deal with this problem 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 potentially have 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*.

## ChatGPT: A Pedagogical Tool for Writing Teachers

**JAINAB BANU**
ENGLISH – RHETORIC, WRITING, AND CULTURE

**ADVISOR:** Anastassiya Andrianova, Ph.D.

ChatGPT might be a new talk in the town, the idea of computer-assisted composition is not new. However, ever since ChatGPT began to amaze people with its ability to write in emergency and respond to any given prompts, it has somehow become a threat to the writing teachers and overall human writers. Composition scholars refer to the "Process theory of Composition" to show how detailed and elaborate a writing process can be which requires a writer's total involvement in the act because writing is an active and recursive process. But does ChatGPT go through the rigorous writing process like human writers? ChatGPT does freewriting. Can it freely write? Can it teach writing for different audiences, situations and purposes? Can ChatGPT replace writing teachers? Or can writing teachers use it as a pedagogical tool to teach writing in different genres? In my paper, I aim to explore the answer to these questions. To do so, I will use the works of several composition scholars and bring their insights regarding ChatGPT in the context of writing classrooms. I will also share what I have been doing to incorporate ChatGPT into my writing instruction. I proclaim that ChatGPT can be a good pedagogical tool for writing teachers and help students become better and digitally equipped writers. I understand that ChatGPT might be a potential threat to writing teachers, but it cannot effectively replace them. Rather, writing teachers can use it as a pedagogical tool and use it as a non-human assistant. My contribution will add value to the discipline of writing studies because the matter is contemporary and the solution that I aim to provide is convenient for most writing teachers who use technology in their writing classrooms.

## Genome Wide Association Study of Anthocyanin And Phenolics in a Cold Climate Wine Grape (*Vitis Spp.*) Population

**RAJASEKHARREDDY BHOOMIREDDY**
PLANT SCIENCES

**ADVISOR:** Harlene Hatterman-Valenti, Ph.D.

To ensure superior wine quality and enhanced health benefits, it is paramount to maintain the stability of anthocyanins and total phenolics in grapevines. These compounds not only impart rich color and robust flavor to wine but also contain antioxidants that are beneficial to human health. However, ensuring the stability of these compounds poses a significant challenge in North Dakota's harsh and variable climate. Deciphering the genetic control of these compounds is crucial for influencing the astringency, color, and mouthfeel of the wine. An incomplete diallel population of 1064 individuals were utilized to examine the genetic basis of total phenolic and anthocyanin composition key compounds that affect both the health benefits and the sensory attributes of wine. To understand the genetic variation responsible for these traits, a genome-wide association study (GWAS) was conducted using 24,000 SNP markers.
The GWAS revealed six significant SNP associations on chromosomes 2, 5, 7, and 16 for anthocyanins, as well as three significant SNP associations for total phenolics on chromosomes 2, 6, and 11 over a period of two years. These findings will provide insights in understanding of the genetic factors affecting phenolic and flavonoid levels in wine grapes, offering a valuable resource for viticulture and enology, with potential applications in grapevine breeding for improved wine quality.

## Enhancing Nutraceutical Properties of Cannabidiol Using High Internal Phase Emulsion Gel

**ANTO PRADEEP RAJA CHARLES**
CEREAL SCIENCE

**ADVISOR:** Jiajia Rao, Ph.D.

Cannabidiol (CBD) from industrial hemp is a promising functional ingredient that exhibits several biological activities, such as anti-cancer and anti-inflammatory effects. However, its poor chemical stability and bioaccessibility hinder its nutraceutical applications. In this study, high internal phase emulsion gels (HIPEG) were generated using ultrasound-modified hemp protein isolate (HPI) to microencapsulate CBD to improve its chemical stability and bioaccessibility. The HIPEG were fabricated using HPI (8 wt%), and soybean oil (80 wt%) containing different concentrations of CBD using high shear dispersion. The impact of CBD concentration (0.1% or 0.5% w/w) and post-storage treatment (with 4 °C refrigeration or without 4 °C refrigeration for 24 h) on the gels' rheological properties and physical stability for 14 days at 4, 25, or 37 °C was evaluated. Further, morphological analysis, chemical stability, molecular interactions, and in vitro gastrointestinal digestion were performed to elucidate the impact of CBD concentration and post-storage conditions. The results showed that the HIPEG fabricated using 0.5% CBD with post-refrigeration is the optimum for CBD delivery as it displayed superior physical stability, dynamic modulus, and storage modulus. Fourier transform infrared spectroscopy identified the molecular interactions between the HPI and CBD in the HIPEG. The morphological analysis performed using the scanning electron microscope and confocal microscopy showed the formation of honeycomb-shaped protein matrices surrounding the lipid droplets, which helped maintain the chemical stability of CBD for 100 days under light and temperature exposure (4, 25, and 37 °C). Importantly, the uniformly arranged protein matrices controlled the lipid digestion and free fatty acid release and consequently improved the bioaccessibility of CBD by up to 78.34%. The fabricated HIPEG acted as an excellent carrier for CBD and enhanced its stability and bioaccessibility. The outcomes indicate that the HIPEG could act as a novel delivery vehicle for developing CBD-based nutraceuticals.

## Achieving Diverse Avian Nesting Requirements with Heterogeneity-based Grazing

**JUSTIN CLARKE**
NATURAL RESOURCE MANAGEMENT

**ADVISOR:** Torre Hovick, Ph.D.

Traditional grazing management focuses on maximizing cattle production through uniform forage utilization, resulting in reduced vegetation structure and plant composition. This homogenization decreases avian niche diversity, contributing to ongoing declines in grassland bird communities. Patch-burn grazing can restore vegetation heterogeneity, but a cultural aversion to fire warrants alternative heterogeneity-based management. To achieve this, we established a modified rest-rotational grazing system in 2018 that varies grazing intensity to create heterogeneity across paddocks in the absence of fire. Our treatment structure includes four replicates, each split into four paddocks based on percent utilization: heavy (60+%), full (40-60%), moderate (20-40%), and rested (0%). We assessed the efficacy of this system to achieve heterogeneity and the subsequent impacts on grassland birds by quantifying grazing intensity impacts on 1) vegetation structure, 2) avian community composition, and 3) nest survival. We conducted vegetation sampling to quantify vegetation structure and rope dragging to locate nests within paddocks. Nests were subsequently monitored to determine their fate. We incorporated vegetation structure and composition measurements at each nest into a hierarchical modeling scheme using RMark to assess nest survival. We found that modifying grazing intensity within a pasture creates heterogeneity in litter depth across years, but changes in vegetation density were less consistent. Additionally, changes in the nesting community between grazing intensity were only seen in 2021 ($p \leq 0.05$). However, we found that nest survival of four of the eight species was impacted either directly by grazing, as seen with the Red-winged Blackbird, or indirectly by changes in vegetation structure associated with grazing, such as the Northern Pintail, Blue-winged Teal, Brewer's Blackbird. Additionally, nesting density of the Gadwall was significantly higher in the moderately grazed paddock than the heavily grazed paddock, and densities of both the Gadwall and Clay-colored Sparrow were indirectly impacted through changes in litter depth. Responses to grazing and vegetation variables were species-specific, reflecting the importance of heterogeneity when managing for diverse grassland birds. Our results demonstrate the potential for an alternative grazing practice to restore heterogeneity and improve grassland bird conservation. We recommend land managers incorporate grazing strategies that promote heterogeneity to benefit grassland birds.

## Paternal Programming: Effect of Divergent Planes of Nutrition on the Sire in Placental Vascularity and Development

**BETHANIA DAVILA RUIZ**
ANIMAL SCIENCES

**ADVISOR:** Lawrence Reynolds, Ph.D.

The idea of paternal programming has gained significant attention in recent years in the reproductive field. It is now recognized that paternal influences on offspring development and well-being are just as crucial as maternal influences. Furthermore, the placenta plays a fundamental role in fetal development as it acts as the primary conduit for nutrients, oxygen, and waste exchange between the maternal and fetal circulations. Hence, our study aimed to examine how different planes of ram nutrition impact placental development. We conducted an 84-day feeding period with mature rams who were individually housed and randomly assigned to one of three groups: positive (POS; n=8), maintenance (MAINT; n=8), or negative (NEG; n=8) nutrition. This duration allowed for all sperm in the ejaculates at the end of the experiment to have been exposed to the dietary treatments through their entire spermatogenic cycle (approximately 47 days in the ram). After the feeding period, the rams were placed in a pen with 10 ewes each for a 28-day breeding period before the ewes were turned out to graze. Upon lambing, ewes were monitored, and the placentas were collected within 4 hours of expulsion. The placenta was weighed and the number of cotyledons (the fetal side of the placenta; COT) was counted. The largest cotyledon near the umbilical cord was manually dissected and weighted. After weight, a cross-section of it was fixed in neutral buffer formalin to immunofluorescent stain for CD-34 and CD-31, which are used as markers for endothelial cells to quantify vascularity, and DAPI for background staining. The MIXED procedure of SAS was used to assess statistical significance (P≤;05). Our results showed no significant difference in placental weight, number, or weight of COT, or placental vascularity between the different planes of nutrition, indicating that different planes of nutrition in the ram for an 84-feeding period do not influence placental development and highlight the remarkable ability of the placenta to adapt to diverse environments.

