north dakota state university

welcome

MESSAGE FROM RCA

Welcome to NDSU Student Research Day 2023!

Today is an exciting day as you will have the opportunity to discover fresh new ideas from our undergraduate and graduate students who are involved in research and creative endeavors at NDSU.

As an R1 institution, we strive to maintain a balanced portfolio of research activities and confer graduate degrees across a wide array of both STEM and non-STEM disciplines as both factors weigh into our success on the prestigious list. The participants of Student Research Day reflect this and they have been conducting work across a broad spectrum of disciplines.

At NDSU, our current research focus and strategic investments are in food, energy, and water security; cybersecurity, life sciences, entrepreneurship and innovation, and materials. The impact of research in these areas is important to the continued success of both our state and the nation and you will find examples of all these and more in the work of the students at Student Research Day. We also have created research commercialization activities to help our students get their ideas quickly to important audiences such as investors and business partners.

Our student researchers have already started a journey along the path of discovery. While it has only begun, none of us knows exactly how far their work will carry them. But we do know it will be a journey beyond anything that they may imagine, and we will all be better because of it. Thanks to each of them for sharing their work and to everyone attending Student Research Day 2023 and for your commitment to the success of the student presenters.

Colleen M. Fitzgerald, PhD

Vice President, Office of Research and Creative Activity

MESSAGE FROM GAMMA SIGMA DELTA

On behalf of Gamma Sigma Delta, the Honor Society of Agriculture, I am delighted to welcome you to our research symposium. Research has driven tremendous progress in agriculture, with outcomes ranging from increased food production to greater resource stewardship. Our Gamma Sigma Delta presenters represent a variety of disciplines, but have in common a love of learning and a commitment to excellence in agriculture. Thank you for joining us today.

Rebekah Oliver, PhD

Associate Professor of Practice, Plant Sciences | President, Gamma Sigma Delta

MESSAGE FROM GRADUATE STUDENT COUNCIL

Hello and welcome to Student Research Day 2023! The Graduate Student Council (GSC) is thrilled to be collaborating with NDSU EXPLORE and Gamma Sigma Delta: The Honor Society of Agriculture. This year, we received a record number of registrations for both oral and poster presentations, surpassing all previous years. Although we regret that we could not accommodate all participants due to limited space and time. We believe that all graduate students have excellent ideas that can contribute greatly to science, technology, and other fields. We are proud to provide graduate students with a platform to showcase their exceptional research work.

We are grateful for the tremendous support we received from our partner organizations, which reflects the dedication and hard work of our graduate students for Research Day 2023. The GSC would like to express our appreciation to the Departments of Biological Sciences, Mechanical Engineering, and Environmental and Conservation Science for their generous donations, which helped with the financial aspect of the event. We also extend our gratitude to the GSC executives, co-chairs, and volunteers who contributed to the success of the event. Lastly, we thank the Graduate School for their yearly support and funding that enable us to participate in such initiatives.

We sincerely hope that NDSU Student Research Day will become a benchmark for NDSU and continue to take place in the future. Furthermore, we believe this event will open up new opportunities for research funding and collaboration, contributing to the growth of science and technology.

Thank you.

Koushik Chandra Howlader

President, Graduate Student Council

participants

NDSU EXPLORE SHOWCASE OF UNDERGRADUATE RESEARCH AND CREATIVE ACTIVITY

ORAL PRESENTATIONS:

Floyd Althoff, Music
Ryan Anderson, Civil and Environmental Engineering
Shane Corbett, Psychology
Kira Eliason, Environmental Engineering
Ashley Goetzfried, Environmental Engineering

POSTER PRESENTATIONS:

Rivers Bachman, Agricultural Education
Frederick Bannier, Chemistry
Eugene Barnes, Earth, Environmental, and Geospatial Sciences
Kaleb Barnes, Pharmaceutical Sciences
Adam Bendewald, Biochemistry and Molecular Biology
Rachel Blawat, Civil Engineering
Cori Bonik, Pharmacy
Ashley Boyer, Anthropology
Elyssa Bredeson, Pharmacy
Catherine Bunker, Geology
Cecelia Carnivale, Biological Sciences
Madison Christenson, Microbiology
Alexandra Donnelly, Microbiology
Grace Farmer, Earth, Environmental, and Geospatial Sciences
Samuel Fernholz, Pharmacy
Austin Fitterer, Music
Kennedy Foss, Hospitality and Event Management
Sean Fuchs, Pharmacy
Angel Gallegos, Coatings and Polymeric Materials
Emily Giere, Chemistry and Biochemistry
Ava Gyolai, Chemistry
Kell Helmuth, Microbiology
Makenna Hesch, Pharmacy
Abigail Hoffarth, Microbiology
Emma Honeyman, Agricultural Economics
Garrett Honzay, Biochemistry and Molecular Biology
Sofia Howe, Biological Sciences
Colter Huseby, Civil, Construction, and Environmental Engineering
Frank Jirik, Biological Sciences
Melody Johnson, Chemistry
Drew Jordahl, Biochemistry and Molecular Biology
Isabella Jurgens, Animal Science
Albert Kargel, Microbiology
Savanah Klegon, Biochemistry and Molecular Biology
Brooke Kohler, Biological Sciences
Isaac Krug, Agribusiness and Applied Economics
Kyla Larson, Anthropology
Sahil Lohana, Pharmaceutical Sciences
Jared Maul, Computer Science
Zoe Muccatira, Earth, Environmental, and Geospatial Sciences
Sarah Nash, Biological Sciences
Joseph Olsen, Biotechnology
Claire Olson, Civil Engineering
Koby Pearson-Bortle, Biological Sciences
Shae Pfenning, Anthropology
Grace Rebel, Anthropology
Sigurd Saude, Physics
Annie Schiro, Chemistry and Biochemistry
Benjamin Schirrick, Geology
Megan Schlangen, Sociology and Anthropology
Madeline Stroud, Pharmaceutical Sciences
Gavin Swinehart, Mechanical Engineering
Curtis Thompson, Chemistry and Biochemistry
Grace Tiffany, Chemistry and Biochemistry
Audrey Tracy, Computer Science
Andrew Toelle, Pharmaceutical Sciences
Wyatt Warkenthien, Biotechnology
Alexander Waugh, Geology
Maggie Wertish, Education
Danielle Wright, Microbiology

RESEARCH SYMPOSIUM OF GAMMA SIGMA DELTA: THE HONOR SOCIETY OF AGRICULTURE

UNDERGRADUATE STUDENT ORAL PRESENTATIONS:

Katlyn Balstad, Crop and Weed Sciences
Carly George, Biotechnology/Crop and Weed Sciences
Savannah Rivers, Equine Science/Animal Science - Biomedical

GRADUATE STUDENT ORAL PRESENTATIONS:

Md Zahangir Alam, Plant Sciences
Bethania Davila, Animal Science
Grady Gullickson, Animal Science
Astina Joice, Agricultural and Biosystems Engineering
Shivreet Kaur, Plant Pathology
Cerly Rini Yeruva, Plant Sciences

UNDERGRADUATE STUDENT POSTER PRESENTATIONS:

Ashton Esco, Biotechnology
Mia Haugan, Microbiology and Biotechnology
Mercedes Morin, Biotechnology
Natalie Visich, Microbiology and Biotechnology

GRADUATE STUDENT POSTER PRESENTATIONS:

Gagandeep Brar, Biological Sciences
Pritika Devkota, Cereal Science
Vimukthi Molligoda, Cereal Science
Amanda Pease, Microbiological Sciences
TM Shaikh, Plant Sciences

RESEARCH SYMPOSIUM OF THE GRADUATE STUDENT COUNCIL

ORAL PRESENTATIONS:

Mahesh Aryal, Physics
Jose Bais, Plant Sciences
Lennel Camuy-Velez, Microbiology
Sifat Karim Chowdhury, Mechanical Engineering
Justin Clarke, Natural Resources Management
Amirreza Daghighi, Biomedical Engineering
Anup Kumar Das, Agricultural and Biosystems Engineering
Razia Dawlaty, Microbiology
Basanta Dhungana, Genomics, Phenomics, and Bioinformatics
Israt Sharmin Dola, Mechanical Engineering
Jenna Duttenhefner, Cellular and Molecular Biology
Omolola Eniodunmo, Chemistry
Jose Figueroa-Cerna, Plant Sciences
Sunil G C, Agricultural and Biosystems Engineering
Kun Gao, Plant Sciences
Shivani Gautam, Computer Science
Bijaya Ghimire, Plant Sciences
Dyllan Goldstein, Emergency Management
Aditya Goyal, Materials and Nanotechnology
Krystal Grieger, Chemistry
Md Faruk Hossain, Physics
Mohammad Jony, Plant Sciences
Heymant Kaur, Cereal Science
Harkamal Kaur, Plant Pathology
MD Tanbir Khan, Civil Engineering - Environmental
Maryam Khan, Microbiology
Esben Kjaer, Range Science
Ashish Kumar, Pharmaceutical Sciences
Gabriela Magossi, Microbiology
Amanda Malik, Cereal Science
Fazal Manan, Plant Pathology
Maria Mazala, Plant Sciences
Ariana McDarby, Chemistry
Haley Mosqueda, Environmental and Conservation Science
Md Ashif Islam Oni, Electrical and Computer Engineering
Sakshi Paudel, Microbiology
Alireza Poursafar, Plant Pathology
Beena Pun, Microbiology
Md Mirazur Rahman, Electrical and Computer Engineering
Mohammad Irshad Reza, Pharmaceutical Sciences
Shahed Safar, Plant Pathology
Biraj Saha, Civil Engineering - Environmental
Philip Salu, Cellular and Molecular Biology
Bhuwan Shah, Agricultural and Biosystems Engineering
Jatinder Singh, Plant Pathology
Jacob Tesch, Cellular and Molecular Biology
Arjun Upadhyay, Agricultural and Biosystems Engineering
Miranda Vanderhyde, Microbiology
Sai Sri Sravya Vishnumolakala, Agricultural and Biosystems Engineering
Himani Yadav, Civil Engineering - Environmental
Kimia Tuz Zaman, Computer Science

POSTER PRESENTATIONS:

Namrata Acharya, Plant Sciences
Rhoda Olaide Adewunmi, Public Health
Shraddha Adhikari, Public Health
Fatema Akter Nisha, Microbiology
Yousuf Alam, Pharmaceutical Sciences
Mark Rigel Ali, Coatings and Polymeric Materials
Melika Ansarinejad, Civil Engineering - Transportation
Bibek Aryal, Mechanical Engineering
Lemlem Asaye, Construction Management
Labiba Noshin Asha, Industrial and Manufacturing Engineering
Valentina Asiedu, Public Health
Aliasghar Bazrafkan, Agricultural and Biosystems Engineering
Hardik Chauhan, Construction Management
Debarshi Dasgupta, Microbiology
Heather Davis, Environmental and Conservation Science
Jessica DeCuyper, Microbiology
Bohdan Domnich, Coatings and Polymeric Materials
Madison Floden, Biological Sciences
Emily Galbraith, Sociology
Shrinwanti Ghosh, Biological Sciences
Savannah Gibson, Pharmaceutical Sciences
Paras Giri, Pharmaceutical Sciences
Mankanwal Goraya, Plant Pathology
David Graupner, Chemistry
Tania Gupta, Microbiology
Emily Hackerson, Biological Sciences
Md Mehedi Hafiz, Plant Sciences
Md Zahidul Hasan, Pharmaceutical Sciences
Moein Younesi Heravi, Construction Management
Demetrios Hospidales, Athletic Training
Muhammad Shahid Iqbal, Environmental and Conservation Science
Md Zahirul Islam, Mechanical Engineering
Kamrun Keya, Civil Engineering - Structural
Yangchao Liao, Civil Engineering - Structural
Tucker Lutter, Natural Resources Management
Rehnuma Maisha, Agricultural and Biosystems Engineering
Siavash Mansouri, Coatings and Polymeric Materials
Raman Mohanpuria, Entomology
Guilherme Montenegro, Music
Muhammad Ali Moriyani, Civil, Construction, and Environmental Engineering
Anupom Deb Nath, Pharmaceutical Sciences
Madeliene Nichols, Animal Sciences
Kyle Nietfeld, Mechanical Engineering
Heather North, Biological Sciences
Caroline Osborne, Genomics, Phenomics, and Bioinformatics
Ali Pakbaz, Mechanical Engineering
Jacob Pithan, Biological Sciences
Komila Rasuleva, Electrical and Computer Engineering
Mahek Sadiq, Biomedical Engineering
Gayathri Senanayake, Microbiology
Alan Snavely, Microbiology
Szeemaine Tigno, Coatings and Polymeric Materials
Andres Torres, Plant Sciences
Talha Tufaique, Agricultural and Biosystems Engineering
Bryce Van Vleet, Developmental Science
Emily Vieweg, Social and Behavioral Sciences
Xinyi Yang, Civil Engineering - Transportation

abstracts

NDSU EXPLORE
SHOWCASE OF UNDERGRADUATE RESEARCH AND CREATIVE ACTIVITY

Influences of Immigration in Cass County, North Dakota at the Turn of the 20th Century

FLOYD ALTHOFF
MUSIC

MENTOR: Kristen Fellows, PhD – Sociology and Anthropology

As a county where nearly one in every twelve residents was born in a foreign country, Cass County and North Dakota owe a significant amount of their history, legislation and political landscape, and agriculture foundation to immigrant residents. This presentation examines the contributions of immigrants in Cass County in the late 19th and early 20th century at a vital point in the early history of North Dakota as a state using historical and anthropological methodologies through census records, oral histories, and archival materials that detail the lives of Cass County immigrants (from Bohemia, Germany, Norway, Ireland, and such). By fostering a better understanding of the contributions of foreign-born residents at a pivotal time in North Dakota's formation, this presentation hopes to shine a light on the importance of immigration in present-day Cass County.