## Cold Hardiness Evaluation

**HAVA DELAVAR**
PLANT SCIENCES

**ADVISOR:** Harlene Hatterman-Valenti, Ph.D.

Cold hardiness profoundly impacts grape production and quality. Low winter temperatures can cause significant damage to grapevines, leading to bud injury and vine death. Identifying quantitative trait loci (QTL) for cold hardiness in grapevines remains challenging due to the bottleneck of field evaluation. Vulnerable plants often die in their first year, limiting study populations. This study addresses this challenge by developing a method to acclimate the entire mapping population in a greenhouse with controlled conditions, enabling comprehensive assessment using differential thermal analysis. Our primary objective is to ensure strong correlation between greenhouse and field evaluations. We compare cold hardiness evaluations of a mapping population resulting from a Vitis riparia and Vitis vinifera Fresno seedless cross under three conditions: natural field conditions in Fargo, greenhouse acclimation, and a temperate climate in California. Environmental parameters in the greenhouse, such as temperature, humidity, and light, are controlled to induce acclimation. This approach overcomes field evaluation limitations and accelerates QTL mapping for cold hardiness in grape and fruit trees. Our study advances understanding of cold hardiness through a comprehensive mapping approach, addressing field condition limitations. Additionally, greenhouse evaluations facilitate year-round assessments, expediting breeding processes. This study establishes a robust framework for future research in this crucial area. Ongoing data analysis will be presented at the NDSU research day.

## Identification of Suppressive Soil for Management of Soybean Cyst Nematode (*Heterodera glycines*)

**ROSHAN DHAKAL**
PLANT PATHOLOGY

**ADVISOR:** Guiping Yan, Ph.D.

The soybean cyst nematode (SCN: *Heterodera glycines*) poses a significant threat to soybean production in the USA including North Dakota (ND). Common management strategies include the use of resistant soybean cultivars, crop rotation, and seed treatment, but these approaches have their limitations. This study aimed to identify the soil suppressive to SCN as an alternative management approach in ND. Initially, 23 soybean fields were selected and sampled based on our prior observations of decreasing SCN populations in these fields over the past years. Among them, 10 fields showing lower SCN densities (0-640/100 cc of soil) were investigated further for their suppressiveness on SCN. Four trials were carried out in a growth chamber with 16-hr daylight at 27°C. SCN white females, cysts, eggs, and juveniles were extracted and recorded after 60 days for each trial. Results from three of the trials consistently showed that two field soils (Field 1 and Field 2) suppressed SCN, as evidenced by significant reduction of SCN (white females, eggs per cyst, final population densities) and reproductive factors in the inoculated natural field soil compared to the inoculated autoclaved field (conducive) soil. Importantly, Field 1 significantly reduced the SCN population when 50% of the natural field soil was mixed with 50% of the autoclaved field soil in two trials. Thus, Field 1 and Field 2 were identified as suppressive to SCN, with Field 1 demonstrating transferability of suppressiveness to conducive soil. This study greatly contributes to the understanding of SCN suppressiveness, and the suppressive soil identified could be further explored to uncover inherent biological control agents to enhance SCN management.

## Edge AI-enabled Road Furniture Monitoring System

**ISRAT SHARMIN DOLA**
MECHANICAL ENGINEERING

**ADVISOR:** Inbae Jeong, Ph.D.

Effective monitoring of road furniture is essential for urban safety and functionality. However, traditional inspections are time-consuming, costly and error prone, while current automated solutions struggle with high initial setup costs, limited flexibility in wide adapting, and reliance on centralized processing that can delay response times. This study introduces an edge AI-based remote road furniture monitoring system which automatically and continuously updates the information of the road digital twin (DT). The main component is a small-size edge device consisting of camera, GPS and IMU sensors, designed to be installed in typical cars. The device captures images, detects the furniture, and estimates their location by employing deep learning and feature matching. This information is transmitted to a dedicated cloud server and represented on a user-friendly user interface. Experiments were conducted to test the system's performance. Results showed the device could successfully detect the furniture and estimate their global coordinates. Outputs were marked and shown on the road DT, proving the integrated and smooth operation of the whole system. The proposed system improves road monitoring by cutting down on maintenance and emergency response times, increasing the ease of data use, and offering a foundation for overview of urban road furniture's current state.

## Unraveling GSTP1's Role: Implications for Metabolic Regulation in PDAC

**JENNA DUTTENHEFNER**
CELLULAR AND MOLECULAR BIOLOGY

**ADVISOR:** Katie Reindl, Ph.D.

Pancreatic ductal adenocarcinoma (PDAC) stands as a formidable adversary in the realm of oncology due to its stealthy progression and limited treatment options. Despite advancements, the 5-year survival rate stands at a disheartening 13%. Pancreatic cancer ranks as the 10th most frequently diagnosed cancer in the United States, with nearly 52,000 projected deaths just this year, underlining its significant impact on public health. Unlike other cancers, reliable screening tests or biomarkers for early detection of pancreatic cancer are lacking. To address these challenges, there is an urgent need for innovative approaches in pancreatic cancer treatment. Our research indicates that the antioxidant enzyme glutathione S-transferase pi 1 (GSTP1) may be a potential target. To investigate the role of GSTP1, we developed doxycycline-inducible GSTP1 knockdown PDAC cells. We have shown that loss of GSTP1 directly affects redox homeostasis and reduces PDAC cell growth. Multi-omics techniques, including transcriptomics, proteomics, and metabolic profiling, were employed to assess the global effects of GSTP1 knockdown on PDAC cells. Various assays were conducted to validate the findings, including qPCR, western blotting, ATP quantification, mitochondrial function assays, and substrate oxidation tests. GSTP1 knockdown led to significant alterations in the transcriptomic and proteomic profiles of PDAC cells, affecting key metabolic pathways. Notably, downregulation of metabolic genes and proteins involved in energy production was observed, leading to impaired cellular metabolism. Metabolic profiling revealed dysregulation of ATP production and lipid metabolism in GSTP1 knockdown cells. Furthermore, mitochondrial dysfunction and increased reactive oxygen species production were observed, contributing to reduced cancer cell growth and survival upon GSTP1 inhibition. Our study highlights the critical role of GSTP1 in maintaining redox balance and metabolic homeostasis in PDAC cells. Targeting GSTP1 and its associated metabolic pathways presents a promising therapeutic strategy for pancreatic cancer treatment. These findings pave the way for developing novel therapies to exploit vulnerabilities in cancer cell physiology, ultimately improving patient outcomes. GSTP1 emerges as a potential novel therapeutic target for pancreatic cancer, offering new avenues for therapeutic intervention in this challenging disease landscape.

## 3D In-Vitro Model: One Step Closer to Fight Against Cancer

**SHRINWANTI GHOSH**
BIOLOGICAL SCIENCES

**ADVISOR:** Jiha Kim, Ph.D.

Cell culture is essential and required step in cancer research. Most cells are cultured using traditional two-dimensional (2D) methods. However, 2D cultures have many drawbacks, such as variations in cell morphology, method of cell division, stages of cell cycle, and cellular cross communication within tumor microenvironment (TME). In this regard, 3D models mimic the complexity of TME, aiming to explain why TME is a prime target in anticancer therapy. The aim of this current study was to create reliable in-vitro 3-D models, able to closely replicate several hallmarks of in-vivo tumors. In this study, we implemented "hanging drop" method to create 3D Tumor Spheroids (TSs). This method was not only sufficient to build the 3D structure, but also significantly enhanced patient-derived cancer cell line establishment rate up to 75%. 3D TSs maintained their histopathological characteristics and original hormone receptor status. We revealed 3D "hanging drop" is a promising model to evaluate essential tumor stages, including cancer cells proliferation, morphology alterations, cell death and oxygen deficiency. To investigate the complex interrelation between the tumor and TME, we cultured TSs with different stromal populations. Analysis of our data revealed that presence of stromal cells in TME enhanced tumor survival. Considering all the results, 3D in-vitro model has potential to provide alternative ways to study cancer cell behavior and improve the scope of drug research for cancer diseases in a more realistic way. The long-term goal of this current study is to explore bone mimicking nano-clay-based 3D scaffold culture systems to investigate development of metastatic tumors and to understand the influence of bone TME on cellular responses in-vitro.

## Mesenchymal Stem Cells-Based Drug Delivery Approach for Management of Pancreatic Cancer

**PARAS GIRI**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Buddhadev Layek, Ph.D.

Pancreatic ductal adenocarcinoma (PDAC) accounts for 3rd leading cause of cancer-related death in the USA with a very low five-year survival rate of only 13%. One of the major causes of PDAC high mortality is late diagnosis. As a result, only 15% of PDAC-diagnosed patients are suitable for surgery and the remaining patients have to rely on chemotherapy. However, conventional anti-cancer drugs are marred with tumor non-specificity and chemotherapy-associated toxicity leading to unbeneficial effects to patients. Nanocarriers were developed as a promise to overcome these limitations by exhibiting improved tumor site drug delivery capacity and controlled release behavior. Even though these nanocarriers possess sustained drug release behavior, their tumor targeting abilities remain elusive. In fact, less than 1% of administered nanocarriers reach to solid tumors leading to insufficient amount of chemotherapeutic drug at the tumor site to elicit effective response. Thus, a new drug delivery approach is required to enhance the prognosis of PDAC. In this study, we used Mesenchymal stem cells (MSCs) as delivery agents of paclitaxel (PTX) for effective management of pancreatic cancer. Due to innate tumor tropism behavior, MSCs coupled with PTX nanocarriers can deliver the cargo to the tumor site easily. We chose PTX since it is recommended chemotherapy for pancreatic cancer treatment. PTX was encapsulated into polymeric matrix poly(lactic-co-glycolic) acid (PLGA) to achieve the sustained release of PTX. Usually, nanocarriers are bonded to MSC via internalization. However, to enhance the nanoparticle payload in MSCs, we anchored PTX NP on the MSC surface. As a result, MSC bearing PTX NP (PTX-MSC) were prepared via dual drug loaded mechanism (endocytosis and surface binding). Characterization of PTX-MSC exhibited admirable drug loading capacity (56 μg PTX/106 MSC), sustained release profile, and in vitro superior cytotoxicity against pancreatic cancer cell lines KPC and PANC-1. Furthermore, the tumor tropism behavior of PTX-MSC was unaffected and an in vivo study revealed that PTX-MSC displayed excellent tumor inhibition as well as enhanced survival in a pancreatic cancer mouse model.