Quantification of Nanoplastics in Landfill Leachate Using Pyrolysis Gas Chromatography and Mass Spectrometry (py-GC-MS)

RYAN ANDERSON
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

MENTOR: Syeed Md Iskander, PhD – Civil, Construction and Environmental Engineering

Plastics pollution is a major problem facing humanity. Global annual production of plastics is predicted to reach 12 billion metric tons by 2050, and approximately 21 - 42% of generated plastic is stored in landfills. These landfilled plastics are broken down through biochemical reactions, having detrimental environmental and human health impacts. Plastic particles smaller than 100 nm are classified as nanoplastics, which end up in landfill leachate and proliferate in the environment. Given the small size of nanoplastics and complex leachate matrix, identification and quantification of nanoplastics in leachate is really difficult. The widely used Fourier Transform Infrared Spectroscopy cannot be applied for identification of a mixture of different polymers in nanoscale. Thus, we have developed a technique using pyrolysis along with gas chromatography and mass spectrometry to quantify different polymer concentrations in landfill leachate in nanoscale. The process requires significant pretreatment steps before pyrolysis as leachate is high in organics. We applied advanced oxidation with different doses of oxidant to remove the organics from leachate followed by multiple concentration steps. We developed a wide array of pretreatment techniques to understand the impact on identification and quantification of leachate nanoplastics in py-GC-MS. We have developed a protocol for leachate nanoplastics quantification that can be applied to other wastewaters. Our effort will help the ongoing fight against plastics pollution by better understanding the nanoplastics presence in the environment.

Attitudes of North Dakota Career and Technical Education Teachers Toward Working with Students with Disabilities

RIVERS BACHMAN
AGRICULTURAL EDUCATION

MENTOR: Brook Thiel, PhD – School of Education

Including all students in regular teaching environments is a legal requirement for schools. Teachers are typically trained to make accommodations for students with disabilities. However, teaching Career and Technical Education (CTE) is different from other content areas. The purpose of this study was to assess teachers' confidence in their ability to teach special education students in their career and technical education courses. Utilizing a survey design, North Dakota CTE instructors were asked to share their perceptions of working with students with special needs, as well as their confidence in making accommodations for those students. We expect to see variation in results based upon experience, content area, and training. The hope is to use the findings of this study to develop professional development for current CTE teachers and training for future CTE teachers at NDSU.

Synthesis of 2,6-diiododithieno[3,2-*b:2',3'-d*]thiophene as a potential halogen-bond donor for crystal engineering applications

FREDERICK BANNIER
CHEMISTRY

MENTOR: Seth Rasmussen, PhD – Chemistry and Biochemistry

Thiophene-based compounds have provided facile precursors to a wide variety of conjugated materials with desirable electronic and optical properties. Such materials have shown use in applications such as solar cells due to their ability to absorb visible light and their favorable charge transport properties. In addition to their utility in the synthesis of conjugated materials, halogen functionalized monomers can participate in halogen bonding to lead to various solid-state structures via crystal engineering. Literature describing the halogen bonding of halothiophenes is sparse, but recent research has reported several cocrystals exhibiting promising electrostatic potential and sheet/ribbon like structures with 2,5-diiodothiophene as a halogen bond donor. To extend these efforts and investigate the effect of larger, fused-ring systems, the potential application of 2,6-diiododithieno[3,2-*b:2',3'-d*]thiophene (DTT-2I) to crystal engineering is now being investigated. Like 2,5-diiodothiophene, DTT-2I should exhibit strong halogen bonding and chalcogen bonding properties. Precursors 3,3'-Dibromo-2,2'-bithiophene and benzenesulfonyl sulfide have been synthesized and should allow the efficient production of dithieno[3,2-*b:2',3'-d*]thiophene (DTT). Lastly, DTT can then be easily iodinated with N-iodosuccinimide to yield DTT-2I, after which its cocrystallization with a variety of nitrogen-based species will be investigated. The overall purpose of these synthetic efforts is to develop a straightforward procedure for the synthesis of DTT-2I and its necessary precursors, with optimized yield, from affordable materials.

Introducing the Fertile Due Field, Minnesota, USA: Dune Types, Wind Directions and Sand Characteristics at Agassiz Environmental Learning Center

EUGENE BARNES
EARTH, ENVIRONMENTAL, AND GEOSPATIAL SCIENCES

GRACE FARMER
EARTH, ENVIRONMENTAL, AND GEOSPATIAL SCIENCES

MENTORS: Kenneth Lepper, PhD – Earth, Environmental, and Geospatial Sciences

CONTRIBUTORS: Benjamin Schirrick and Alexander Waugh

The Fertile Dune Field is located on the Eastern shores of Glacial Lake Agassiz near the town of Fertile, Minnesota. The dune field formed after the Sand Hill Delta, which it overlies, was exposed to wind mobilization following a significant retreat of Glacial Lake Agassiz from the Herman shoreline. The goal of this project was to begin study of the eolian history of the dune field within the boundaries of the Agassiz Environmental Learning Center. This presentation deals with the dune types and sizes, the wind directions(s) represented in the dune field, grain size distribution of selected sample sites and sand grain surface morphology. The project utilized GIS for spatial analysis, field work including sample collection for lab analysis and SEM grain imaging. Dunes were categorized as barchan or parabolic and by size. The large barchans had a strong north to south orientation while the small parabolic dunes were dominantly south to north orientation. Sampling pits were excavated in three dunes, with one on the nose and arm at each location. Paleosols were found in three of the five excavations indicating a minimum of two eolian activation episodes. Detectable changes in grain size distribution were noted between layers separated by a paleosol. Predominant grain size was upper fine sand in higher layers and lower medium sand in lower layers. SEM imaging showed that the sand grains exhibited varying degrees of sphericity, roundness, sorting, and eolian weathering textures among samples. These observations are consistent with short distance eolian transport.

Impact of Estrogen receptor (ER) alpha on the accumulation of lipid droplets in cardiomyocytes

KALEB BARNES
PHARMACEUTICAL SCIENCES

MENTOR: Natasha Fillmore, PhD – Pharmaceutical Sciences

CONTRIBUTORS: Savannah Gibson and Sofia Howe

Even with major improvements in modern research and medicine, cardiovascular diseases (CVD) remain the number one cause of death in the world. Risk factors for obtaining CVD include obesity, hypertension, diabetes mellitus, and high levels of LDL cholesterol. If ER alpha is regulated correctly it can lead to improvements in right ventricular pressure and a decrease in vascular remodeling. However, if it is under expressed it can have negative effects on cardiac function. In this research we are studying ER alpha's role on accumulation of lipid droplets, which help store lipids in the heart. We also measured perilipins, key proteins that affect lipid droplet size and quantity. We expect to see evidence that ER alpha decreases the accumulation of lipids in the heart. With this research and future studies there is hope to better understand lipid droplets role in cardiomyocytes and cardiovascular diseases.

The structural basis of Coproheme III Acid - Base Behavior and Its Role in Heme *b* Biosynthesis

ADAM BENDEWALD
CHEMISTRY AND MOLECULAR BIOLOGY

MENTORS: Kenton Rodgers, PhD – Chemistry and Biochemistry and Gudrun Lukat-Rodgers, PhD – Chemistry and Biochemistry

CONTRIBUTOR: Olivia Stiller

Coproheme III is both a substrate and a product of the coproporphyrin-dependent and siroheme-dependent heme *b* biosynthesis pathways in Gram positive bacteria. Insertion of Fe^{2+} into coproporphyrin III to yield coproheme III is catalyzed by a ferrochelatase, CpfC, in *Staphylococcus aureus*. Coproheme III is then transferred to coproheme III decarboxylase, ChdC, which catalyzes H_2O_2-dependent oxidative decarboxylation of two propionate substituents to give vinyl groups. To better understand the factors involved in these two enzymatic reactions, the acid - base properties of coproheme III have been examined. This work has revealed that aqueous coproheme III exists as an equilibrium mixture of monomers and dimers. Three pK_as have been experimentally determined for both monomeric and dimeric coproheme III. However, the deprotonation sites for the three pK_as remain unidentified. It is also unknown whether the monomeric and the dimeric pK_as correspond to deprotonation of the same acid groups. This project utilized resonance Raman spectroscopy of coproheme III samples buffered at different pHs to observe changes in the molecular vibrations of coproheme III. The aim of investigating the pH dependence of coproheme III resonance Raman spectra is to gain insight into the structural basis of its acid - base behavior.

Knockout of PKM2 in Cardiac Myofibroblasts Preserves Cardiac Ejection Fraction without Preventing Cardiac Fibrosis in Angiotensin-II Induced Cardiac Remodeling

RACHEL BLAWAT
CIVIL ENGINEERING

MENTOR: Ang Guo, PhD – Pharmaceutical Sciences

Heart failure (HF) is associated with cardiac remodeling, which results from cardiomyocyte hypertrophy and fibrosis induced by the activation of cardiac fibroblasts. This structural remodeling is accompanied by metabolic reprogramming that resembles the cancer-like Warburg effect in glucose metabolism. Pyruvate Kinase M2 (PKM2), a known hallmark of the Warburg phenomenon in cancer, is also dramatically elevated in failing hearts. Both cardiomyocytes and cardiac fibroblasts express PKM2, while cardiac myofibroblasts (myfbs), derived from cardiac fibroblasts, play a crucial role in cardiac fibrosis. The impact of PKM2 on the pathological contribution of cardiac myfbs to cardiac remodeling remains unclear. In this study, we utilized a genetically engineered mouse model to achieve myofibroblast-specific PKM2 knockout. We discovered that myofibroblast-specific PKM2 knockout preserved cardiac contractile function in angiotensin-II induced cardiac remodeling. Interestingly, cardiac fibrosis was not reduced, suggesting that PKM2 may not be essential for myfbs proliferation and differentiation. We hypothesize that PKM2 knockout in cardiac myfbs may reduce detrimental inflammatory responses to cardiac function. This hypothesis will be tested in future studies.

In silico studies to identify new metal complexes with the potential antibacterial activity against TonB dependent mechanism

CORI BONIK
PHARMACY

MENTOR: Roberto Gomes, PhD – Pharmaceutical Sciences

Pseudomonas aeruginosa is a gram-negative bacteria and opportunistic human pathogen that often shows to be a challenge to treat because of its antibiotic resistance. This bacteria is iron-dependent for survival and virulence, so as a defense mechanism, our human immune system uses transferrin to arrest it during infection. However, the bacteria use iron chelators called siderophores to compete with transferrin and bring the iron into the cell via TonB dependent transporters in the bacteria's outer membrane. This project's goal is to target the TonB dependent transport mechanism using metal analogs that bind to the transporter and block entry of iron into the cell. The crystal structure of the transporter of *Pseudomonas aeruginosa*, FpvA, its reference ligand, and 56 new metal complexes were used to perform in silico studies. The same molecular docking was also done for *Escherichia coli's* TonB dependent transporter, FepA. Results showed that metal complexes containing Ni, Cu, Fe and rare earth metals such as La, Dy and Eu complexes had the greatest affinity to the transport protein and would be likely to show *in vitro* antimicrobial results. Interestingly, these rare earth metals with the same substitutions (4-aminoantipyrine) were the best results for both bacterial species. In conclusion, the identified hits are the most promising for performing *in vitro* studies.

How Newspapers Discussed Legal Executions in North Dakota (1899-1905)

ASHLEY BOYER
ANTHROPOLOGY

MENTOR: Kristen Fellows, PhD – Sociology and Anthropology

This research looks at three different historical executions in the state of North Dakota from the years 1899 to 1905 and how executions are discussed in newspapers over that time-period. Newspapers published on the day of the execution and up to a week afterwards serve as the primary source material. The newspapers are examined for the language used discussing the person being executed, public reaction, and other themes. Focusing on the general time-period of when executions were performed in North Dakota, the executions of James W. Cole, Ira O. Jenkins, and John Rooney provided case studies. Analysis found that over the course of the study period, an ideological shift in how executions were discussed in newspapers occurred. Starting with a positive view of executions, discussion shifted to a more skeptical take on this form of punishment. Moreover, general patterns in how executions were approached in this era compared to more recent practices are revealing. For instance, it was common to name the executioner in newspaper articles, whereas this practice would be verboten by today's standards. Commonalities across articles in conjunction with differences between cases demonstrate how the print media helped to shape the larger narrative of a given guilty party.

MILK-PHED: Part 2 - Increasing Pharmacist Confidence in Managing Breastfeeding Patients

ELYSSA BREDESON
PHARMACY

MAKENNA HESCH
PHARMACY

MENTOR: Julia Muzzy Williamson, PhD, PharmD, BCPPS, BCNSP, C-ELBW – Pharmacy Practice

While major health organizations recognize breastfeeding as the optimal source of nutrition for most infants, current research suggests knowledge barriers are preventing pharmacists from providing optimal medication management to breastfeeding patients. To increase pharmacist confidence in managing medications in breastfeeding patients, a pre-assessment followed by a 5-hour continuing education was distributed to licensed North Dakota pharmacists as well as participants of MILK-PHED: Part 1. After each hour of continuing education, participants were assessed with a post-quiz, containing the pre-assessment questions, to track learning. The preliminary results of the survey show more confidence and correctness following completion of the 5-hour continuing education as opposed to the pre-assessment responses given before the continuing education. This trend is anticipated to continue throughout the study, which affirms that additional education and training is required to help pharmacists support safe medication practices for breastfeeding patients.

Distribution and Diversity of Foraminifera in the Upper Triassic of New Zealand

CATHERINE BUNKER
GEOLOGY

MENTOR: Lydia Tackett, PhD – Earth, Environmental, and Geospatial Sciences

Foraminifera are important microfossils for interpreting environmental conditions in Earth's past. The present research aims to expand the known geographic and temporal ranges of foraminifera from Upper Triassic (220-208 million years ago [Ma]) sediments from New Zealand. Twenty-six microfossil samples were collected, representing a span of about 20 million years. Of the 26 samples, only 14 samples contained foraminifera microfossils, which shows moderate 58% distribution among samples. The most common taxon, Nodosaria, represented 74% of observed specimens, occurring throughout the Upper Triassic samples. The least common taxon, Eoguttulina, represents about 1% of the total diversity, observed in only one sample. This investigation aims to provide new information about the diversity, geographic range, and temporal ranges of foraminifera by adding new occurrences from New Zealand.

Immune Response to Various Light Treatments in the Leopard Gecko

CECELIA CARNIVALE
BIOLOGICAL SCIENCES

MENTOR: Matthew Smith, PhD – Biological Sciences

Ultraviolet B radiation (UVB) is required for the photobiochemical synthesis of vitamin D3 in leopard geckos (*Eublepharis macularius*). Vitamin D is necessary for proper calcium absorption and regulation in the body. A lack of usable calcium advances to a wide array of nutritional diseases. Findings have suggested that leopard geckos benefit from short term UVB light treatments, but the extent of this benefit is insufficient to fully understand how varying exposure time affects the immune functions of the leopard gecko. The purpose of this study is to better understand the physiological effects of two crepuscular light treatments, and to optimize daily duration of UVB. Twenty-one male and female leopard geckos were divided into three random groups and assigned a 2-hour UVB, 4-hour UVB, or 4-hour LED treatment group. They are under observation for 75 days, while their weights, shedding, and activity patterns are being monitored. Because of the crepuscular nature of the leopard gecko, their activity patterns are also being considered. After 75 days, blood samples will be drawn from each gecko and treated with e coli to test the immune response from each treatment. The findings of this study will potentially aid in our understanding of the optimal care procedure for domestic leopard geckos.

The Effectiveness of Chlorine Dioxide as a Sporicidal Agent against *Paenibacillus larvae*

MADISON CHRISTENSON
MICROBIOLOGY

ALEXANDRA DONNELLY
MICROBIOLOGY

DANIELLE WRIGHT
MICROBIOLOGY

MENTOR: Birgit Pruess, PhD – Microbiological Sciences

Paenibacillus larvae is a bacterium that infects honeybee larvae and causes American Foulbrood (AFB), a fatal bee disease. Spores remain dormant for years and are spread to hives by both bees and beekeepers. AFB is only eliminated by burning equipment and killing the infected colonies, making the disease quite detrimental. Chlorine dioxide gas (ClO_2), a sterilizing agent, is being tested for its effectiveness at killing *P. larvae* spores on hive frames. A virulent *P. larvae* strain, ATCC 9545, was incubated for five days to produce spores to be purified in a gradient column. Hive frames were sterilized with 20mg/L of ClO_2 gas. *P. larvae* spores at $1.04*10^4$ CFU/ml were spot inoculated onto the frame. Two types of swabs were compared for the best spore recovery method. Percentage recovery was calculated by plating serial dilutions onto agar plates and counting colonies per dilution. Two spore inoculums of $1.76*10^4$ and $8*10^3$ CFU/mL were planted onto sterile frames. Afterwards, the frames were treated with 10 mg/L of ClO_2. FLOQswabs recovered the spores, followed by numeration of plated spores. Recovery of inoculated spores using FLOQswabs was 54%, which was higher than the cotton swabs recovery rate. After the frame was treated with the chlorine dioxide gas, there was no spore presence above the 10 CFU/mL minimum level of detection. These results suggest ClO_2 has sporicidal properties on *P. larvae* in a contained environment. Experimentation with other equipment for inoculations and fluctuation of the gas concentration will give more insight of this AFB prevention method.

Geographic and General Trends in Sleep Manipulation Research: A Bibliometric Analysis

SHANE CORBETT
PSYCHOLOGY

MENTOR: Leah A. Irish, PhD – Psychology

Geographic inequities in scientific research are well established, with certain geographic regions (e.g., the U.S., Western Europe) often overrepresented in publications and citations. This is a significant concern for our global evidence base because it fails to represent meaningful differences in sociocultural and physical factors across populations, instead assuming a one-size-fits-all approach based on Western populations and values. Although sleep is universally important to health and functioning and sleep manipulation (sleep deprivation, restriction, or extension) research is used to inform the development of treatment and health promotion efforts, the geographic distribution of sleep research is relatively unexplored. Thus, in the present bibliometric analysis, we aimed to quantify geographic trends in the production and impact of sleep manipulation research. Scientific documents related to sleep manipulation were compiled through a Web of Science search. A total of 11,456 empirical and review articles were analyzed and visualized using Excel, Biblioshiny, and VOSviewer. Results indicated a severe inequity in the geographic distribution of sleep manipulation research. Northern America and Europe produced about 70% of the research on the topic. The best-represented region was Northern America, with one publication for every 92 people. Africa, the worst represented, has one publication for every 15,303 people. Additionally, publications from Northern America and Europe had more average citations. These findings suggest a need for greater equity in scientific representation, which might be facilitated in part through more international collaborations. This review also highlights the need to acknowledge the inherent bias in our conclusions regarding sleep manipulation research.

Rare Earth Elements (REEs) in Sands Collected from Southern California Sea Beaches

KIRA ELIASON
ENVIRONMENTAL ENGINEERING

MENTOR: Syeed Iskander, PhD – 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.

Angiotensin-converting enzyme (ACE) expression in renal cancer is decreased with the inhibition of integrin α2β1

SAMUEL FERNHOLZ
PHARMACY

MENTOR: Sijo Mathew, PhD – Pharmaceutical Sciences

Background: The tumor microenvironment requires extracellular matrix proteins, one of the most important is collagen1. This protein can be found in kidney cancer. It has been shown that collagen1 expression upregulates many cells signaling pathways. The upregulation of these pathways promotes cancer proliferation, invasion, and growth. Collagen1 binding and signaling are regulated by integrin α2β1. Within the kidney cortex, the renin-angiotensin system (RAS) is carried out. The RAS is known to regulate blood pressure as well. The major enzyme in the RAS is called the angiotensin-converting enzyme (ACE). This enzyme promotes the formation of new blood vessels (angiogenesis) and also proliferation through the angiotensin 1 receptor (AT1). It is currently unknown how increased collagen1 in ACE-mediated signaling pathways affects solid tumors in the TME. This study aims at finding the significance of collagen1 signaling with integrin α2β1 on the ACE-mediated mechanism that is partly responsible for tumor growth. We hypothesized that through the inhibition of α2β1 that tumor growth would be prevented, this is through decreasing ACE-mediated fibrosis promoting cell signaling in renal cancer.

Method: We tested our hypothesis using an integrin α2β1 inhibitor called BTT 3033 and a collagen1 signaling disrupter called talin-1 shRNA. These were used in cancerous kidney cells called Caki-1. Puromycin selection was used for talin-1 shRNA, and through this multiple clones were gathered (talin-1 knock-down). We used immunostaining for total and active integrin β1. AIIB2 and 12G10 antibodies were used in this process. Molecular changes were found using qRT-PCR and immunoblotting.

Results: Integrin α2β1 activation was significantly decreased with the BTT 3033 treatment. However, in these Caki-1 cells, the total expression of integrins was not altered. With this same BTT 3033 treatment a significant decrease in ACE expression was found. Talin-1 is one of the major activators of integrin α2β1, so we decided to downregulate it with shRNA. This downregulation caused a significant decrease in α2β1 activation and expression. This then in turn led to a 35% decrease in cell adhesion on collagen1, along with a significant decrease in focal adhesion. The α2β1 inhibition also led to a significant decrease in ACE expression, pro-proliferative signaling AKT phosphorylation, ERK ½ phosphorylation, and AT1 receptor expression when compared to the control. Our study found that integrin α2β1-ACE signaling is significant in cancer progression through the AT1 receptor.

Conclusion: This study shows and illustrates Integrin α2β1-mediated tumor progression in renal cancer.

Phonetics in Music: Implications for Instruction of Composition and Vocal Performance

AUSTIN FITTERER
MUSIC

MENTOR: Kyle Vanderburg, DMA – Challey School of Music

The use of the human voice in singing and songwriting has been fundamental to the history and progression of music through the ages. As musicians continue to perform masterpieces or create new works, phonetics in language becomes a crucial component in musical practice and composition. Performers, composers, and music educators would benefit from understanding how diction, perception, and basic language phonetics affect and improve musical practice or future musical writing. In this presentation, I will discuss recent trends and studies within language, music theory, and musicology that involve the role that phonetics plays within the context of performance and composition. Some of these examples include visual and auditory perceptions that shape musical writing, effect of prosody on rhythm and melody, and pedagogical methods for the vocal performer. These phonetic considerations may be useful in the instruction of music composition and vocal performance and could provide additional opportunities for research in language and musicology.

Unlocking the Potential of Virtual Reality Videos in Destination Marketing

KENNEDY FOSS
HOSPITALITY AND EVENT MANAGEMENT

MENTORS: Juwon Choi, PhD – Apparel, Merchandising, Design and Hospitality Management and Hyeongjin Jeon, PhD – Apparel, Merchandising, Design and Hospitality Management

This study delves into the effectiveness of virtual reality (VR) videos as a means of promoting travel destinations. VR videos have gained popularity as an immersive experience that motivates potential visitors to visit destinations and generates revenue. However, it is unclear which features of VR videos influence behavior. This study aimed to identify the components of VR videos that influence potential visitors' intention to visit a travel destination. The study recruited a sample of individuals aged at least 18 years old who had not previously visited the destination featured in the VR video. Participants watched a VR video of Italy and completed a survey evaluating their virtual tour experience, including information quality, video presence, perceived usefulness, and intention to visit. Results indicated that information quality, video presence, and perceived usefulness are primary factors that attract potential visitors to travel destinations. This study provides practical recommendations for destination marketers to prioritize quality information, a sense of presence, and perceived usefulness when creating immersive promotional videos for travel destinations using VR technology. These findings highlight the importance of using VR videos as a marketing tool and identify which features are most likely to impact individuals' travel decision making.

Tumor-targeted delivery of paclitaxel for the treatment of lung cancer

SEAN FUCHS
PHARMACY

MENTOR: Buddhadev Layek, PhD – Pharmaceutical Sciences

CONTRIBUTOR: Albert Kargel

Lung cancer is the leading cancer killer in both men and women, accounting for ~25% of all cancer deaths. Since a large proportion of patients (57%) are diagnosed with metastatic disease, the five-year relative survival rate is only 6%, resulting in a greater than 50% mortality rate within a year of diagnosis. The poor treatment outcomes of conventional chemotherapeutics are primarily associated with their inefficient distribution to the tumor tissue and the tumor's innate resistance to chemotherapy. Thus, there is a critical need for new approaches for tumor-selective delivery of chemotherapeutics that will enhance the therapeutic efficacy while minimizing chemotherapy-associated toxicities. The long-term goal of the proposed research is to advance cetuximab-conjugated nanocarriers as an efficient drug delivery platform for the tumor-targeted delivery of paclitaxel. Initially, we formulated paclitaxel-loaded PLGA nanoparticles via a single emulsion solvent evaporation method. The size and zeta potential of the nanoparticles was 270 nM and -17 mV, respectively, as determined by Zetasizer Nano ZS. The release profile revealed the sustained release of paclitaxel from PLGA nanoparticles over 2 weeks. Furthermore, the in vitro cytotoxicity on A549 human lung cancer cell lines exhibited the IC50 of nanoparticles and solution to be 5 nM and 7 nM, respectively, suggesting higher antitumor efficacy of nano-encapsulated paclitaxel as compared to the solution.

MaterialsBase: A Web-based Tool to Store, Analyze Chemical Data and Design of New Materials

ANGEL GALLEGOS
COATINGS AND POLYMERIC MATERIALS

MENTOR: Bakhtiyor Rasulev, PhD – Coatings and Polymeric Materials

CONTRIBUTORS: Stephen Szwiec and Gerardo Casanola-Martin

This study is devoted to the interdisciplinary scientific field that combines computational chemistry, machine learning, cheminformatics, materials informatics and computer science. The project is currently focused on the development of a materials database, called MaterialsBase. In the last few months, MaterialsBase has gone from consisting of only empty basic part to store chemical data (a back-end server and API), to a version that includes a front-end web application (a visual web application to manipulate chemical data), allowing researchers to view and access information from a web browser. The MaterialsBase will allow several scientific groups involved in collaborative research to access new results from their projects and exchange data between groups and share with a public. Recent work also includes new front-end features such as dynamic object storage for chemical descriptor data, back-end parser functions for better handling chemical compounds data, and a work in-progress feature allowing for mass upload for experimental datasets related to the projects.

Future project goals include implementation of machine learning algorithms within the same web framework, which will assist in the predictive modeling and design of new polymeric materials, nanomaterials, and hybrid/composite materials, and provide for the prediction of various physico-chemical properties. The implementation of this project will provide a wide range of scientists the high-quality computational tools for their STEM research, allowing them to investigate various chemical and materials data and design new chemicals and materials with desired properties.

Synthesis and Characterization of Fluorinated Polymeres

EMILY GIERE
CHEMISTRY AND BIOCHEMISTRY

MENTOR: Hariharaputhiran Subramanian, PhD – Chemistry and Biochemistry

The significance of fluorinated polymers in pharmaceutical sciences, agrochemistry, materials sciences, and biological sciences has grown over the past decade owing to the unique properties of fluorine atoms and an increase in the demand for better performing materials for high-tech applications. We have developed methodology to synthesize amphiphilic block copolymers derived from fluorinated peptides with the aim of synthesizing polymer nanoparticles for biomedical applications. Results from our synthetic efforts towards making these fluorinated block copolymers as well as their characterization data will be presented.