## Chitosan Biopolymer Composite as an Effective Solution for Arsenic Contamination Mitigation in Water Systems

**ADITYA GOYAL**
MATERIALS AND NANOTECHNOLOGY

**ADVISOR:** Achintya Bezbaruah, Ph.D.

Arsenic contamination in water sources poses a significant threat to human health globally, necessitating innovative remediation strategies. This abstract provides an overview of utilizing chitosan biopolymer composites as a promising solution for arsenic remediation in water systems. Chitosan, derived from chitin, offers a versatile platform due to its abundant amino and hydroxyl functional groups, making it an ideal candidate for developing effective adsorbents. When integrated into composite materials, chitosan exhibits enhanced adsorption capacity and selectivity towards arsenic species, facilitating efficient water treatment. Synthesis methods and characterization techniques for chitosan-based composites tailored for arsenic remediation are discussed, along with factors influencing adsorption performance such as pH, temperature, contact time, and initial arsenic concentration. The mechanisms underlying arsenic adsorption onto chitosan biopolymer composites, including electrostatic attraction, complexation, and surface precipitation, are elucidated. The advantages of chitosan-based composites, including eco-friendliness, cost-effectiveness, and scalability, render them suitable for large-scale deployment in arsenic-contaminated regions. Challenges and future research directions in developing and applying chitosan biopolymer composites for arsenic remediation are addressed, emphasizing the importance of interdisciplinary collaboration and technological innovation to address this pressing environmental and public health concern. This abstract highlights the potential of chitosan biopolymer composites as efficient adsorbents for arsenic remediation, offering insights into their synthesis, performance optimization, and practical applications in water treatment systems.

## Development and Evaluation of the Utility of Two Assessments for Measuring Student Knowledge of Green Chemistry Principles

**KRYSTAL GRIEGER**
CHEMISTRY – DISCIPLINE-BASED EDUCATION RESEARCH

**ADVISOR:** Alexey Leontyev, Ph.D.

The integration of green chemistry into the chemistry curriculum has taken center stage with the American Chemical Society's (ACS) requirement that all ACS certified schools provide students with a working knowledge of the twelve green chemistry principles (GCPs). Within the literature, there are numerous examples of how to integrate green chemistry into the curriculum; however, there currently are very few reports of assessments capable of validly and reliably measuring student knowledge of green chemistry. This causes two problems: 1) it limits the conclusions that can be made about the effectiveness of the reported instructional methods, and 2) since assessment communicates to students the importance of the assessed content, the lack of green chemistry assessment signals to students that green chemistry material is superfluous. Therefore, this study sought to develop and evaluate the reliability and validity of the data obtained from two assessment instruments: 1) a close-ended 24-item true-false instrument entitled Assessment of Student Knowledge of the Green Chemistry Principles and 2) an open-ended assessment entitled Green Chemistry Generic Comparison that asked students to decide what factors they would consider when deciding which of two reactions is greener. Both assessments were administered to students in general and organic chemistry courses at a research-intensive university in the Midwest. Student responses were first coded thematically for which GCPs were addressed and then quantitatively for response accuracy. Both instruments were found suitable for measuring student learning gains and eliciting student knowledge of GCPs. Unfortunately, due to the nature of the close-ended instrument, it was not designed to measure student knowledge of GCPs beyond the scope of its statements. However, the open-ended prompt was capable of eliciting both correct and incorrect student conceptions of GCPs. Therefore, it is recommended that the two assessments be used in conjunction with each other to obtain a more holistic perspective of student GCP knowledge. This presentation addresses the development, evaluation, and utility of these two assessments.

## Nanocellulose Fibers from Agricultural Waste for Effective Removal of Aqueous Phosphate

**ANAND GUPTA**
ENVIRONMENTAL AND CONSERVATION SCIENCES

**ADVISOR:** Achintya Bezbaruah, Ph.D.

The widespread usage of phosphorus fertilizers in agriculture has led to excess phosphorus in waterbodies causing eutrophication. Restricting phosphorus can alleviate eutrophication. We have produced nanocellulose (NC) from barley straw (an agricultural waste) and activated it to get activated nanocellulose (ANC). The ANC was later functionalized with iron (Fe–ANC). The production efficiency for NC from raw barley straw was ~22% and that of ANC was ~4.3%. The size of the produced NC was 11.5–91.5 nm and that of ANC was 2–45 nm. The FTIR results indicated the presence of high hydroxyl (–OH) functional groups in NC while –CH and –C–C groups dominated in the ANC. The SEM results confirmed the fibrous structure of produced NC. Batch study results showed no removal of phosphate with raw barley straw and NC. While ANC (15g/L) only removed 19.33% phosphate (5 mg/L) while Fe–ANC (2 mg/L) achieved the efficiency to 100%. The optimum molarity of iron for functionalization was found 0.15 M. The kinetics data is best fitted to pseudo-second-order kinetic models indicative of phosphate removal by chemisorption. This work suggested that Fe–ANCs are promising candidate for phosphate removal from aqueous media.

## Alternative Grading Practices in Undergraduate STEM: A Scoping Review

**EMILY HACKERSON**
BIOLOGICAL SCIENCES

**ADVISOR:** Jenni Momsen, Ph.D.

Alternative grading practices (AGP) are gaining popularity as methods to promote accurate reflections of learning (Nilson, 2014; Schinske & Tanner, 2014; Clark & Talbert, 2023). However, a lack of evidence of efficacy has contributed to continued skepticism. We completed a scoping review to identify gaps in the literature (Arskey & O'Malley, 2005; Khalil et al., 2016; Miles, 2017). We developed three research questions (1) what is currently known about the impacts of AGPs on student outcomes across STEM disciplines, (2) what gaps currently exist in the body of research, and (3) is the research on alternative grading in STEM occurring in discipline- or methods-based silos. Our search yielded 332 records. We limited included studies to peer-reviewed research done in the United States at the undergraduate level. After applying these criteria to the 332 records, 75 studies remained. We coded study contexts/characteristics and performed citation analyses. Study contexts were coded for course delivery, course type, course audience, course level, course enrollment, Carnegie classification, discipline, and name of AGP. Study characteristics were coded as the variable being measured, how they were making the measurement, and whether results were in favor of alternative grading. We also analyzed citation patterns through direct citation analysis and co-citation analysis (He et al., 2021). The most common AGPs were SBG (n = 18), mastery grading (n=16), and specifications grading (n = 14). Studies were largely coming from Chemistry (n=21) and Engineering (n=30). We identified 179 variables measured across the 75 studies, the most common being student performance (n=74). Results were largely in support of alternative grading. Citation analyses also indicate disciplines are isolated from each other in practices they are implementing and literature they are citing to support the practice. Adoption of AGPs seem to be outpacing the collection of empirical evidence of their efficacy. This review highlights the need for future research to be grounded in theoretical frameworks. This will allow for translation across disciplines and selection of appropriate instruments to measure constructs theorized to be impacted. While research is currently limited, the large proportion of positive results is promising and this clearly warrants further research.

## Transfer Kinetics of Cargo Items among Mobile Nanocarriers

**MD FARUK HOSSAIN**
PHYSICS

**ADVISOR:** Sylvio May, Ph.D.

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.

## Screening for Fusarium Effectors That Play a Role During Root Rot Infection on Dry Bean

**RUBYLYN INFANTE**
PLANT PATHOLOGY

**ADVISOR:** Malaika Ebert, Ph.D.

Dry bean production faces significant challenges from diseases like root rot, caused by a complex of pathogens including Aphanomyces euteiches, Pythium spp., Rhizoctonia solani, and Fusarium species, with Fusarium being the most prevalent. During infection, these pathogens release small molecules called effectors, impacting disease progression, microbial competition, and nutrient acquisition. Previous research in the F. oxysporum - tomato pathosystem identified 14 secreted in xylem (SIX) effectors during infection using xylem sap analysis. Our lab aims to employ a similar method to identify effectors secreted by Fusarium spp. during dry bean infection. To identify effectors during Fusarium-dry bean interactions, we assessed Fusarium spp. collected during dry bean survey in 2022 to determine the level of virulence and used amplification with a translation elongation factor alpha 1 (TEF-1α) primer set to see which Fusarium strains could travel from roots to leaves during infection. We found that Fusarium strain 10-1 was present in leaves and displayed high level of virulence. Therefore, we chose this Fusarium strain for Nanopore sequencing with subsequent genome assembly, and annotation. Whole-genome sequencing of Fusarium strains 10-1 yielded a 50x coverage genome of 60.68 Mb. Long-read assembly produced 17 contigs with an N50 length of 4.3 Mb. Comparisons with F. solani Fusso1 genome revealed high similarity across chromosomes 2 to 13, while chromosomes 14 to 17 of Fusarium strain 10-1 exhibited reduced similarity, possibly suggesting accessory chromosomes. Chromosome 1 of Fusarium strain 10-1 exhibited notably low similarity, suggesting that Fusarium strain 10-1 is a member of the F. solani species complex. However, we are currently not able to assign it to a specific Fusarium species. Additionally, xylem sap from healthy and Fusarium strain 10-1-inoculated plants was analyzed via mass spectrometry, identifying 60 putative fungal candidate proteins, including three with predicted signal peptides. We are currently in the process to design and develop knockout mutants for these three candidate genes in Fusarium strain 10-1 for in planta testing to assess their impact on fungal virulence. Understanding the molecular dynamics of the Fusarium-dry bean interaction will aid in breeding dry bean varieties resilient to Fusarium root rot.

## Integrating Alfalfa and Sainfoin with Sunflower through Intercropping: Enhancing Forage Production, Soil Health, and Biodiversity

**MD SHAZZADUL ISLAM**
PLANT SCIENCES

**ADVISOR:** Marisol Berti, Ph.D.

Increasing challenges in soil health, food security, and environmental sustainability call for the adoption of sustainable agricultural methodologies. Pressed by economic, environmental, and biological demands, the exploration of innovative agronomic techniques becomes imperative. Intercropping systems, notably the combination of alfalfa (Medicago sativa L.) and sainfoin (Onobrychis viciifolia Scop.) with sunflower (Helianthus annuus L.), offer a valuable solution. This strategy not only boosts crop yields but also capitalizes on the deep-rooting abilities of alfalfa and sainfoin to scavenge nitrates, effectively minimizing nitrate leaching into the groundwater. Additionally, their comprehensive root systems play a crucial role in soil stabilization, markedly diminishing soil erosion and overall health. This study aimed to assess the viability of cultivating alfalfa and sainfoin alongside sunflower through intercropping, in comparison to traditional standalone crops, evaluating the impact on subsequent cash crop yields and the forage production of alfalfa or sainfoin in the following year. Conducted between May 2023 and 2024 in Hickson and Prosper, ND, USA, employing a randomized complete block design with four replicates, the experiment explored various treatments: (1) solo alfalfa, (2) alfalfa intercropped with sunflower at 40 kg N/ha, (3) alfalfa intercropped with sunflower at 80 kg N/ha, (4) solo sainfoin, (5) sainfoin intercropped with sunflower at 40 kg N/ha, (6) sainfoin intercropped with sunflower at 80 kg N/ha, and (7) sunflower alone. Findings revealed that intercropping alfalfa with sunflower did not significantly alter sunflower grain yields (average yield of 2302 kg/ha) or the forage and nutritive quality of alfalfa, whereas sainfoin intercropped scenarios exhibited a decrease in forage yield. Interestingly, the intercropped plots had an upsurge in beneficial insect populations, indicating an enhancement in biodiversity. Hence, in the upper Midwest, the integration of sunflowers with either alfalfa or sainfoin emerges as a forward-thinking approach to concurrently produce valuable forage while cultivating sunflowers, mitigating soil erosion, enhancing groundwater quality through reduced nitrate leaching, and bolstering agrobiodiversity through increased beneficial insect populations. This intercropping system thus presents a multifaceted solution to sustainable agriculture, promising not only soil conservation but also ecological balance and improved crop yields.

## Evaluating the Timing of Grazing in Smooth Brome Invaded Prairie Using Axillary Buds

**ZACHARY JOHNSON**
NATURAL RESOURCES MANAGEMENT

**ADVISOR:** Shawn DeKeyser, Ph.D.

Grasslands are imperiled ecosystems, and invasive species have contributed to their degradation. Smooth brome is an invasive grass in the Northern Great Plains that has contributed to reduced plant diversity. Recent research suggests grazing is important in preventing smooth brome invasion and may improve diversity of already invaded prairie. Grazing during smooth brome's active growing periods, spring and fall, could make it more difficult for smooth brome plants to persist through repeated defoliation. Axillary buds are belowground buds that grow out into new aboveground stems. Since these buds play a significant role in the persistence of many perennial grasses, monitoring their abundance can help evaluate the effects of grazing on smooth brome. The objectives of the study were to compare plant community composition and abundance of axillary buds between grazing treatments and no grazing (control). Our treatments were grazing during the spring only, fall only, and a combination of spring and fall grazing (spring+fall). To monitor plant community composition, we estimated the abundance of each species in each treatment in 2022 and 2023. During those years, we also collected stems of smooth brome to estimate the abundance of axillary buds in smooth brome. Smooth brome made up less of the plant community in the spring only and spring+fall treatment compared to the fall only treatment and the control, however, the abundance of axillary buds in the treatments were similar to the control. These results suggest that axillary bud abundance did not change the abundance of smooth brome. This may be due to indirect effects of grazing on smooth brome's abundance, or a greater period may be necessary to observe changes in axillary buds due to grazing. An additional year of data will help us draw better informed conclusions for the efficacy of our grazing treatments in improving plant diversity of invaded prairie.

## A Power Electronic Building Block - Based Converter for Electric Propulsion System in Spacecrafts

**AWAIS KARNI**
ELECTRICAL ENGINEERING

**ADVISOR:** Omid Beik, Ph.D.

High-voltage and high-power electric propulsion (EP) systems for large spacecrafts have gained much attention as they offer high exhaust speeds, low propellant consumption, extended operational duration, and increased flexibility. In such EPs a heat-source that consists of a nuclear reactor, a Brayton cycle and a high-speed turbine provide torque and speed for an electric generator that converts mechanical power on its shaft to an electric power for the spacecraft's electric thruster. To control the output power of the generator, as well as manage the power for the electric thruster power electronics converters in different forms and shapes, and for different conversion such as ac-dc, dc-dc, and dc-ac, and ac-ac are employed. Neutral point clamped (NPC) converters are a suitable candidate for high-voltage and high-power conversion where they have been proposed for dc-ac conversion. However, their application for dc-dc conversion has not been investigated. This paper proposes the NPC converter topology for dc-dc conversion for electric propulsion in large spacecrafts. The proposed topology is in the form of a power electronic building block (PEBB) that can be configured to be used in a modular structure in different parts of the spacecraft. Two operational scenarios for the converter are discussed with different duty cycles that result in a 3-level unipolar dc voltage. It is demonstrated that both scenarios work equally well and can be utilized to synthesize a desired reference voltage. The switching scheme is constructed, and mathematical models are derived. The proposed dc-dc topology is compared with H-bridge common in spacecraft, and it is shown that the topology in this paper offers less ripple factor at lower frequencies, lower voltage, and current stress for the switches, and is amenable to higher voltages due to multilevel architecture. Furthermore, a conceptual space modulation diagram (C-SMD) is proposed that is used to synthesize a dc voltage in a space vector modulation domain.

## Crack Pattern-Based Degradation Analysis of Landfill Plastics and Their Implications

**MD TANBIR KHAN**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Syeed Iskander, Ph.D.

Degradation of plastics in landfills is evidenced by signs such as crazing, cracking, and delamination. Macro-plastics typically undergo breakdown in landfills, yielding micro and nano-plastics through weathering and environmental stress cracking of the plastic wastes. This presents a significant environmental concern. This study aims to investigate the degradation mechanisms of plastics in landfills through advanced crack pattern analysis. Plastics from different depths in landfills were collected to represent distinct organic degradation stages and physicochemical environments. Polypropylene (PP), Polyethylene (PE), Polyethylene terephthalate (PET), Polystyrene (PS), and Polyvinyl chloride (PVC) were identified as prevalent polymers in landfills. Cracks were observed on the surfaces of hard plastics. Based on the extracted crack images, four types of cracks such as linear, curve, net, and random cracks were observed on the surfaces of the hard plastics. Two-dimensional spectral analysis of the extracted cracks indicates that the surfaces of hard plastics exhibit cracks with notable regularity according to their patterns, whereas such regularity is not observed on the surfaces of soft plastics. Crack metrics (e.g., line density) were correlated with carbonyl index of the plastics. Moreover, line density closely correlated with depth of gas wells (GWs). Total per- and polyfluoroalkyl substances (PFAS) were measured on plastics from two landfill GWs, namely GW 13 and GW 17. However, a strong positive correlation was observed between line density and the total PFAS on plastics in GW 17. Overall, the findings from this study will contribute to a better understanding of plastic degradation in landfills and their conversion to micro and nano-plastics.

## Associations of Antioxidant Consumption from Food and Supplement Sources on Cognitive Function in Older Adults

**KELLY KNOLL**
EXERCISE SCIENCE

**ADVISOR:** Yeong Rhee, Ph.D.

Background: Oxidative stress, the imbalance of prooxidants and antioxidants, has been recognized as a possible risk factor for cognitive impairment. We postulate that increased dietary antioxidant consumption could help preserve cognitive function during aging. Methods: Dietary intake and cognitive function of 50 adults aged ≥65-years (66% women; aged: 71.5±5.1 years) were examined. Three-day food logs, which encompassed intake of all food, beverages, and supplements, were collected from each participant using Cronometer, an electronic nutrition tracking and analysis application. The Saint Louis University Mental Status examination assessed cognition using a 30-point scale to categorize participants with normal cognition, mild neurocognitive disorder, or dementia. Cognitive dysfunction was defined as having a score below the normal cognition threshold (≤ 27 points with a high school education or ≤25 points with less than a high school education). Results: The chi-squared ($p \leq 0.01$) and fisher's exact tests ($p \leq 0.01$) revealed a significantly lower percentage of cognitive dysfunction (31.6%; 6 of 19 participants) among participants that met or exceeded the Recommended Daily Allowances (RDAs) for the antioxidants vitamin C, vitamin E, selenium, and manganese (with or without the use of dietary supplements) when compared to those that did not (74.2%; 23 of 31 participants). However, average cognitive scores differed insignificantly between those meeting RDAs (26.2 ±4.2 points) and those that did not (24.9 ±2.9 points; $p = 0.07$). Conclusion: Intake that meets or exceeds the RDA for antioxidants, specifically vitamin C, vitamin E, selenium, and manganese, may mitigate cognitive decline in older adults.