Efficient Removal of Organic Micropollutants from Municipal and Agricultural Wastewater by KrCl* Excimer Lamps

ASHLEY GOETZFRIED
ENVIRONMENTAL ENGINEERING

MENTOR: Jiale Xu, PhD – Civil, Construction and Environmental Engineering

The KrCl* excimer lamp (excilamp) emitting at far-UVC 222 nm is a promising technology for water and wastewater treatment. Additional advantages of the KrCl* excimer light source include the absence of mercury, no harm to exposed human tissues, and high stability at low temperature (~5 Â°C), compared to the conventional low-pressure mercury ultraviolet (LPUV) lamps which emit primarily at 254 nm. Recently, KrCl* excilamps have also emerged as a powerful tool for UV-based advanced oxidation processes and direct photolysis of organic micropollutants (OMPs) in clean water. However, the performance of KrCl* excilamps for removing OMPs in municipal and agricultural wastewater is still largely unknown for common OMPs. To address this knowledge gap, we conducted studies to evaluate the efficiency of KrCl* excilamps in degrading common pesticides and pharmaceuticals in wastewater matrixes. Generally, the KrCl* excilamps efficiently removed atrazine, sulfamethoxazole, ibuprofen, and 2,4-dichlorophenoxyacetic acid, the typical OMPs in wastewaters. The photolysis followed first-order kinetics, and the decay rate constants were 0.27â€“0.84 min-1. Our results indicated that these contaminants can be efficiently removed from our environment whether they feature high or low absorbance at 222 nm, and KrCl* excilamp is a potentially promising technology for wastewater treatment.

Understanding the Complexation of Coproheme Decarboxylase with Coproheme III

AVA GYOLAI
CHEMISTRY

MENTOR: Kenton Rodgers, PhD – Chemistry and Biochemistry

CONTRIBUTORS: Olivia Stiller, PhD and Gudrun S Lukat-Rodgers, PhD

Heme *b* is essential to the function of a large number of diverse proteins and enzymes such as globins, peroxidases, sensors, and catalases. In Gram-positive bacteria, heme *b* is produced in the coproporphyrin-dependent heme biosynthesis pathway. In the second-to-last step of this pathway, coproporphyrin III ferrochelatase (CpfC) catalyzes the insertion of ferrous iron into coproporphyrin III, converting it to coproheme III. The coproheme III is transferred to coproheme decarboxylase (ChdC), which catalyzes the oxidative decarboxylation of propionate groups at b-pyrrole positions 2 and 4 to yield heme *b*. As no members of the ChdC family from Gram-positive bacteria are found in humans, it holds promise as a yet unexploited target for antimicrobial therapeutics. The goal of this study was to determine if surface amino acid mutations in ChdC alter the complexation of this enzyme with its substrate (coproheme III) or with CpfC, the enzyme from which coproheme III is transferred to ChdC. The affinity of wild type ChdC from *Staphylococcus aureus* and several ChdC variants for coproheme III is reported. These affinities were determined via spectrophotometric titration of coproheme III with wild-type ChdC and ChdC N112L, K129A and Y133F variants. The surface mutations had little or no effect on the thermodynamic stabilities of the enzyme-coproheme III complexes. However, two of the three mutations did affect the extent of coproheme III transfer from CpfC to ChdC.

Does vasoactive intestinal peptide signaling impact gut microbiota function?

KELL HELMUTH
MICROBIOLOGY

MENTOR: Glenn Dorsam, PhD – Microbiological Sciences

The mammalian gut microbiota consists of trillions of microorganisms including bacteria, fungi, archaea, eukaryotic parasites, and viruses that play vital roles in host physiology, metabolism and immunity. Gut microbiota waste-products, called short chain fatty acids (SCFA), are used by the mammalian host as an energy source for intestinal epithelial cells, and they also bind to host receptors, thus impacting their metabolism. Vasoactive intestinal peptide (VIP) is a neuropeptide involved in the regulation of circadian rhythms, feeding behavior, metabolism, and immunity. Previous studies by our group revealed the homeostatic effects of VIP signaling on the gut microbiota. VIP-deficient mice exhibited a gut microbiota dysbiosis characterized by reduced bacterial diversity and decreased abundance of Gram-positive *Firmicutes*, with blooms in Gram-negative LPS-expressing bacteria. However, the mechanism by which VIP signaling modulates microbiota taxa and function are unknown. In an effort to better understand the functional changes of the dysbiotic microbiota from VIP deficient mice, we will measure metabolic metabolites, including SCFAs, from WT and VIP KO fecal samples. These data will be analyzed by MetaAnalysis 5 software to determine whether there are significant metabolic pathways altered in KO animals (e.g., tricarboxylic acid cycle, lipid and/or glucose metabolism). We expect to use this data set to propose future hypotheses regarding how VIP signaling regulates functional changes within the gut microbiota ecology that provides both beneficial and deleterious effects to the host.

Cercospora beticola Population Dynamic Fluctuations in Response to Fungicide Applications in the Field

ABIGAIL HOFFARTH
MICROBIOLOGY

MENTOR: Nathan Wyatt, PhD – Plant Pathology

CONTRIBUTORS: Rebecca Spanner, Viviana Rivera, Gary Secor, and Melvin D. Bolton

Cercospora beticola is an economically important fungal pathogen of sugar beets that causes the foliar disease, Cercospora Leaf Spot (CLS). Yield losses due to CLS primarily stem from reductions in sucrose content and lower sucrose purity, though total crop failure is possible under environmental conditions favorable to the pathogen. The Red River Valley (RRV) is a large sugar beet growing region spanning from the Canadian border to southern Minnesota and producing nearly 50% of domestic sugar production. Due to the large geographic range of the RRV, the management of CLS differs from northern to southern regions. Southern regions of the RRV typically experience greater disease pressure and faster disease onset for CLS primarily due to warmer temperatures earlier in the growing season. Management of CLS is typically accomplished through the timely application of fungicides. However, fungicide resistance to most chemistries has been identified and presents a challenge in managing CLS. In recent years, multiple CLS epidemics have occurred in the RRV primarily due to the emergence of widespread fungicide resistance. To better understand the population dynamics of *C. beticola* in the RRV, isolates were collected across the geographic range over multiple years, and whole genome sequenced. Preliminary results showed evidence of gene flow throughout the RRV, indicative of a singular panmictic population as well as evidence of sexual and clonal reproduction.

Qualitative challenges in collecting survey data from meatpacking workers in rural Minnesota

EMMA HONEYMAN
AGRICULTURAL ECONOMICS

ISAAC KRUGG
AGRIBUSINESS AND APPLIED ECONOMICS

MENTOR: Thomas Krumel, PhD – Agribusiness and Applied Economics

This research was designed to retrospectively analyze the impact that working conditions played in COVID-19 spread in a rural Minnesota community. The research design is based on published research by our project lead to test whether meatpacking plants improved their working conditions once the outbreaks started occurring in the industry. With the approval of human subjects, survey data is currently being collected from low-income workers through our partnering with a local social service provider. We have found the collection of this data to be more challenging than initially anticipated, as the workers have indicated a reluctance to participate in the study because of a documented concern of reprisals from their employer. In discussing our sampling strategy with our partner organizations, the primary concern is that many of these workers have uncertain immigration documentation, which puts them in a perceived difficult position with their employer. This poster documents the challenges our research team has faced once field collection commenced and outlines our attempts to address these unanticipated challenges through a community-driven approach. Qualitative assessment throughout the data collection process has provided the basis for improvements in our sampling strategy to ensure that we collect a sufficient sample size of workers to engage with the broader research topic this Duncan project supports.

Effect of Surface Mutations on Reactivity of Coproheme Decarboxylase with Hydrogen Peroxide

GARRETT HONZAY
BIOCHEMISTRY AND MOLECULAR BIOLOGY

MENTOR: Kenton Rodgers, PhD – Chemistry and Biochemistry

CONTRIBUTORS: Olivia Stiller, PhD and Gudrun S Lukat-Rodgers, PhD

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. Coproheme III (CH3) decarboxylase (ChdC) is an enzyme found in the novel coproporphyrin-dependent heme biosynthesis pathway of Gram-positive bacteria, wherein it catalyzes the two-step, H_2O_2-dependent conversion of CH3 to heme b. This occurs in a step-wise manner with propionate-2 of CH3 being converted to a vinyl group yielding the half-product harderoheme III (HH3). Subsequent decarboxylation of propionate-4 converts HH3 to heme b. The enzyme-substrate complexes, CH3:ChdC and HH3:ChdC, bind and activate H_2O_2 at the substrate Fe^{3+} center. Several amino acids on the surface of the ChdC structure have been identified as candidates for involvement in protein:protein complex formation between ChdC and coproheme ferrochelatase, the enzyme that provides CH3 to ChdC. These surface amino acids were mutated and the resulting ChdC variants, ChdC(N112L), ChdC(K129A), and ChdC(Y133F) were isolated and purified. The goal of this study was to determine if these mutations affect the reactivity of CH3:ChdC with H_2O_2. This was quantitatively assessed by 1) spectrophotometric titrations of the CH3 complexes of wild-type and mutated ChdCs with H_2O_2 and 2) kinetic assays of each coproheme:enzyme complex reactions with H_2O_2. The thermodynamic and kinetic parameters of the CH3:ChdC variants' reactions with H_2O_2 will be presented and interpreted through comparison with those of the wild-type enzyme.

Impact of regulating PPAR alpha on lipid droplets and mitochondria in cardiomyocytes

SOFIA HOWE
BIOLOGICAL SCIENCES

MENTOR: Natasha Fillmore, PhD – Pharmaceutical Sciences

CONTRIBUTORS: Robert Anderson, Kaleb Barnes, Savannah Gibson, Subashini Varadharajan and Sathish Venkatachalem, PhD

Despite recent advances in managing and treating cardiovascular diseases, it still remains the leading cause of death in the United States. There are contributing factors leading to cardiovascular disease and eventual death such as type 2 diabetes, obesity, and non-alcoholic fatty liver disease. If peroxisome proliferator activated receptor α (PPARα) is over activated, it can deleteriously affect cardiac function and triglyceride regulation. In this study we are interested in studying the role of PPARα in regulating lipid droplets, organelles that store lipids, in the heart. We expect to see a larger number and size of lipid droplets in hearts in which PPARα has been activated via short-term fasting. We also expect altered perilipin levels, key lipid droplet proteins, in cardiomyocytes in which PPARα was activated. Long term, we expect that this research will also help us have a better understanding of cardiac mitochondria, which interact with lipid droplets via perilipins, and are both involved in cardiovascular diseases.

3-D Realistic Reconstruction of Human Breast Cancer Cell Using Patient-specific Data

COLTER HUSEBY
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

MENTOR: Trung Le, PhD – Civil, Construction and Environmental Engineering

Understanding the transportation of breast cells through the human body may provide insight in cancer diagnosis and treatment procedures. While computational studies of cancer metastasis have provided valuable insights into the cancer migration, most previous studies assumed idealized spherical shapes of the cancer cells. However, our research objective is to investigate how the true three-dimensional shape of cancer cells affects their migratory paths using confocal microscopic images.

Designing Easy On-site Varroa Mite Detection Tests Using Synthetic Biology

FRANK JIRIK
BIOLOGICAL SCIENCES

JOSEPH OLSEN
BIOTECHNOLOGY

WYATT WARKENTHIEN
BIOTECHNOLOGY

MENTOR: Joseph Reinhart, PhD – USDA; Barney Geddes, PhD – Microbiological Sciences and Danielle Condry, PhD – Microbiological Sciences

Varroa mites are parasites that infect beehives globally and their presence eventually leads to hive failure. Varroa mites migrate throughout the hive and into brood chambers where they feed on developing pupae and act as vectors that spread diseases within the bee population. Despite the economic importance of understanding and detecting varroa mites, current detection strategies provide no quantitative information and disrupt the hive, causing stress to the bees. Developing a detection system that can provide quantitative information about varroa mite infections is our primary goal. In addition, it needs to be non-intrusive and harmless to the bees. Lastly, we aim to create a system that is easy and accessible to beekeepers, meaning the test should provide results in the field and can be used without opening the hive. Our solution is a card test that uses the lysate of genetically engineered bacteria to detect the severity of varroa mite infestations in beehives. The card tests will quantify the amount of guanine as it is found in extremely high amounts in varroa mite fecal matter. Beekeepers will swab the hive entrance and mix the swab in a buffer. A drop of this buffer will be applied to a litmus paper card covered with freeze-dried cell lysate. In response to guanine, the rehydrated lysate will produce an acid causing the litmus paper to change colors. Beekeepers can compare this color to a swatch to assess the number of varroa mites in the hive.

Bio-Based Imide Resins for Stereolithography

MELODY JOHNSON
CHEMISTRY

MENTOR: Ivan Hevus, PhD – Coatings and Polymeric Materials

CONTRIBUTORS: Sandip Tiwari, Mukund Sibi, PhD, and Dean C. Webster, PhD

Additive manufacturing (3D printing) is a technique that has begun to revolutionize many different production industries. It can be used to make a wide variety of items from body tissues to construction materials to art and beyond. Stereolithography (SLA) 3D printing uses photopolymerization of liquid monomers as the method to form parts. While acrylates and epoxy resins constitute the majority of commercially available monomers for SLA, other chemistries capable of forming high-performance polymer materials are also being explored. Polyimides, among others, show promise due to their exceptional thermal and mechanical properties, as well as chemical and corrosion resistance. Bismaleimides, in particular, are interesting starting materials for SLA resins due to their ability to undergo a variety of addition reactions like Alder-ene and Diels-Alder reactions in the post curing stage. In this regard, we studied the reaction between an aliphatic bismaleimide and a series of novel biobased diallyl monomers yielding aromatic imide resins. Furthermore, a formulation containing the bismaleimide and a similar commercial monomer was successfully printed, showing that the bismaleimide-diallyl monomer system has the potential to work as a 3D printable resin. Further testing is still required to determine the mechanical and thermal properties of each formulation and evaluate the overall effectiveness of the system.