## Activation of ERβ Receptor in Airway Smooth Muscle by 2-Hydroxyestradiol (2HE) Alleviates Airway Remodeling

**ASHISH KUMAR**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Sathish Venkatachalem, Ph.D.

Rationale: Asthma is a heterogeneous chronic inflammatory disorder of the lungs and is characterized by airway inflammation and remodeling. The hallmark features of airway remodeling include hyperplasia/hypertrophy of airway smooth muscle (ASM) cells, and increased extracellular matrix (ECM) production and deposition. Due to this paradoxical role of estrogen in cellular remodeling, the question remains whether these effects are solely due to estrogen or its active metabolites play a role. In addition, studies from the cardiovascular system suggest the differential role of estrogen metabolites (particularly 2-hydroxyestradiol (2HE) and 16α-hydroxyestradiol (16αHE2) in regulating cellular remodeling. We hypothesize that specific estrogen metabolites regulate ECM deposition via activation of ERα or ERβ in the context of airway remodeling. Methods: Primary ASM cells were isolated from human lung tissue (Mayo Clinic, IRB-approved), and cultured in DMEM-F12. After serum deprivation, cells were exposed to vehicle, 17β-estradiol (E2;1nM), 2-HE (1nM), 16αHE2 (1nM), ERα antagonist (MPP;1nM), and ERβ antagonist (PHTPP;1nM) with/without TGFβ (2ng/ml). ECM protein expression was determined by qRT-PCR and Western analysis. ASM-derived ECM deposition was measured by In-cell Western analysis. The ERE-luciferase reporter assay was performed using different antagonists. Moreover, the functional findings were confirmed using ERα and ERβ-shRNA transfected cells. Results: ASM cells exposed to TGFβ increased the expression and deposition of ECM proteins. 16αHE2 exposure upregulated the TGFβ-induced ECM protein and mRNA expression, whereas 2-HE exposure significantly blunted TGFβ-induced effects. Similarly, 16αHE2 exposure showed a significant increase in TGFβ-induced ECM-production and depositions compared to TGFβ alone, whereas 2-HE exposure alleviates the effect. Further, ASM cells with shRNA mediated ERα knockdown and exposed to 2-HE showed a significant decrease in TGFβ-induced ECM production. Whereas, with ERβ knockout ASM cells, we did not observe any significant effects of 16αHE2 and 2-HE on regulating TGFβ-altered ECM production. Further, using specific antagonists for ERα and ERβ, we performed a luciferase reporter assay and observed that 16αHE2 is functioning via ERα and 2-HE via ERβ. Conclusion: Overall, these data suggest a differential role of estrogen metabolites via activation of ERs, where 16αHE2 may be detrimental while 2-HE beneficial in regulating the ECM production and airway remodeling.

## Feeding Behavior in Heifers fed High-Forage and High-Concentrate Diets

**BROOKLYN KUZEL**
ANIMAL SCIENCES

**ADVISOR:** Carl Dahlen, Ph.D.

With the world population growing every second, the question may arise of "how are we going to feed all these people?" Producers have made the switch to more sustainable practices, and they need research to make those switches happen. Currently at North Dakota State University, researchers in the Animal Sciences department are studying effects of maternal transfer to fetus in beef cattle. Put simply, if we feed mom a certain way, what effects will it have on the baby? The data I'm working with is feed behavior data in pregnant beef heifers. Feed behavior data shows important characteristics such as average daily intake, average daily gain, and gain:feed ratio as well as information about how palatability and texture of the diet affects feeding behavior in these heifers. Methods This study was conducted at NDSU's Beef Cattle Research Complex (BCRC). BCRC utilizes an Insentec feeding system which allows for ease of collection of feeding behavior data. My dataset includes 46 pregnant heifers split into two diet treatment levels: high forage (HF25) and high concentrate (HC75). Feed characteristics included in analysis are average daily gain (ADG), gain:feed ratio (G:F), feeding event visits per day, feeding event meals per day, time eating in minuters per visit, time eating in minutes per meal, time eating in minutes per day, dry-matter intake per day, dry matter intake per visit, dry matter intake prr meal, and eating rate. All this data is collected using the Insentec feeding system and will be analyzed using a mixed procedure with day as a repeated measure in SAS 9.4. Results Data is currently under analysis but will be done by time of presentation. I expect to see differences in feeding behaviors between the two diet treatment levels based on palatability and texture of the diet. Conclusion Data is currently under analysis but will be done by time of presentation.

## Exploring Epistemic Messages in a Calculus-Based Intro-Physics Classroom

**IDRIS MALIK**
PHYSICS – DISCIPLINE-BASED EDUCATION RESEARCH

**ADVISOR:** Warren Christensen, Ph.D.

We seek to explore how students and instructors think about what "Math" is and what "Physics" is, and how those conceptions blend when talking about and doing math/physics tasks in a Calculus-based Introductory Physics course. We used electronic field notes from each instructional class period throughout the semester to document instances where students and the instructor mentioned disciplines in general and the use of each discipline in the context of this course or other courses. We also documented any emergent features of student-student and student-instructor discourse and actions. Our analysis attended to Epistemic Messages, which are cues that a teacher sends to students about the nature of knowledge and learning, and also beliefs about what should be happening in the classroom. This preliminary analysis revealed some distinctions between students and the instructor regarding math and physics conceptions and work procedures. Prominent distinctions include values attached to doing "Math" and "Physics" and opinions on the course structure and focus. We also conducted semi-structured student interviews to explore which epistemic messages (seen in classroom observations) students retained at the end of the course. These interviews included student reflections on the notation used in instructional materials, the intention of specific class activities and instructor behaviors, and how the course achieved the learning objectives listed in the syllabus. We argue that epistemic messages are an under-explored faucet of physics curricular structure and could be leveraged to make course content, including the relevant mathematical concepts and procedures that are common in physics, more approachable for students. Our findings will guide the creation of future curricular and instructional materials that center focused and constructive epistemic messages. Material based on work supported by NSF PHY 1912152. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF.

## Enedione Derivates as a Potential Cancer Treatment through the Inhibition of COPZ1

**ALLANA MARTINS**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Roberto Gomes, Ph.D.

Background: Pancreatic cancer is a disease with a rising incidence of around 64,050 new cases in 2023, and a low survival rate. The most common treatments available are chemotherapy and radiation, which are not selective, resulting in side effects such as pain, hair loss, nausea, and vomiting. They are also ineffective against stem-like and dormant tumor cells, which could lead to a relapse and/or metastasis. Consequently, the development of drugs with tumor-specific targets is needed. COPI is a coatomer that coats vesicles transporting proteins, responsible for the retrograde transport from the Golgi complex (GC) to the endoplasmic reticulum (ER). Tumor cells are COPZ1 dependent, and the inhibition of this protein could lead tumor cells to apoptosis selectively once COPZ2 is naturally downregulated. Methods: In this work, molecular docking, synthesis, and cell biology were performed. A set of 84 molecules was submitted to molecular docking, and 9 compounds containing the active metabolite 4-aminoantipyrine and enedione fragment were selected for synthesis and in vitro evaluation. Cell Viability Assay (MTT) was performed to evaluate the cytotoxicity of the selected compounds in normal (HPNE) and pancreatic cancer cell lines (MIA PaCa-2 and AsPC-1). Also, a Micronucleus assay was performed to evaluate the genotoxic activity of chemicals in cultured cells. Results: After in silico studies, 9 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 protein. Interestingly, compounds 1-4 showed cellular growth inhibition of pancreatic tumor cell lines (MIA PaCa-2 and AsPC-1), but not for pancreatic normal cell line (HPNE). 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. Micronucleus formation occurred only for the positive control (Doxorubicin and Cisplatin), but not for the selected compounds. Significance: The tested compounds can target COPZ1-dependent tumor cells; therefore, they are great candidates for further studies aiming to develop a selective cancer treatment.

## The Promise of Nano-Modified Phosphate Fertilizers for Sustainable Agriculture

**SHIRSA MAZUMDAR**
MATERIALS AND NANOTECHNOLOGY

**ADVISOR:** Achintya Bezbaruah, Ph.D.

Phosphorus (P) is one of the most essential nutrients needed for optimum plant growth and development. However, the conventional application of phosphorus fertilizers in the fields has faced challenges related to low utilization efficiency by plants, environmental pollution, and so on. As phosphorus is crucial for enhancing crop production, our hypothesis posits that polymer coated nano phosphate fertilizers will enhance fertilizer utilization efficiency by effectively managing as well as improving phosphorus runoff and leaching, consequently leading to an improvement in phosphorus uptake by plants. In this research, commercially available rock phosphate (RP) fertilizer was used to obtain nano-sized RP particles. Subsequently, we used polymeric layer deposition techniques to coat these nano-sized RP particles with biodegradable polymers, that includes chitosan and hyperbranched citric acid. The adhesion between the polymer layers was strengthened through physical crosslinking via electrostatic interactions between the negatively and positively charged groups on both the polymers. This coating strategy is aimed to achieve controlled release of P from the RP. Fourier transform infrared (FTIR) spectroscopy and scanning electron microscope (SEM) analyses indicated conformal assembly and stability of the coatings over RP. Furthermore, coated RP fertilizers were tested in aqueous environment to investigate the release kinetics of P over time which revealed that the initial chitosan coating effectively reduced P release, serving as a physical barrier. The subsequent coating with the hyperbranched citric acid facilitated higher release of P in a controlled manner over a specific duration, a crucial aspect for supporting both the early growth stages of plants and their later development.