Expanding the "Library" of Metal-Organic Frameworks for Enzyme Biomineralization

DREW JORDAHL
BIOCHEMISTRY AND MOLECULAR BIOLOGY

MENTOR: Zhongyu Yang, PhD – Chemistry and Biochemistry

Metal–organic frameworks (MOFs) are advanced platforms for enzyme immobilization. Enzymes can be entrapped via either diffusion (into pre-formed MOFs) or co-crystallization. Enzyme co-crystallization with specific metals/ligands in the aqueous phase, also known as biomineralization, minimizes the enzyme loss compared to organic phase co-crystallization, removes the size limitation on enzymes and substrates, and can potentially broaden the application of enzyme@MOF composites. However, not all enzymes are stable/functional in the presence of excess metal ions and/or ligands currently available for co-crystallization. Furthermore, most current biomineralization-based MOFs have limited (acid) pH stability, making it necessary to explore other metal–ligand combinations that can also immobilize enzymes. Here, we report our discovery on the combination of five metal ions and two ligands that can form biocomposites with two model enzymes differing in size and hydrophobicity in the aqueous phase under ambient conditions. Surprisingly, most of the formed composites are single- or multiphase crystals, even though the reaction phase is aqueous, with the rest as amorphous powders. All 20 enzyme@MOF composites showed good to excellent reusability and were stable under weakly acidic pH values. The stability under weakly basic conditions depended upon the selection of enzyme and metal–ligand combinations, yet for both enzymes, 3–4 MOFs offered decent stability under basic conditions. This work initiates the expansion of the current "library" of metal–ligand selection for encapsulating/biomineralizing large enzymes/enzyme clusters, leading to customized encapsulation of enzymes according to enzyme stability, functionality, and optimal pH.

Vitamin and Mineral Supplementation During Gestation

ISABELLA JURGENS
ANIMAL SCIENCE

MENTOR: Carl Dahlen, PhD – Animal Science

Neonatal vitamin and mineral concentrations are correlated with maternal nutrient intake during gestation, and vitamins and minerals play an important role in many processes necessary for fetal development. The objective of this project was to evaluate the impact of maternal vitamin and mineral supplementation on neonatal ovarian characteristics. Fourteen Angusbased heifers (body weight [BW] = 603.4 ± 2.43 pounds [lbs]) were randomly assigned to a control treatment group that received a basal diet fed at a rate of 1 lb/heifer/day (CON; n = 7) or a treatment group that received the basal diet with the addition of a vitamin and mineral supplement at a rate of 4 oz/heifer/ day (VTM; n = 7). Heifers were subjected to their respective treatments from 60 days before breeding, throughout gestation and through calving. Calves were euthanized thirty hours after birth, and the reproductive tract was subsequently removed. Upon removal, ovaries were weighed and vertical and horizontal measurements were taken. The right ovary was halved then placed in neutral-buffered formalin to preserve the tissue until processing. The samples were then serially sectioned into three 5-micron sections with ten sections between to avoid counting follicles more than once. The sections were placed on slides and stained with Hematoxylin and Eosin for histological evaluation. Using MoticEasyScan Pro, each slide was digitally scanned and total number of ovarian follicles (microscopic structures within the ovary that encases an egg) were recorded and classified depending on stage of maturity as primordial, primary, secondary or antral. Data were analyzed using the Mixed procedure of SAS with heifer as the experimental unit. There was no difference in ovarian size or in number of primordial, primary, secondary or antral follicles between treatments ($P \geq 0.13$). Additional investigation in this area may be beneficial in determining maternal nutritional impact on measures of offspring reproductive development at further post-natal time points.

Role of sex-steroids in regulating expression and function of adipokines in obesity-associated asthma

ALBERT KARGEL
MICROBIOLOGY

MENTOR: Sathish Venkatachalem, PhD – Pharmaceutical Sciences

CONTRIBUTORS: Jacob Tesch, Mohammad Ishad Reza and Nilesh Sudhakar Ambhore, PhD

Asthma is characterized by chronic inflammation of conducting airways in association with airway hyperresponsiveness (AHR) and remodeling. Airway smooth muscle (ASM) plays an important role in contributing to both exaggerated AHR and remodeling. A major factor regarding the prevalence of asthma is obesity. Studies have demonstrated that adipose tissues express multiple adipocytokines like leptin and adiponectin which influence airway inflammation and remodeling. Leptin is pro-inflammatory and adiponectin is anti-inflammatory. Clinical studies reported an association of high levels of adiponectin with reduced asthma in pre-menopausal and post-menopausal women. As the incidence of obesity-associated asthma is more predominant in females, we hypothesize sex-steroids such as estrogen and testosterone have a predominant role in regulating adipocytokines and their influence on ASM functions. Primary human ASM cells isolated from lung resections were cultured in DMEM-F12 medium and treated with vehicle, TNFα (20ng/mL), IL-13 (50ng/mL), 17β-estradiol (E_2; 1nM), and/or testosterone (10nM). The expressions of leptin and adiponectin were determined using immunofluorescence, RT-qPCR, and Western blotting. We observed expression of both leptin and adiponectin in human ASM cells. TNFα and IL-13 exposure increased leptin and adiponectin expression compared to vehicle, with a larger observed effect on leptin expression. Further, we observed E_2 exposure increased leptin expression, while testosterone showed upregulated adiponectin expression. Overall, these results show altered leptin/adiponectin expression in ASM cells during inflammation which may lead to the worsening of asthma, particularly during obesity. Additionally, we observed sex-steroids differentially regulate the ASM expression of adipokines, and highlight the importance of sex-steroids in regulating obesity-associated asthma.

Does vasoactive intestinal peptide (VIP) deficiency negatively impact intestinal epithelial cell glycogen content in fed mice?

SAVANAH KLEGON
BIOCHEMISTRY AND MOLECULAR BIOLOGY

MENTOR: Glenn Dorsam, PhD – Microbiological Sciences

CONTRIBUTOR: Razia Dawlaty

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.

Effects of Flonicamid on the Locomotion of the Alfalfa Leafcutting Bee Abstract

BROOKE KOHLER
BIOLOGICAL SCIENCES

MENTOR: Jacob Pithan – Biological Sciences

Since 1984, there has been a 13% increase in species of insects and mites resistant to insecticides. There is a growing concern for multiple resistance to insecticides, and effective alternatives are being developed. Flonicamid, one of these alternatives, is an insecticide of alfalfa, cotton, lettuce, spinach, and cole crops, and is believed to be harmless to bees. Its main targets include piercing and sucking pests, such as aphids. Flonicamid is thought to be safe for pollinators due to its highly water-soluble properties, which allows the chemical to be repelled off the hydrophobic exoskeleton of insects. However, further research is needed to understand the effects on different modes of entry. In this study, *Megachile rotundata*, the alfalfa leafcutting bee, was used to assess the effects of flonicamid on pollinators. Newly emerged *M. rotundata* females were reared to adulthood and exposed to flonicamid, either topically or by ingestion, at increasing concentrations of 0x, 1x, and 10x, following the manufacturer's guidelines. Walking performance was assessed by locomotion activity monitors (TriKinectics), and flight performance was assessed by a cylinder drop assay. Concentration and treatment had no effect on walking performance. When exposed to the control, nearly all females were able to succeed at flight. However, only 20% of the females that ingested the 10x solution were able to succeed. Additionally, with increases in concentration, the number of attempts needed to succeed at the drop test increased. This data suggests that flonicamid may influence *M. rotundata's* flight performance, which can affect reproduction and behavior.

How Communal Efforts Have Changed Over the Course of Historic Floods in the Fargo/ Moorhead Area

KYLA LARSON
ANTHROPOLOGY

MENTOR: Kristen Fellows, PhD – Sociology and Anthropology

This research looks at three different historic floods within the Fargo-Moorhead area and how communal response has changed throughout them. Primary sources including news articles, social media posts, and photographs will be analyzed. Photos and Primary sources will show the different materials and leadership used in response to the floods. News accounts and social media sources are also critical for organizing a coordinated response to more current Floods. The analysis will show that with the increase in technology since the 1897 flood, collaboration within the community has also increased. State and National responses have grown to support local communities during a time of disaster. Modern technology brings the access necessary for communication, organization, and materials crucial for negating an emergency.

Phenotypic characterization of primary non-nodular and nodular lymphangeioleiomyomatosis (LAM) cells

SAHIL LOHANA
PHARMACEUTICAL SCIENCES

MENTOR: Sathish Venkatachalem, PhD – Pharmaceutical Sciences

CONTRIBUTORS: Jacob Tesch, Ashish Kumar and Premanand Balraj

Background: Lymphangioleiomyomatosis (LAM) is a rare lung disease that predominantly develops in women between the ages of 20–40 years. The main characteristics of LAM are metastatic spread and infiltration of tissues by proliferative, abnormal smooth muscle- like cells (nodular LAM cells); Nodular LAM cells originate from a distal tissue and are phenotypically different than the normal airway smooth muscle-like cells (non-nodular LAM cells). This continued abnormal growth leads to cystic structures that result in progressive dyspnea, increased risk of respiratory infections, and potentially death by respiratory failure. In this context, we aimed to address the phenotypic and functional differences between the patient-derived primary non-nodular and nodular LAM cells using morphological and molecular analysis. We hypothesize that *in vitro* nodular LAM cells possess diseased phenotype and show differential phenotypic characteristic features compared to non-nodular LAM cells.

Methods: LAM lung tissues samples were obtained through National Disease Research Interchange (NDRI) exchange program. Lung samples were collected from LAM patients who underwent surgical dissection to separate cystic excrements and used to isolate LAM cells (papain digestion method). Isolated human nodular and non-nodular LAM cells from the obtained lung tissues were plated onto 100 mm plates grown to 70% confluence in a 5% CO_2 humidified incubator. The change in expression pattern of LAM-specific phenotypic marker Glycoprotein 100 (GP-100) was evaluated by standard Western and qRT-PCR analysis. Further, proliferation of nodular and non-nodular LAM cells were evaluated by MTT assay and Lion heart Fx Cell count (LFx) assay. Finally, Western and qRT-PCR analysis were used to evaluate the changes in expression pattern of proliferative markers: PCNA, Cyclin D1 and Cyclin E.

Results: We observed significantly higher expression of GP100 in nodular LAM cells compared to non-nodular LAM cells. Further, nodular LAM cells show significantly increased proliferation compared to non-nodular LAM cells. This was supported by both mRNA and protein expression of increased proliferative markers (PCNA, Cyclin D1 and Cyclin E) in nodular LAM cells compared to non-nodular LAM cells.

Conclusion: The phenotypic marker proteinGP-100 confirm the identity of LAM phenotype in isolated nodular cells. This was further supported by increased proliferation rate and proliferative markers. Overall, our data suggests differential phenotypic characteristic features of nodular LAM cells compared to non-nodular LAM cells *in vitro*.

Patient Misidentification Prevention II

JARED MAUL
COMPUTER SCIENCE

AUDREY TRACY
COMPUTER SCIENCE

MENTOR: Jeremy Straub, PhD – Computer Sciences

Despite numerous preventative techniques, patient misidentification is a continuing issue in the healthcare industry. The use of ID wristbands, questions to confirm patient identity, and other techniques all aid in patient identification yet still fall short of providing a complete solution. We have proposed an additional layer of protection to be included along with existing techniques. Our work suggests that machine learning can be applied to biometrics commonly collected during a hospital stay to prevent patient misidentification. This approach has been explored previously and the tests presented serve to extend the original.

Environmental Controls on Morphological Diversity: A Case Study on the Late Triassic *Monotis*

ZOE MUCCATIRA
EARTH, ENVIRONMENTAL, AND GEOSPATIAL SCIENCES

MENTOR: Lydia Tackett, PhD – Earth, Environmental, and Geospatial Sciences

Morphological variation in a taxon can reflect environmental gradients. However, it is hard to identify the relationships between environment and morphological diversity in deep (geologic) time. New Zealand today represents a unique place to study endemic taxa along geological gradients from the Triassic Period. *Monotis* are a bivalve genus from the Late Triassic (220 million years ago) that tend to form dense shell beds that exhibit a wide degree of morphological variation, primarily in New Zealand. *Monotis* have several endemic subgenera that vary in shell inflation, size, and thickness. We collected *Monotis* samples from three different regions throughout New Zealand: southern South Island (Hokonui Hills), northern South Island (Nelson), and northern North Island (Kiritehere Beach). Older and younger fossil samples from each region were collected to determine if there is a temporal, geographic, and/or sedimentological relationship with shell morphology and variation. On individual specimens, height, width, and inflation were measured, with variation expected in measurements between older and younger samples of *Monotis*. In this poster, we will post the results of our analysis highlighting the differences in these populations in time and space, with implications for latitude null gradients and morphology.

Effects of DNA methylation on diapause in M. rotundata using the methylation inhibitor 5-aza-2-deoxycytidine

SARAH NASH
BIOLOGICAL SCIENCES

MENTOR: Joshua Rinehart – Biological Sciences

Diapause is an important life stage in the alfalfa leafcutting bee (*Megachile Rotundata*) that allows them to survive the harsh environmental conditions of winter. Not all bees will enter diapause and will emerge as a second generation of adults during the same summer. Many studies have explored the potential cues for diapause in *M. rotundata*, with results suggesting that the cue is maternal. In other insects, these maternal cues are mediated by the methylation of DNA. This study will further examine the role of DNA methylation by examining the effects of the methylation inhibitor 5-aza-2-deoxycytidine on the diapause status of *M. rotundata*. We will be treating adult *M. rotundata* with the methylation inhibitor before releasing them into the field at different nesting boxes. As the females reproduce, we will collect the completed nests to evaluate the diapause status of the progeny. We will then evaluate the correlation between the bees fed the different concentrations of the methylation inhibitor and the diapause status of the *M. rotundata* offspring.

Calibrating the Built Environment Using Biosensing Equipment

CLAIRE OLSON
CIVIL ENGINEERING

MENTOR: Ganapathy Mahalingam, PhD – Architecture

Creative ways to improve an individual's physical well-being is becoming an increasingly urgent priority in building design. This research aims to create a system of calibration to assign buildings individualized wellness scores that calculate the positive effect the built environment has on building users' physical wellness. A model user will make prototype journeys while collecting data points including distance traveled, calories burned, steps taken, and change in heart rate. This data is then used to calibrate an equation that calculates a standardized wellness score. The case study buildings used for this research are Klai and Renaissance Hall at North Dakota State University.

Wing damage propagation in alfalfa leafcutting bee (*Megachile rotundata*)

KOBY PEARSON-BORTLE
BIOLOGICAL SCIENCES

MENTOR: Jacob Pithan – Biological Sciences

Organisms with wings often experience wing damage caused by collisions, predation, weather, and intraspecific interactions. This can decrease foraging and offspring provisioning, while increasing predation risk. Previous studies on wing damage have been done on insects such as odonates, lepidopterans, and social hymenopterans. However, little is known of the propagation and consequences of wing damage in solitary bees, such as the alfalfa leaf cutting bee, *Megachile rotundata*. Due to their high level of flight activity and solitary lifestyle, we hypothesize that age increases the propagation of wing damage of *M. rotundata*. Female *M. rotundata* were reared to adulthood and then released in the field. On days 7, 14, and 21, they were collected from the field and brought back to the lab for wing dissection. The wings were removed and photographed using a dissection microscope. Wing area was measured in millimeters which was obtained using ImageJ, a software program. The proportion of individuals with wing damage was found to increase with age. Additionally, it was found that the wing area decreased with age and that wing damage was cell specific, primarily in the distal cells. The propagation of wing damage was found to affect morphometric flight performance as well. The findings from this study show similarities to past aging studies which we can conclude that age affects the propagation of wing damage. In continuation of understanding how wing damage affects *M. rotundata*, future research will be conducted to find how wing damage affects foraging behavior and offspring provisioning.

Oral Histories of Bonanza and Tenant Farming in Cass County of the 19th and 20th Centuries

SHAE PFENNING
ANTHROPOLOGY

MENTOR: Kristen Fellows, PhD – Sociology and Anthropology

Bonanza farms in the Cass County area had a substantial impact with its introduction of innovative and improved machinery that later impacted tenant farming. The aftermath of bonanza farming is still seen today with the amount of wealth that it has brought to the area. As part of a larger project centered on these agricultural enterprises, this research makes use of oral histories previously collected from people who worked and lived on the farms. Sources located in the North Dakota State Historical Society and Digital Horizons were transcribed and analyzed in an effort to examine the lived experiences of people in the Cass County area who lived and/or worked on the bonanza and tenant farms in the 19th and 20th centuries. Focused on two case studies, this preliminary research has offered insights into how large-scale farming operated, how it was managed, and how its infrastructure changed over the years. For future direction, this research would like to start looking at maps of the area and gather more oral histories on small scale farming.

"I Think That I'm Broken" An Oral History Examination of Disability in Academia

GRACE REBEL
ANTHROPOLOGY

MENTOR: Ellen Rubinstein, PhD – Sociology and Anthropology

In Anthropology Seminar 491: Disability and Culture, students, like myself, conducted oral histories to explore experiences of "disability" as defined and described by their collaborators or interviewees. The final product of these oral history exhibits feature codes, quotes, and images that encapsulate key points of the interviewee's lived experiences. Data for this project was collected through a singular oral history from my interviewee Bethany. The final five codes are titled 'Smart Kid', "Brain on Fire", Sister, Terminology, and "Red String". Bethany's experiences correlate with many main themes from disability and culture studies like stigma, language, and the overarching theme of disability in academia. This story exemplifies just one of the many experiences of disability within academia, an incredibly common experience yet not regularly discussed. The use of oral history to articulate one person's lived experiences can create a greater understanding of your own. It is incredibly important for these stories to continue being told and shared so that nobody else assumes they are broken.

Computational Modeling of Ion Distributions in Ionic Microgel Solutions

SIGURD SAUDE
PHYSICS

MENTOR: Alan Denton, PhD – Physics

Ionic microgels are soft colloidal particles made of cross-linked networks of polymer chains. When dispersed in a polar solvent, the particles swell and acquire charge by releasing ions. Swelling of ionic microgels depends on the solvent conditions, such as pH, temperature, salt concentration, and osmotic pressure. The response of microgels to their environment enables applications in drug delivery, biosensing, and bioengineering. In this work, we explore how the distributions of ions inside and outside of microgels, and associated swelling, depend on the fixed charge on the polymer chains. Within the primitive model, treating the solvent implicitly as a dielectric continuum, we perform molecular dynamics simulations using the LAMMPS package to model a single ionic microgel in a spherical cell with explicit mobile ions. We demonstrate that ion distributions, and thus swelling behavior, are highly sensitive to the distribution of fixed charge, with potential significance for a range of practical applications.

Metabolic Assessment of 3D Cell Cultures

ANNIE SCHIRO
CHEMISTRY AND BIOCHEMISTRY

MENTOR: John Wilkinson, PhD – Chemistry and Biochemistry

Three-dimensional cell culture is a powerful technique used to grow cells as isolated sphere-like structures, providing a more accurate representation of the in vivo microenvironment compared to traditional two-dimensional monolayer cultures. However, the metabolic adaptation of cells to a three-dimensional growth environment is not well understood. To address this, a mitochondrial function assay was adapted to characterize the metabolic state of three-dimensional cancer cell lines. This assay involves the activation of a redox-sensitive dye by the cells' mitochondria when they utilize substrates, which is then detected by a plate reader. This project aimed to adapt this assay for a three-dimensional format and use it to investigate the metabolic role of Apoptosis-Inducing Factor (AIF), a mitochondrial flavoprotein involved in stabilizing the respiratory chain and NADH-oxidase activity. The results of the study indicate that there is a shift in metabolic preferences in 3D culture compared to 2D culture, and the function of AIF in this process appears to be time dependent. Specifically, 3D cells on day one are more metabolically similar to 2D cell culture and become progressively distinct over time. The significance of this work lies in the potential to better understand the metabolic changes that occur in three-dimensional cell cultures and develop more accurate models for research. By identifying the metabolic pathways involved in this process and the influence of AIF, we can gain valuable insights into the tumor microenvironment and potentially develop new therapeutic strategies. Further research is needed to fully elucidate the mechanisms involved in these metabolic adaptations.

Introducing the Fertile Dune Field, Minnesota, USA: Context, Geomorphology and Chronological Constraints

BENJAMIN SCHIRRICK
GEOLOGY

ALEXANDER WAUGH
GEOLOGY

MENTOR: Kenneth Lepper, PhD – Earth, Environmental, and Geospatial Sciences

CONTRIBUTORS: Grace Farmer and Eugene Barnes

The Fertile Dune Field is located southwest of the town of Fertile in northwestern Minnesota. It overlies the Sand Hill Delta, where the Sand Hill River fed into the eastern shoreline of Glacial Lake Agassiz (GLA). The surface of the delta was exposed allowing eolian mobilization of the sand during a major drawdown event of GLA. The objectives of this project were to identify the types of dunes present, evaluate dominant paleo-wind direction(s), develop a chronology for the dune field and determine if multiple eolian activity phases are represented in the dunes. This presentation deals with the geologic context, geomorphology, and chronologic constraints for the dune field. The project utilized GIS for spatial analysis, field work, and SEM grain imaging. The delta lies west of and lower in elevation than the Herman shoreline of GLA, and is overprinted along the western side by a beach ridge previously inferred to be a Norcross or Tintah shoreline. These geomorphological relationships constrain the formation of the Sand Hill delta between 14.2 ka and 13.4 ka. The dune field exists along the southern, eastern, and northern periphery of the delta, with the most dune forms atop the northern part. Both barchan and complex parabolic dune forms are present ranging in size from < 50 m to > 250 m. Many dune crests have been noticeably modified by what are interpreted to be later stage blowouts and small-scale parabolic dunes. Paleosols identified within the dunes give evidence for at least two activation periods.

Public Devil: Success of a Superhero

MEGAN SCHLANGEN
SOCIOLOGY AND ANTHROPOLOGY

MENTOR: Kristen Fellows, PhD – Sociology and Anthropology

Daredevil is one of Marvel Comics longest running and most iconic characters, leading to new ideas about what a hero is. My research included examination of primary written and visual sources from 1964 to the present, synthesis of secondary analysis of the character and media, and application of qualitative research strategies to determine cultural impact. Key points of investigation included changes to Daredevil's superhuman abilities, representations of his disability, stylistic adaptations, and interactions with its audience. Preliminary findings about factors that led to the success of Daredevil include evolving portrayals of Daredevil being blind, Frank Miller's contributions to the Daredevil canon, ongoing religious aesthetics, and public engagement with the character. At this stage in research, a podcast covering the general history of the Daredevil literature has been completed but further research into social involvement and closer investigation into the complete canon will lead to greater insight into the interrelationship between audience and media. It is my intention to pursue in-depth research about Daredevil and public engagement as part of my graduate Anthropology studies

Role of Telomerase Reverse Transcriptase (TERT) on Bioenergetics in Human Brain Microvascular Endothelial Cells in Aging

MADELINE STROUD
PHARMACEUTICAL SCIENCES

MENTOR: Yagna Jarajapu, PhD – Pharmaceutical Sciences

Human brain microvascular endothelial cells (HBMEC) maintain blood flow in the brain and require ATP-generation to function efficiently. However, with aging, bioenergetics and respiration of HBMEC may be impaired. Telomerase reverse transcriptase (TERT) is responsible for maintaining telomere length. This study analyzed the impact of TERT on bioenergetics of HBMEC using cycloastragenol (CAG), a TERT activator, and BIBR-1532, a TERT inhibitor. Our study hypothesized that TERT activation would reverse aging-associated damage in older HBMECs.

Cells were cultured to passage 8 (young) and 15 (old), and oxidative phosphorylation (OXPHOS) and glycolysis were analyzed through Seahorse (XFp) bioanalyzer. Oxygen consumption rate (OCR) measured basal respiration, ATP-linked respiration, proton leak, maximal respiration, spare respiratory capacity, and non-mitochondrial respiration by injecting oligomycin (2 μM), FCCP (1.1 μM), and rotenone/antimycin A (0.5 μM). Basal glycolysis, basal proton efflux rate, compensatory glycolysis, and post-2DG acidification were determined by extracellular acidification rate (ECAR) upon injection of rotenone/antimycin A (0.5 μM) and 2-Deoxyglucose (2-DG) (50 mM). CAG (0.3 μM) and BIBR-1532 (1 μM) were used to activate or inhibit TERT.

OXPHOS significantly decreased ($p<0.05$, $n=3$) in old cells compared to young indicated by decreased OCR parameters explained above. Old cells also had lower glycolysis ($p<0.05$, $n=3$) compared to young illustrated by decreased ECAR parameters that were previously mentioned. Treatment with CAG showed increased trend in basal respiration, ATP-linked respiration, maximal respiration, spare respiratory capacity, and basal glycolysis in old cells compared to young.

Our study demonstrated the possible restorative effect of CAG on bioenergetics of aging HBMEC.

Additive Manufacturing Custom Components

GAVIN SWINEHART
MECHANICAL ENGINEERING

MENTOR: Chad Ulven, PhD – Mechanical Engineering

Using common strategies that pertain to different additive manufacturing (AM) processes such as fused filament fabrication (FFF) and stereolithography (SLA), new designs for printing were trialed and used to create prototype components for advanced AM research. With the capabilities provided by the average consumer FFF/SLA 3D printer, new functional concepts were applied to the process and greatly reduced the time spent in creating the necessary parts to advance the research. The development of the continuous carbon fiber reinforced thermoset additive manufacturing process is completely new and there are very few off the shelf items that can be used in the research of this new process of AM. One of the new AM systems uses two-part resins which required a method to hold the resin containers and give the fiber a path to follow. Both were accomplished with designing and printing functional parts.

Formation of Two Adjacent Chiral Centers Through Mukaiyama

CURTIS THOMPSON
CHEMISTRY AND BIOCHEMISTRY

MENTOR: Mukund Sibi, PhD – Chemistry and Biochemistry

The formation of CC bonds in organic chemistry is essential when trying to make various materials, natural products, or pharmaceuticals. Additionally, in forming new CC bonds, there is a potential to generate new chiral centers. These chiral centers are known to play a significant role in a compound's biological properties, despite the challenge of being able to synthesize them enantioselectively. Thus, developing new protocols where multiple chiral centers are formed selectively has been deemed important. We were able to develop a method using Mukaiyama-Michael addition reactions to generate two adjacent chiral centers from a β-substituted Michael acceptor and a furan-derived silyl ketene acetal. Various auxiliary groups, Lewis acid catalysts, PyBox ligands, and additives were investigated to generate the most diastereoselective and enantioselective product while maintaining high yields. Our findings related to the Mukaiyama-Michael addition reactions of the βsubstituted Michael acceptors will be presented.

Pyrrolidine and 3-Pyrroline Bound Defects to (6,5) Carbon Nanotubes and Their Effect on Emission: DFT Insights

GRACE TIFFANY
CHEMISTRY AND BIOCHEMISTRY

MENTOR: Svetlana Kilina, PhD – Chemistry and Biochemistry

The emission properties of a single-walled carbon nanotube (SWCNT) can be significantly enhanced by creating the sp^3-hybridized defect at the tube's lattice via covalent attachment of a small number of organic molecules to the surface of SWCNTs. In our studies, we utilize Density Functional Theory (DFT) and Time-Dependent DFT (TD-DFT) to investigate the ground and excited state properties of the (6,5) SWCNT with the defect introduced by the attachment of pyrrolidine and 3-pyrroline molecules. We compare the divalent defects, when a molecule is bound to more than one carbon atom in the SWCNT, with their monovalent counterparts. The energy and optical intensity of the defect-associated optically active state strongly depended on the defect configuration – a way of molecule attachment with respect to the tube's axis. Obtained insights into optical and structural properties of SWCNTs with chemical defects are important for potential applications of single-walled carbon nanotubes (SWCNTs) as single photon emitters in the near-infrared range.