## Interviews with Undergraduate Chemistry Faculty: The Process of Adoption and Implementation of Alternative Grading in Their Courses

**ARIANA MCDARBY**
CHEMISTRY AND BIOCHEMISTRY

**ADVISOR:** Alexey Leontyev, Ph.D.

Alternative grading practices are slowly being adopted by chemistry faculty across the United States. While there are some accounts in the literature of implementation of these practices, there lacks detail about faculty perception and motivation for adoption of novel grading practices. The goal of this project was to investigate variations of alternative grading practices, process of implementation, and motivation for instructional decisions among faculty teaching general and organic chemistry classes. Faculty (N = 15) were interviewed using a semi-structured interview protocol in the Spring 2023. Interviews were transcribed verbatim and early analysis has revealed some general themes: equity for students, implementing in both lecture and lab style courses, designing courses around a hierarchical structure of learning objectives, overall positive feedback from students, and perceived barriers from instructors. This talk will address the findings of this study, including factors that impact faculty motivation to adopt alternative grading and specific steps of their implementation process.

## Effect of Nitrate on the Photolysis of Organic Micro-pollutants by KrCl* excimer lamp (222nm)

**DAUDA MOHAMMED**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Jiale Xu, Ph.D.

The widespread source water contamination by agricultural runoff and wastewater effluent discharge has become a global concern. The presence of toxic trace-level organic micropollutants (OMPs) such as pesticides, and pharmaceutical compounds in such water sources presents a significant risk to human health and aquatic lives. Recently, KrCl* excimer lamp (excilamps) emitting at 222 nm has emerged as a promising technology for removing OMPs by direct photolysis or advanced oxidation. However, the effects of background water constituents such as nitrate on OMP photolysis at 222 nm remain unknown. Nitrate photolysis can produce reactive oxygen species (e.g., hydroxyl radical) and reactive nitrogen species that can degrade OMPs. In this work, the photolysis of five selected OMPs, including sulfamethoxazole, atrazine, 2,4-dichlorophenoxyacetic acid, and ibuprofen, were evaluated in the presence of nitrate at UV-222 nm. The results revealed a concentration-dependent effect of nitrate toward the OMP degradation rates. At moderate nitrate concentration (up to 5 mg/L NO3-) nitrate significantly enhances OMP degradation rates by a factor of 1.2 to 6 times, while at higher nitrate concentration a further increase in nitrate level has a negligible effect on the the degradation rates. This enhanced removal was attributed to hydroxyl radical (•OH) and nitrating agent formed from nitrate photolysis, leading to the indirect photolysis of OMPs. To elucidate the mechanism, radical scavenger, radical probe studies and kinetic modeling were employed to discern the roles of each transformation pathway (e.g., direct photolysis, hydroxyl radical, and reactive nitrogen species). Oxidation by •OH was revealed as the dominant mechanism responsible for OMP transformation by nitrate.

## Demystifying Cyber crimes and Cyber Insurance for Businesses in the U.S. Market

**ZIA MUHAMMAD**
COMPUTER SCIENCE – SOFTWARE AND SECURITY ENGINEERING

**ADVISOR**: Jeremy Straub, Ph.D.

In the interconnected world of digitization, businesses are vulnerable to cyber threats due to limited resources and a lack of protection. These businesses are required to evolve to defend services and business operations from cybercriminals. This requires a proactive risk mitigation approach and a risk transfer strategy. The research will explain why cyber threats are inevitable and how every business is vulnerable. It will discuss some statistics and graphs on the trends, frequency, and severity of cyber-attacks on small businesses and the benefits of cyber insurance. The presentation identifies risk mitigation strategies that companies can adopt to improve their cybersecurity posture, which will significantly reduce their cyber insurance costs. Finally, it proposes a risk transfer strategy in terms of a 'Cyber Insurance Benchmark', a three-tiered diagram that helps small businesses determine the optimal coverage level. The benchmark has three levels, ranging from low to high, and each level corresponds to different types of cyber risks and coverages. The goal is to explain how small businesses can use these strategies to build cyber resilience that best meets their situation.

## Dual Targeting of ERK and PI3K Pathways to Impede Pancreatic Adenocarcinoma Progression

**GAUTHAMI NAIR**
CELLULAR AND MOLECULAR BIOLOGICAL SCIENCES

**ADVISOR:** Katie Reindl, Ph.D.

One of the leading causes of cancer related deaths worldwide, pancreatic ductal adenocarcinoma (PDAC), has a poor five-year survival rate of 13% primarily due to its late-stage detection and distant metastasis. Since surgical resection is only possible in about 10-20% of the cases, chemotherapy is the sought after option. However, this strategy commonly results in toxicity and drug resistance in patients. Therefore, there is an increasing need for newer combination of drugs that will reduce PDAC progression by targeting molecules involved in cell signaling pathways. The KRAS gene is mutated in almost 95% of the pancreatic cancers resulting in a hyperactivated K-ras protein, which activates downstream growth-promoting signaling pathways such as extracellular signal-regulated kinase (ERK) and phosphatidylinositol 3 kinase (PI3K). Thus, we hypothesized that a combination of inhibitors targeting the kinases: ERK 1/2 and PI3K could lead to reduced PDAC cell proliferation. Our hypothesis was tested using a combination of SCH772984 (an ERK 1/2 inhibitor) and Pictilisib (a class I PI3K inhibitor) on human PDAC cell lines: MIA PaCa-2 and PANC-1. Cell viability assays and clonogenic survival assays showed that both the drugs synergized with each other, reduced colony growth and cell proliferation compared to single inhibitor treatment. Additionally, western blotting experiments proved that both the inhibitors were able to engage with their targets: ERK 1/2 and AKT. Further steps will be encapsulating the drugs in a nanoparticle formulation to increase its solubility and stability and testing the drug combination in an animal model. This novel drug combination may help advance the field of treatment for addressing PDAC.

## Design of an Automatic Charging System for Continuous UAV Operation

**KYLE NIETFELD**
MECHANICAL ENGINEERING

**ADVISOR:** Inbae Jeong, Ph.D.

The demand for Unmanned Aerial Vehicles (UAVs) in various industries has surged, driven by applications ranging from precision agriculture to infrastructure inspection. However, their inherent limitation of finite flight time continues to be an obstacle for developing fully autonomous systems. This presentation details the development of an automatic charging system for UAVs, designed to address the challenges posed by conventional charging methods. The three main components of the system are the direct contact charging platform, on-board charging module, and the landing algorithm that utilizes Artificial Intelligence (AI). The charging platform's design significantly reduces the flight precision required for a successful landing and also supports simultaneous UAV charging. The custom on-board charging module is designed to adapt any UAV model to be compatible with the charging platform. Despite any differences in battery charging requirements, the on-board charging module not only allows charging, but also optimizes the charging rate for any UAV's battery. Lastly, to facilitate the landing process, a Deep Learning (DL) model is designed to detect and locate the charging platform. The DL model is trained using the latest Yolov8 library for detecting the charging platform with Oriented Bounding Boxes (OBB). This innovative automatic charging system for UAVs overcomes many limitations posed by traditional automatic charging methods, and introduces a path forward to enable fully autonomous systems.

## Investigating the Effect of Refining Parameters on Acetic Acid Removal and the Quality of Epoxidized Soybean Oil

**TOSIN OYEWOLE**
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

**ADVISOR:** Ewumbua Monono, Ph.D.

Washing crude epoxidized oil is an indispensable step for the removal of residual acetic acid and unreacted hydrogen peroxide after epoxidation. There are many studies on the epoxidation of vegetable oils but there are many discrepancies in the washing process which likely leads to water wastage, excess use of neutralizing agent, and additional processing time. Hence, this study aims to optimize the washing step by analyzing the quality of each washing step and developing a model that can predict the amount of acid removed. Soybean oil (1.5 kg) was epoxidized at 60 °C for 5.5 h using Amberlite IR 120H as a heterogeneous catalyst. To determine the optimum water washing level, process parameters such as number of washing cycles (1 - 5), proportion of epoxidized oil to water volume (1:0.5, 1:1, 1:2, 1:3, 1:4, 1:5), and water temperature (20 °C, 40 °C, 60 °C) were examined. The main responses were the residual acid value and pH of the washed epoxidized oil. Results revealed that 64% of the acid was removed after 5 washing cycles irrespective of the washing water temperature and proportion. In contrast, approximately 57% of the acid was removed in the first two washing cycles. Increasing the temperature of the water affected acid removal; with approximately 54% of acid removed at 20 °C compared to 60% at 60 °C. Doubling or tripling the amount of water needed above a 1:0.5 ratio did not significantly affect the amount of acid removed. The model developed was significant with a predicted R2 of 96% and a root mean square error (RMSE) of 1.1 when the model was validated at different washing scenarios. Therefore, this study shows that it is possible to significantly reduce the amount of water used and processing time while maintaining resin qualities.