Characterization of Western Diet-Induced Obesity in the Diversity Outbred Mice

ANDREW TOELLE
PHARMACEUTICAL SCIENCES

MENTOR: Yagna Jarajapu, PhD – Pharmaceutical Sciences

CONTRIBUTOR: Kishore Chittimalli

The prevalence of obesity in US is 42%, which was largely attributed to the western diet. A wide inter-individual variation is observed in the susceptibility to the diet-induced obesity due to genetic differences. Diet-induced obesity in laboratory mice show extensive strain-dependent variability in the development of glucose tolerance and inflammatory stress. Therefore, inbred strains are not ideal for the discovery and development of novel pharmacological targets for the treatment of obesity. This study characterized obesity in a novel Diversity Outbred (DO) mouse model, which is derived from eight different founder strains and contain ~90% of genetic diversity observed in mouse species with >50 million potential gene variants. DO or C57Bl/6j inbred mice were fed with western diet (WD) or control diet (CD) for 20 weeks. Body weight and blood glucose levels were monitored over time. Glucose tolerance was determined by determining blood glucose levels following intraperitoneal injection of glucose (2g/Kg). CD45 $Ly6G^-CD11b^+Ly6C^{hi}$ inflammatory monocytes in the peripheral blood were enumerated by flow cytometry. DO mice showed wide variability in the weight gain and blood glucose with WD (n=10), that was not observed in the inbred mice (n=8). Similar variability was observed in the glucose tolerance in DO mice. WD increased the number of inflammatory monocytes in DO mice with variability. Future studies will address the variability in the beneficial effects of treatments that were shown to decrease WD-induced obesity in inbred strains.

North Dakota Career and Technical Teachers' Perceptions of Work-based Learning

MAGGIE WERTISH
EDUCATION

MENTOR: Brook Thiel, PhD – School of Education

I'm conducting a research project to understand teachers' perceptions and implementation of work-based learning. Work-based learning is a requirement in order to receive Carl Perkins funding. Therefore, any school that receives Perkins funding must have a Work-based learning program for students. I created a survey and emailed it to all of the Career and Technical teachers in North Dakota via the listserv. I am expecting a wide range of answers from Career and Technical educators because there is such a wide range of years of teaching and experience in educators. It is my hope that with this research, we will learn more about how work-based learning is being implemented across the state of North Dakota. This information will also provide information that can be used to develop targeted professional development in the future.

RESEARCH SYMPOSIUM OF GAMMA SIGMA DELTA

UNDERGRADUATE ABSTRACTS

Advancing Great Plains Food Crops to Evaluate Glycemic Control and Cognitive Functional Bioactive Compounds

KATLYN BALSTAD
MANAGEMENT COMMUNICATION AND CROP AND WEED SCIENCES

MENTOR: Kalidas Shetty, PhD – Plant Sciences

While malnourishment of certain macronutrients such as carbohydrates and proteins is still a problem for approximately 1 billion people, another major global challenge is the overconsumption of hyper processed carbohydrates. Around 2 billion people are experiencing the side effects of this overconsumption that is increasing non-communicable chronic diseases (NCDs). The COVID-19 pandemic acutely exposed the issue of overconsumption as those with existing co-morbidities were more susceptible to COVID-19 and less likely to recover from it. The pre-existing co-morbidity conditions results in less effective immune response in comparison with those without co-morbidities. Oxidative damage due to the refined carbohydrates can worsen the development of co-morbidities like diabetes and cardiovascular disease. Cognitive issues like Parkinson's are also more likely to develop later in life following sustained NCDs. Bioactive compounds, like phenolics, in food products have the potential to reduce oxidative damage which has been linked to NCDs. Eating foods high in phenolics and fiber like whole grains, fruits, vegetables, and legumes can provide necessary antidotes to support gut functions while promoting redox protective reactions. Evaluating different food crops for their phenolic properties will help us focus our production towards a healthy, sufficient food supply as the population continues to grow. The Great Plains is an area rich in crop diversity; local producers grow approximately 45 different crops. In my master's research, I will evaluate 5 different cereals species and 5 legume species for their antioxidant phenolic properties and cognition relevant tyrosine and tryptophan compounds. Tyrosine is a precursor to levodopa (levodopa is a precursor to dopamine essential for positive brain function). Tryptophan is a precursor to serotonin associated with calm brain positive state). Improper functioning of these bioactive compounds is linked to cognitive issues like Parkinson's and other cognitive declines with aging. Parkinson's patients are often given levodopa supplements, so by evaluating the levels of levodopa in food crops at different stages, we would be able to optimize plant foods into producing these health relevant compounds potentially decreasing the risk of impaired cognitive development with aging.

Prevalence of Seedborne Transmission of Fungal Pathogens in Commercial Sugar Beet Lots

ASHTON ESCO
BIOTECHNOLOGY

MENTOR: Nathan Wyatt, PhD – USDA Agricultural Research Service

Cercospora beticola is a fungal pathogen that causes the sugar beet foliar disease Cercospora leaf spot (CLS). CLS can cause economic losses for sugar beet growers by reducing the yield and purity of recoverable sucrose. *C. beticola* spreads via splash and airborne dispersal of conidia, and it has been shown that inoculum persists in crop debris and soil. Evidence for gene flow between globally diverse populations has been observed, indicating an unidentified mechanism of long-distance dispersal. Recently, *C. beticola* was shown to be present in the pericarp of sugar beet seeds collected from commercial seed lots. Whether seedborne *C. beticola* isolates contribute to disease during the growing season has yet to be examined. To assess the relative risk of seedborne *C. beticola* to commercial sugar beet production, samples from commercial seed lots available during 2022 were screened for the presence of seedborne fungal pathogens. Fungal isolates' genus were classified by sequencing the internal transcribed spacer region (ITS), a common barcode sequence within fungal taxonomy. Isolates belonging to known sugar beet pathogens in *Alternaria*, *Cercospora*, and *Fusarium* genera were identified. *Cercospora* and *Fusarium* isolates are currently being prepared for whole genome sequencing and variant identification. The resulting seedborne sugar beet pathogen variants will be compared to a collection of *C. beticola* and *Fusarium* isolates sampled from commercial fields in 2022. Genotypic overlap between seedborne and field collected isolates will be used to determine if seedborne isolates establish in commercial fields and provide additional evidence for a potential mechanism of long-distance dispersal.

Functional Analysis of Gene PtrV1_06931 Using the CRISPR-Cas9 Technique

CARLY GEORGE
BIOTECHNOLOGY AND CROP AND WEED SCIENCES

MENTOR: Zhaohui Liu, PhD – Plant Pathology

Tan spot disease in wheat is caused by the fungal pathogen *Pyrenophora tritici-repentis (Ptr)*. Three known effectors, ToxA, ToxB, and ToxC have proven to be involved in disease development. ToxA and ToxB are proteins; however, the nature of ToxC is not identified. Recently, the *ToxC1* gene had been cloned but was not sufficient for the production of ToxC. After inoculation with a ToxC1 knockout mutant and wild type, RNAseq analysis has revealed many significantly down-regulated and up-regulated genes. PtrV1_06931 showed the most significant change among these genes. In this project, CRISPR-Cas9 technology is being deployed to study the biological function of gene PtrV1_06931. Findings of this research will help to understand how PtrV1_06931 contributes to ToxC production and leads to tan spot disease.

Using a Genomically Diverse *Rhizobium leguminosarum* Library to Identify Elite Strains for Biological Nitrogen Fixation in *Pisum sativum*

MIA HAUGAN
MICROBIOLOGY AND BIOTECHNOLOGY

MENTOR: Barney Geddes, PhD – Microbiological Sciences

Rhizobium leguminosarum bv. viciae is the primary nitrogen fixing symbiont of pea crops. Rhizobia perform biological nitrogen fixation (BNF) by converting atmospheric nitrogen into ammonia for the plant and the plant provides energy rich carbon compounds in return. These bacteria can be applied as inoculant to pea crops as an alternative to nitrogen fertilizers. In efforts to increase yield by improving BNF we must better understand how two primary factors, competitiveness between strains and effectiveness at fixing nitrogen change based on soil conditions and plant cultivar, as well as among different genomes. Here we created a library of pea-nodulating rhizobia from North Dakota soils consisting of 48 genomically distinct and 48 genomically similar *R. leguminosarum* strains to explore these qualities. Genomic similarity was determined with ERIC (Enterobacterial Repetitive Intergenic Consensus) PCR. Each strain was used to individually inoculate pea plants to identify the nodule size, and dry shoot weight associated with each strain. Next, the strains were marked with a plasmid containing a barcode DNA sequence quantify abundance in the nodule using next generation sequencing. These marked strains were then used in a competition assay composed of different soil conditions and cultivars of peas. The results from these experiments support the rhizobium competition problem, highlight specific strains that are both competitive and efficient nitrogen fixers, and show that phenotypic diversity of rhizobia does not necessarily correlate with genomic diversity as defined by ERIC PCR.

Advancing Health Targeted Foods for Glycemic Control and Cognitive Functions from Indigenous Food Systems

MERCEDES MORIN
BIOTECHNOLOGY

MENTOR: Kalidas Shetty, PhD – Plant Sciences

The indigenous populations of North America are disproportionately affected by non-communicable chronic diseases (NCDs) such as type 2 diabetes and hypertension compared to non-Hispanic whites and other minority groups. These health disparities are due to major changes to their social determinants of health such as food security challenges, loss of culture, and increased intake of highly processed refined carbohydrates contributing to the rapid rise of NCDs. The initial pathway of NCDs is the higher glycemic load leading to type 2 diabetes and cardiovascular disease which in later leads to dementia and cognitive failure. This requires re-working of the global food system to facilitate easier access to a more complete balanced diet to counteract NCDs and its consequences. Therefore, improving global food diversity with higher intake of whole grains, nuts, legumes, fruits, and vegetables with high fiber to support the human microbiome and high key redox protective phytochemicals supporting digestive and vascular pathways while preventing late-stage cognitive breakdown associated with NCD is essential. Based on this rationale, the goal of this study will focus on a wide functional analysis of anti-glycemic phenolic bioactive compounds for commonly consumed nuts and seeds. In addition to anti-glycemic bioactive analysis, the antioxidant functions related to improved management of blood pressure and phenolic compounds associated with cognitive functions such a tyrosine, a precursor of levodopa and tryptophan, a precursor for serotonin will be analyzed. By identifying these components, we can use the results to create a product with a long-term goal of improving diets for cognitive improvement with human aging along with greater glycemic control. This is a step for identifying a natural treatment for these diseases as indigenous communities often have limited access to healthcare.

You Don't Have to Be a Work Horse to Know Your Horse: A Look into the Validity of Equine Personality Assessments

SAVANNAH RIVERS
EQUINE SCIENCE AND ANIMAL SCIENCE

MENTOR: Carrie Hammer, DVM and PhD – Animal Sciences

Understanding a horse's personality is vital in ensuring optimal performance and welfare. Experience level of the participants has not been adequately considered within several previously validated equine personality assessments. Therefore, the objective of this study was to determine how the perception of a horse's personality changes based on who was answering the questions. We hypothesized that those with larger amounts of horse experience will answer personality questionnaires differently than those with limited horse experience. A previously validated equine personality survey was sent to 46 individuals at North Dakota State University. Inclusion criteria were workers at the equine center (EC; n=7), members of the Equestrian Teams (TEAM; n=35) or equine science faculty members (FAC; n=3). Three horses that were common to all groups were selected and respondents were asked to complete 20 questions for each horse. Questions were grouped into 3 categories: Anxiety, Trainability, and Affability. Our survey was completed by 35 respondents (EC, n=3; TEAM, n=25; and FAC, n=3) giving a completion rate of 76 %. Additionally, Equestrian Team members were grouped into 3 levels (1=Beginner; 2=Intermediate; 3=Advanced) based on experience using IHSA divisions. Data were analyzed using the general linear model procedure of SAS. No difference was noted between respondent groups ($P \geq 0.09$) or between the 3 experience levels ($P \geq 0.19$). This implies that the equine personality testing questionnaire used is accurate regardless of experience level. However, it is noted that the sample size of this study was small and should be repeated before making generalized statements.

Characterization and Collection of *Rhizobium leguminosarum* Strains from North Dakota Soils

NATALIE VISICH
MICROBIOLOGY AND BIOTECHNOLOGY

MENTOR: Barney Geddes, PhD – Microbiological Sciences

Rhizobium leguminosarum bv. viciae is a species of soil bacteria capable of nitrogen fixation in symbiosis with peas (*Pisum sativum*). Although peas are often inoculated with *R. leguminosarum bv. viciae*, many natural members of this species are also abundant in North Dakota soils. In a large-scale sampling effort to assess the diversity of pea-nodulating rhizobia from North Dakota soil, soil samples were collected from twelve sites across North Dakota to be used in a trapping assay. Peas were grown in the soils for four weeks after which nodules were collected. Approximately 1000 rhizobia samples were collected from the nodules, which were then categorized into 44 unique strains based on ERIC PCR. Strains then had 16S RNA and *nodD* genes analyzed with BLAST to verify species. Interestingly, four of the 44 strains were found to be a different species of rhizobia, most similar to *Rhizobium mongolense*. *R. mongolense* is a nitrogen-fixing bacteria native to Mongolia, and is known to form symbiosis with alfalfa (*Medicago sativa*). Since this species has not been previously reported to form symbiosis with peas, we are performing bioinformatic analysis of new genomes to determine if we have discovered a novel species. Further investigations are being performed to verify the symbiotic capacity of the newly identified strains to form a novel symbiotic relationship with peas, and evaluate the productivity of the potentially novel symbiosis.