## Activation of Aryl Hydrocarbon Receptor Inhibits Extracellular-Matrix in Airway Smooth Muscle Cells

**MOHAMMAD IRSHAD REZA**
PHARMACEUTICAL SCIENCES

**ADVISOR:** Sathish Venkatachalem, Ph.D.

Airway remodeling is an irreversible process involving structural change caused by an increased airway smooth muscle (ASM) mass, due to cell proliferation, migration, extracellular-matrix (ECM) production, and deposition. The aryl hydrocarbon receptor (AhR) is a ligand-activated transcription factor and cellular chemical sensor used by cells to sense the environment and respond to endogenous and exogenous organic molecules. We previously found ubiquitous AhR expression in human airway. However, the functional role of AhR in airway remodeling is still elusive. Therefore, this study is aimed to decipher the regulatory function of AhR on ASM ECM production and deposition in the context of airway remodeling. Primary human ASM cells isolated from surgical lung resections were cultured in DMEM-F12 medium (Mayo IRB approved). Cells were seeded in culture plates and at ~80% confluency, serum deprived and treated with PDGF/TGFβ (2 ng/mL), and AhR agonist 2,3,7,8-tetrachlorodibenzo para dioxin (TCDD: 10 nM) with/or without AhR antagonist (CH223191) and determined the expression of ECM proteins using real-time qPCR, and Western blotting. ECM depositions were evaluated by measuring fibronectin and collagen-III using In-Cell western analysis. To further confirm the results, we generated stable AhR knockdown ASM cells using AhR short hairpin RNA (shRNA) and determined ECM proteins expression. Separately, murine ex vivo PCLS was performed to check the AhR effect on ASM thikcness. TCDD abrogated TGF-β-induced production of ECM mRNA and proteins (Collagen I/III, and Fibronectin) in ASM cells. Additionally, In-Cell western analysis demonstrated inhibitory effect of TCDD on TGFβ-induced ECM deposition (Collagen III, and Fibronectin). However, these inhibitory effects were reversed by AhR antagonist (CH223191). Interestingly, the AhR knockdown ASM cells showed enhanced ECM protein expression in the presence of TGF-β compared to negative shRNA ASM cells. Notably, TCDD treatment was ineffective in reducing ECM proteins expression in AhR knockdown ASM cells. Morever, PCLS exposed to PDGF showed an increased ASM thickness (indicated by increased α-SMA fluorescence intensity), and reduced by TCDD treatment. Collectively, the current study depicted AhR activation regulates the human ASM ECM production and deposition, which can be further explored in airway remodeling to mitigate asthma.

## PFAS Occurrence and Distribution in Yard Waste Compost Indicate Potential Volatile Loss, Downward Migration, and Transformation

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**ADVISOR:** Syeed Iskander, Ph.D.

We discovered high concentrations of PFAS (18.53 ± 1.5 μg kg−1) in yard waste compost, a compost type widely acceptable to the public. Seventeen out of forty targeted PFAS, belonging to six PFAS classes were detected in yard waste compost, with PFCAs (13.51 ± 0.99 μg kg−1) and PFSAs (4.13 ± 0.19 μg kg−1) being the dominant classes, comprising approximately 72.5% and 22.1% of the total measured PFAS. Both short-chain PFAS, such as PFBA, PFHxA, and PFBS, and long-chain PFAS, such as PFOA and PFOS, were prevalent in all the tested yard waste compost samples. We also discovered the co-occurrence of PFAS with low-density polyethylene (LDPE) and polyethylene terephthalate (PET) plastics. Total PFAS concentrations in LDPE and PET separated from incoming yard waste were 7.41 ± 0.41 μg kg−1 and 1.35 ± 0.1 μg kg−1, which increased to 8.66 ± 0.81 μg kg−1 in LDPE and 5.44 ± 0.56 μg kg−1 in PET separated from compost. An idle mature compost pile revealed a clear vertical distribution of PFAS, with the total PFAS concentrations at the surface level approximately 58.9–63.2% lower than the 2 ft level. This difference might be attributed to the volatile loss of short-chain PFCAs, PFAS's downward movement with moisture, and aerobic transformations of precursor PFAS at the surface.

## Hydrophobization of Nanocrystalline and Microfibrillated Cellulose using Covalent Grafting of Plant Oil-Based Copolymers

**TETIANA SHEVTSOVA**
COATINGS AND POLYMERIC MATERIALS

**ADVISOR:** Andriy Voronov, Ph.D.

Cellulose, a linear polysaccharide biopolymer, finds applications in various industries such as food packaging, personal care products, construction, etc. due to its unique physico-chemical properties, as well as biocompatibility and biodegradability. This study introduces a methodology to enhance the hydrophobicity of nanocrystalline (CNC) and microfibrillated (MFC) cellulose, using the covalent attachment (grafting) of copolymers based on plant oils. Current methodologies for cellulose surface modification are limited in terms of hydrophobizing agents due to their high cost, most of them are not renewable. This study focuses on the synthesis of surface modification of CNC and MFC by graft copolymers from plant oil-based acrylic monomers (POBMs) developed by this research group. The grafting and the properties of the resulting copolymers were determined using Fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), and X-ray photoelectron spectroscopy (XPS) to demonstrate the presence of grafted POBMs and their impact on the characteristics of modified CNC and MFC.

## The Effects Of Limit-Feeding a High-Concentrate or High-Forage Diet on Replacement Heifer and Fetal Offspring Liver and Jejunum Tissue Oxygen Consumption and Mitochondrial Function

**KATHRYN SLAVICK**
ANIMAL SCIENCES

**ADVISOR:** Carl Dahlen, Ph.D.

The study aimed to assess the impact of limit-feeding replacement heifers high-concentrate or high-forage diets on the energy utilization in liver and jejunum tissues of dam and offspring. We hypothesized that altering the diet would modulate tissue oxygen consumption and mitochondrial function. Once received to the NDSU Beef Cattle Research Complex, replacement heifers were blocked by initial body weight (n=20; initial body weight [BW] = 339.8 ± 34 kg) and randomly assigned to either a high-concentrate (HC; n = 10) or high-forage (HF; n = 10) diet targeting BW gains of 0.45 kg•heifer-1•d-1. After an adjustment period, heifers were on their allocated treatment diet approximately 85 days prior to conception and remained on their respective dietary treatments until time of fetal harvest. Fetal harvest was conducted at 180 ± 3 days of gestation (n = 20; final body weight [BW] = 481.7 ± 33 kg), at which time maternal liver, jejunum, and fetal bull calf jejunum was collected and tissue oxygen consumption and mitochondrial function was assessed via high resolution respirometry (Oroboros Instruments, Innsbruck, Austria). The following respiratory states were evaluated: LEAK respiration (L), OXPHOS capacity (P), NADH-linked OXPHOS (PI), and electron transfer capacity (E). Data were analyzed using the GLM procedure of SAS with fixed effect of treatment. Maternal and fetal jejunum were not influenced by maternal dietary treatment at any respiratory state ($P \geq 0.095$). However, hepatic oxygen consumption was influenced by maternal diet, with an observed decrease in PI ($P = 0.037$) and E respiration ($P = 0.0367$), in HC heifers compared to HF heifers. This observation between HC and HF heifers is important because greater PI and E capacity is an indicator of mitochondrial energy efficiency, whereas decreased oxygen flux at these states is a potential indicator of impaired ATP synthesis. The modulations in liver mitochondrial function are a prospective method to evaluate animal health status, and a component to consider when feeding replacement heifers high-concentrate diets during breeding and gestation.

## Integration of Drone Imagery, LiDAR, and ADCP Bathymetry for Topography Reconstruction

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CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Trung Le, Ph.D.

Civilization began with the settlement of ancient peoples along riverbanks, harnessing the resources provided by these water resources. However, rivers are dynamic entities, prone to shifting their courses over time, resulting in the destruction of infrastructure established along their banks and the collapse of bridges. Such rivers are commonly referred to as migrating rivers, thereby prompting a focused area of research aimed at comprehensively understanding their behavior and mitigating associated risks. Numerical simulations serve as indispensable tools in investigating migrating rivers, yet their efficacy relies heavily on accurate site features and topographical data. Accordingly, the initial step in this research endeavor involves generating detailed topographical models of migrating rivers and their adjacent banks. One prevalent technique for accomplishing this task is light detection and ranging (LiDAR), a remote sensing method capable of producing high-resolution 3D models of terrain. However, LiDAR exhibits certain limitations, including its prohibitive cost and infrequent updating cycles, resulting in outdated data. Moreover, LiDAR fails to capture crucial data on water resources such as rivers. To surmount these challenges, researchers have turned to alternative methodologies, notably drone imagery, and Acoustic Doppler Current Profiler (ADCP) bathymetry. Drone imagery offers unparalleled precision in capturing the topography of river banks, effectively supplementing outdated LiDAR data. Conversely, ADCP facilitates the extraction of river bathymetry, a task unattainable through LiDAR signals. By merging LiDAR, drone imagery, and ADCP bathymetry, researchers can construct comprehensive 3D models of rivers, enabling a nuanced understanding of their behavior and aiding in prevention of future catastrophes stemming from erosion. However, the integration of these methodologies is not devoid of challenges. Foremost among these is establishment of a consistent coordinate system across all three methods. Additionally, handling of vast datasets generated by drone imagery necessitates access to high-performance computing resources. Moreover, the limitations inherent in drone signals, such as their inability to penetrate vegetation, necessitate post-processing techniques to ensure data accuracy. In light of these challenges, the objective of our research is to develop a robust framework for effectively integrating these methodologies, thereby enabling a comprehensive understanding of migrating rivers and facilitating informed decision-making to mitigate associated risks.

## MW-Scale Powe & Propulsion System for Large Spacecrafts

**SARAH TALEBZADEH**
ELECTRICAL AND COMPUTER ENGINEERING

**ADVISOR:** Omid Beik, Ph.D.

This article presents a medium voltage direct-current (MVDC) system for megawatt (MW)-scale power and propulsion systems for large spacecrafts. The proposed system provides a common MVDC bus and integrates multiple energy sources including: (i) A nuclear electric propulsion (NEP) that powers a dual-rotor multiphase hybrid generator whose output is rectified and connected to the MVDC bus. (ii) A solar photovoltaic (PV) source that is interfaced to the MVDC bus using a unidirectional boost DC-DC converter. (iii) A back-up battery energy storage system (BESS) that connects to the MVDC bus using a bidirectional DC-DC boost converter. The NEP serves as the main power source of MW-scale for the spacecraft electric thruster, while the solar PV and BESS are intended to provide power for the payload and low-voltage power system. The power is processed to the thruster via a dual active bridge (DAB) converter, where it controls the voltage and current to the electric thruster. This article will propose a control system for solar PV and BESS boost converter, and for the thruster's DAB. Simulation studies are performed to validate the effectiveness of the proposed scheme and the controllers.

## Evaluating Phosphorus Fertilizer Rates and AMF Populations for Soybeans in North Dakota

**DAYNE TALLIER**
SOIL SCIENCE

**ADVISOR:** Lindsay Malone, Ph.D.

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 additions, fertilizer P-rates recommended at low soil test P 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 will be measured at all sites. We also assessed AMF populations (colonization percentage and PLFA), hypothesizing that high STP would result in lower AMF populations, but preliminary results do not support this. Trails in SE ND did not show a yield response to P-application (p= 0.93). However, one site in Fairmount, ND showed a positive correlation between spring soil test P and soybean yield (p- 0.004). A consistent protocol over 8 sites across ND will provide farmers with usable recommendations beyond a single region.

## Emotion Regulation Moderates the Prospective Association Between ERN and Anxiety in Early Adolescence: An Age-Specific Moderation of Cognitive Reappraisal but not Expressive Suppression

**JARON XE YUNG TAN**
PSYCHOLOGY

**ADVISOR:** Pan Liu, Ph.D.

The increasing prevalence of anxiety problems during adolescence underscores the importance of a better understanding of the development of anxiety. Existing literature has documented a prospective association between error responsivity - characterized by the ERP component of error-related negativity (ERN) - and anxiety in youths. However, it remains unclear to what extent the ERN-anxiety relationship may be moderated by emotion regulation, another attribute critical to the development of anxiety. We collected two waves of data from 115 healthy early adolescents (66 girls; Mean age/SD at T1 =11.00/1.16 years), approximately one year apart. Participants completed an EEG Go/No-Go task and reported on their anxiety symptoms at T1 and T2; they also reported on their emotion regulation tendencies (i.e., cognitive reappraisal [CR] and expressive suppression [ES]) at T2. The ERN was quantified via a principal component analysis. We found a moderating effect of ES on the ERN-anxiety association. Specifically, a larger T1 ERN predicted greater T2 anxiety symptoms for youths with higher, but not lower, ES. Interestingly, the moderating effect of CR on the ERN-symptom association was conditioned on age. Among older youths (upper age tercile) only, the association between T1 ERN and T2 symptoms was significant for those with lower, but not higher, CR. These findings contribute novel evidence on the moderating effect of emotion regulation on the prospective ERN-anxiety relationship in early adolescence. Our results elucidate age-specific patterns in the moderating effect of CR. Future studies can leverage these findings to tailor emotion regulation interventions for youths of different ages.

## Preparation of Hydrophobic Poly vinyl alcohol Films via Waxing

**ABODURIN TIJANI**
ENVIRONMENTAL AND CONSERVATION SCIENCES

**ADVISOR:** Ademola Hammed, Ph.D.

Despite the exceptional hydrophobic properties of carnauba wax (CW), there have been no recent reports of its complementary effect on improving polyvinyl alcohol (PVA) films. PVA is a promising food bio-packaging material with excellent film-forming capabilities that can be enhanced by modifying its hydrophilic nature using CW. This study aimed to prepare emulsified bioactive PVA films incorporating varying concentrations of carnauba wax (0%, 0.5%, 1%, 2%, and 5%) using the solvent casting method. The FTIR result indicates a structural change in the composite films after the incorporation of CW, suggesting a possible interaction between the CW emulsion and PVA. The microstructure analysis using scanning electron microscopy revealed continuous and rough surfaces of the films, indicating good incorporation of CW into the polymer matrix. The addition of CW to PVA films significantly improved their hydrophobicity, with improvements in the functional properties of PVA films recorded. The water solubility of the composite films reduced from 52.83% for the control to 24.28% with 5% CW, and the contact angle increased from 60.61% to 106.32% with 0% and 5% wax, respectively. However, the films with varying concentrations of wax showed a high level of cracking, leading to poor mechanical properties. Overall, our findings suggest the potential use of PVA/CW films as food packaging materials that could reduce the availability of unsafe and environmentally unfriendly food packages.

## Orphan Receptor GPRC5B in Airways

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PHARMACEUTICAL SCIENCES

**ADVISOR:** Sathish Venkatachalem, Ph.D.

Background: Asthma is characterized by chronic inflammation of the airways and airway hyperresponsiveness. Almost 30% of the drugs currently prescribed target G-protein coupled receptors (GPCRs). Yet, there are several orphan GPCRs with their endogenous ligands and/or functions not identified so far. Class C G-Protein coupled receptor Type 5 Member B "GPRC5B" is an orphan GPCR. Earlier studies report GPRC5B expression and function in various cell types and in several diseases. Airway smooth muscle (ASM) plays a crucial role in asthma pathophysiology. There are several ongoing studies to identify new drug targets to address the impaired intracellular calcium ([Ca2+]i) in ASM. We previously reported increased expression of GPRC5B in asthmatic ASM. However, the expression of GPRC5B and effect of GPRC5B on [Ca2+]i during inflammation is not known. Our objective for this study is to investigate the role of GPRC5B in regulating [Ca2+]i during inflammation in ASM and uncover the underlying mechanisms. We also intend to deorphanize GPRC5B by identifying possible ligands. Methods: Non-asthmatic primary human ASM cells were transfected with GPRC5B siRNA prior to treatment with pro-inflammatory cytokines (TNFα (20ng/ml), IL-13 (50ng/ml), IL-6 (20ng/ml)). Fura 2-AM loaded ASM cells were stimulated with various contractile agonists – Histamine (10 μM), Acetylcholine (1 μM) and Bradykinin (1 nM) and [Ca2+]i responses were recorded. Results: Exposure to pro-inflammatory cytokines upregulated GPRC5B expression. Fura 2-loaded ASM cells showed increased [Ca2+]i responses to the contractile agonists in the presence of cytokines, while the [Ca2+]i responses were blunted in GPRC5B knockdown ASM cells in the presence of cytokines. GPRC5B PRESTO-TANGO plasmid was transfected to human ASM cells to identify possible ligands that can bind to GPRC5B. Conclusion: Our findings suggest the plausible role of GPRC5B in regulating ASM [Ca2+]i and thereby airway contractility during inflammation. Thus, GPRC5B could be considered as a novel therapeutic target for asthma management.

## Assessing the Carbon Footprint of Plastic – Packaged Fruits

**HIMANI YADAV**
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

**ADVISOR:** Syeed Iskander, Ph.D.

Plastics are indispensable across various sectors, prominently in the fruit packaging industry. While plastic packaging for fresh produce ensures hygiene and extends shelf life, the associated convenience comes at a significant cost to both humanity and the environment. We investigate the carbon footprint implications of purchasing plastic-packaged fruits compared to alternative options. We assess 18 varieties of popular fruits consumed in America. Through the analysis of plastic packaging using a Total Organic Carbon (TOC) analyzer, the carbon dioxide equivalent of each packaging component is determined. Our findings reveal that purchasing smaller packaging of fruits (by weight) exponentially increases the carbon footprint. Consumers opting for open-stock fruits over plastic-packed alternatives have been making the most sustainable choice, reducing the carbon footprint by 94%. Conversely, selecting fruits in a box instead of a bag escalates the carbon footprint by 78%. Furthermore, choosing concentrated juice in a bottle over raw fruit elevates the carbon footprint by approximately 91%. Additionally, the polymers constituting the plastic packaging are analyzed using Fourier Transform Infrared (FTIR) spectroscopy in the attenuated total reflection (ATR) mode, revealing a mixture of polymers dominated by Polyethylene (PE), Polyethylene terephthalate (PET), Polypropylene (PP), Polystyrene (PS), Acrylonitrile Butadiene Styrene (ABS), Polyamide 6 (PA6), and Polyvinyl chloride (PVC). Our study shows that polymeric material of plastic packaging drastically impacts the carbon footprint. PE bags exerted 80% less carbon footprint compared to the bags made of PET. Moreover, additional components such as wrappers, bases, top labels, seal tags, top bindings, threads, or bottom labels increase the carbon footprint of the primary packaging component (box, bottle, or bag) by an average of 3%. These results underscore the urgency for manufacturers to reconsider their plastic packaging designs. In addition, emphasizes the pivotal role of consumer behavior in mitigating the environmental impact of plastic packaging.

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