Resistance of Canola (*Brassica napus* L.) to *Leptoshaeria maculans* Infection

MD ZAHANGIR ALAM
PLANT SCIENCES

MENTOR: Mukhlesur Rahman, PhD – Plant Sciences

Canola, an updated version of *B. napus* L. with a trace amount of erucic acids and glucosinolates and a rich amount of omega-3 fatty acids, 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 variety 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 race of *L. maculans*, and screen out the resistant line(s) from their interaction. We inoculated 113 canola lines with nine replications by 10 microliters spore suspension of the virulent race of the fungus in the greenhouse 12 days after sowing. 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). Data were recorded 10 days after inoculation (DAI) and 20 DAI. At 10 DAI, we observed 1 highly resistant, 6 resistant, 60 moderate, 33 susceptible, and 10 highly susceptible lines, whereas, at 20 DAI, we got 2 highly resistant, 1 resistant, 8 moderate, 23 susceptible, and 76 highly susceptible canola lines. The identified resistant lines will be a valuable resource for developing high-yielding and durable blackleg-resistant canola cultivars in the future.

Do Pollen-Borne Microbes Benefit Juvenile Growth and Survival in the Solitary Bee, *Megachile rotundata*?

GAGANDEEP BRAR
BIOLOGICAL SCIENCES

MENTOR: Julia Bowsher, PhD – Biological Sciences

The alfalfa leaf cutting bee, *Megachile rotundata* F. is an important field crop pollinator. The females provision its offspring with pollen from different plant species. Pollen has a diverse community of microbes that are symbiotically associated with bees and contribute to their health and survival. Additionally, *Lactobacillus* clade is the most abundant microbe in the gut helping bees to digest pollen and has demonstrated resistance to a broad range of antibiotics. Despite the apparent importance of the microbial community, evidence concerning the direct and indirect effects of provision microbes on physiology, growth rate, and survival is lacking in *M. rotundata.* To test this hypothesis, we reared larva on the following provision treatments: pollen provision with antibiotics, sterile pollen provision, sterile pollen provision + *Lactobacillus micheneri*, natural pollen provision + *Lactobacillus micheneri*, and natural pollen provision (control). Gamma irradiation was used to sterilize the natural pollen provision. We hypothesis that individuals reared on manipulated diet showed significant effects on the growth rate, survival, and mass of larvae, prepupae, and cocoon. Moreover, we used metagenomics to study whether the bee-microbiome interaction and quality of diet can shape the fitness of *M. rotundata*. In the future, this study will improve the understanding of microbiome symbiotic relations with bee health and nutrition.

Estradiol Downregulates Myometrial Progesterone Receptor Protein Expression in Late Gestation Ewes

BETHANIA DAVILA
ANIMAL SCIENCES

MENTOR: Lawrence Reynolds, PhD – Animal Sciences

Preterm birth is the major cause of neonatal mortality throughout the world, the range in US livestock reaches 5-10%. Parturition requires activation of myometrial contractility, which may be driven by a withdrawal of progesterone and a rise in estrogen levels; however, estradiol can induce early parturition without the withdrawal of progesterone, the mechanism is unclear. The aim of this study was to evaluate if the progestogenic responsiveness of the uterus in late gestation ewes is affected by estradiol levels. We hypothesized that estrogen would affect myometrial progesterone receptor protein expression. To test our hypothesis, late gestation ewes were randomly assigned to either E (4 Silastic implants of 50 mg of estradiol; 200 mg/ewe; n=6) or C (4 empty implants; n=6) treatment groups. All treatments began at d 139 to 142 of gestation and ewes were euthanized 26 hr for tissue collection. Formalin-fixed cross-sections of the uterus were immunofluorescently stained for progesterone receptors along with DAPI for counterstaining and confocal imaging of myometrium was generated for image analysis of the receptor expression. Statistical significance ($P<0.05$) was assessed using the MIXED procedure of SAS. Results showed that estradiol treatment significantly downregulated myometrial progesterone receptor protein expression in E vs C groups (27.02 ± 36.68 vs 42.0 ± 3.68 intensity units, P=0.01). These results suggest that estradiol downregulates myometrial progesterone receptors, leading to activation of the myometrium, and early delivery.

Physical Properties of Cereal Grains Commonly Grown in North Dakota

PRITIKA DEVKOTA
CEREAL SCIENCE

MENTOR: Frank Manthey, PhD – Cereal Science

Cereal grains are one-dry seeded fruits called a caryopsis. Each grain is surrounded by a floral envelope or hull that is composed of palea and lemma. The hull protects the grain from disease, insects, and moisture. The hull is easily removed from wheat but not from barley, kernza, or oat during harvest. After harvest, the hull can be removed from barley and kernza by abrasion force and from oat by impact force. The hull represents about 14% of the weight of barley grain, 32% of the oat grain, and 40% of the kernza grain. Understanding the physical properties of grain is a crucial step in developing processes for grain movement, storage, and milling. The presence of the hull on the grain reduces the test weight, bulk density, and flowability of the grain but increases the force required to fracture the grain during the milling process. The results of this study indicated that dehulled grains had a better flow and handling properties compared to hulled grains. These results enable an evaluation of the grains to meet specific processing requirements and consumer needs, ultimately benefiting the food industry.

The Effects of Replacing Dried Distillers Grains with Solubles with A Heat-Treated Soybean Meal in Forage-Based Growing Cattle Diets

GRADY GULLICKSON
ANIMAL SCIENCES

MENTOR: Zachary Carlson, PhD – Animal Sciences

This study aimed to evaluate the effects of increased concentrations of metabolizable protein and lysine from heat-treated soybean meal (TSBM) in forage-based growing cattle diets predicted to have positive metabolizable protein balance. Seventy Angus-based steers (298±16 kg initial BW) were utilized in an 85-d randomized generalized block design with animal as the experimental unit. Dietary treatments were arranged to replace a proportion of the basal protein source, DDGS included at 16% dietary dry matter (DM), with TSBM at rates of 0% (TSBM0), 4% (TSBM4), 8% (TSBM8), and 12% (TSBM12) dietary DM. Steers were provided with ad libitum access to feed and water. The basal diets contained (DM basis) 44% corn silage, 37% oat hay, and 3% supplement. Steers were blocked by BW into light, medium, and heavy blocks. Daily feed disappearance was measured using an automated feed system with disappearance assumed to be intake. Steers were individually weighed every 28 d to calculate average daily gain (ADG) throughout the experiment. Growth performance and feed intake were analyzed utilizing the MIXED procedure of SAS with fixed effects of BW block and TSBM inclusion level. Treatments were evaluated when the F test was significant ($P \leq 0.05$). There were no differences ($P \geq 0.16$) for ending BW, ADG, dry matter intake (DMI), or gain:feed (G:F) among treatments. Therefore, in growing diets predicted to be sufficient in metabolizable protein, replacing distillers grains with a source of metabolizable protein and amino acids provided by heat-treated soybean meal did not affect growth performance.

Weed Detection on Croplands using Single Board Computers and Deep Learning Algorithms

ASTINA JOICE
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Igathinathane Cannayen, PhD – Agricultural and Biosystems Engineering

Weeds are plants out of place that can grow easily and competently which impacts crop yield and quality. Advances in electronics and information technologies including image processing have become promising tools for precise real-time weed and crop detection in the field, providing valuable information for site-specific weed management. Most of these systems are expensive and use relatively larger computing systems, therefore alternative inexpensive computing systems moved toward the image capture sensors are actively researched. Hence it is important to study the existing scenario so as to guide the research development in this specialized field. A single-board computer (SBC) is built on a single main circuit board that comprises a microprocessor, memory, input/output, and other peripherals. Raspberry Pi, Nvidia Jetson TX series, BeagleBone Black, Qualcomm Snapdragon, Intel Edison, and Odroid are some of the single-board computers. They operate on the principles of automation and robotization with encoded algorithms using sensor data collection in precision agriculture for a wide range of applications, including weed detection, disease detection, monitoring plant phenotype, and soil nutrient analysis. These boards could deploy advanced models such as deep learning to enable weed recognition in fields. Several research works highlight the aspects of single-board computers in precision agriculture yet there isn't any consolidated information on the research issue of in-field weed detection for better management. Consequently, a systematic literature review on SBCs to provide a foundational understanding of their role in weed management and identify the research gaps was conducted. A total of 38 relevant peer-reviewed journal articles were found across three academic databases (IEEE Xplore, Web of Science, and Scopus) using selected keywords and screening criteria. The collected research articles were published between 2012 and 2022 in scientific peer-reviewed journals. From the study, it was found that Raspberry Pi was used the most among SBCs because of its affordability, ease of use, access to various operating systems, and a bevy of accessories. The identified research opportunities will be used to guide the present research leading to the development of algorithms and tools for image processing and deep learning for cropland weed detection.

Keywords: Weed, Single board computers, Automation, Robotization, Precision agriculture, Deep learning, Image processing.

Tapping Global Wheat Diversity for Identifying Novel Sources of Genetic Resistance Against the Cereal Killer, Wheat Rust

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PLANT PATHOLOGY

MENTOR: Upinder Gill, PhD – Plant Pathology

Leaf rust (LR), caused by *Puccinia triticina (Pt)* is among the most devastating diseases posing a significant threat to wheat production globally. Genetic resistance is the most efficient and cost-effective management tool for combatting leaf rust. The continuously evolving virulent Pt races in North America call for exploring new sources of leaf rust resistance. A diversity panel of 365 bread wheat accessions selected from a worldwide population of landraces and cultivars was evaluated at the seedling stage against four *Pt* races (TDBJQ, TBBGS, MNPSD and TNBJS). A wide distribution of seedling responses against the four *Pt* races was observed. The majority of genotypes displayed a susceptible response with only 28 (9.8%), 59 (13.5%), 45 (12.5%), and 29 (8.1%) wheat accessions exhibiting a highly resistant response to TDBJQ, TBBGS, MNPSD and TNBJS, respectively. Further, we conducted a genome-wide association study (GWAS) using a set of 302,524 high-quality single nucleotide polymorphisms. The GWAS analysis identified 27 marker-trait associations (MTAs) for leaf rust resistance on different wheat chromosomes of which 20 MTAs were found in vicinity of known *Lr* genes, MTAs, or quantitative traits loci (QTLs) identified in previous studies. The remaining seven significant MTAs identified represent genomic regions that harbor potentially novel genes for leaf rust resistance. Furthermore, the candidate gene analysis for the significant MTAs identified various genes of interest that may be involved in disease resistance. The identified resistant lines and SNPs linked to the QTLs in this study will serve as valuable resources in wheat rust resistance breeding programs.

Image Analysis Approach to Study the Effect of Tempering on Particle Shape of the Whole Wheat Flour from Stone Mill

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CEREAL SCIENCE

MENTOR: Frank Manthey, PhD – Cereal Science

Stone milling is considered the oldest milling technique in the world. In recent years there has been increased interest in artisan bread products made using stone-milled flour. The flour flow properties are affected by their shape. Tempering is a premilling treatment associated with roller milling which has been found to affect particle shape. The effect of grain tempering on the particle shape of the stone-milled flour is an under-studied area. Tempered wheat samples were kept for 1, 2, and 4 days at 12, 14, and 16% moisture content. Particle shape factors such as circularity, radius ratio, relative size, roundness, diameter, perimeter, area, length, and width were measured using digital image processing. The particle shape factors were not significantly affected by tempering days or tempering moistures. Particle diameter, perimeter, area, radius ratio, length, and width tended to increase with increasing tempering moisture. Roundness and circularity of the flour particles tended to decrease with increased tempering moisture.

Chemotactic Differences Between Strains of *Rhizobium leguminosarum bv. viciae*

AMANDA B. PEASE
MICROBIOLOGICAL SCIENCES

MENTORS: Birgit Pruess, PhD, and Barney Geddes, PhD – Microbiological Sciences

Plants exude chemicals (chemoattractants) from their roots to attract beneficial microbes to the root system. Legumes particularly will form a symbiotic relationship with certain species of nitrogen fixing bacteria, such as peas with *Rhizobium leguminosarum bv. viciae*. These bacteria create plant-usable nitrogen, a key element in plant health, through nitrogen fixation. Nitrogen fixing bacteria strains can vary in efficiency, however, the use of chemoattractants to enhance symbiosis with efficient strains has been left relatively unexplored. Therefore, the aim of this study was to evaluate chemotactic responses of a diverse set of strains to a panel of chemoattractant sugars and amino acids. Four strains of *R. leguminosarum bv. viciae*, three North Dakota natives, G11, G22, and G8A, and one wild-type, 3841, were tested for chemotactic behavior using 19 different chemoattractants at 1mM in minimal media soft-agar swim plates. Standardized bacterial cultures were inoculated in the center of the plate and swim ring diameters were recorded over time. Distinct differences in swim rate between strains and chemoattractants were found indicating an exciting possibility for precise bacterial attraction. G22, a more effective nitrogen fixer, showed greater chemotactic responses in Meso-erythritol and L-Asparagine than G11, a less effective nitrogen fixer. This study is a first step towards the use of chemoattractants to specify bacterial "recruitment" for nitrogen fixing efficiency. Future experimentation in greenhouse pea assays using erythritol and asparagine should give a more detailed picture of how these swim plate results could translate into a plant root environment.

Homozygosity Mapping Identified Loci and Candidate Genes Responsible for Freezing Tolerance in *Camelina sativa*

T M SHAIKH
PLANT SCIENCES

MENTOR: Mukhlesur Rahman, PhD – Plant Sciences

Homozygosity mapping is an effective tool for detecting genomic regions responsible for a given trait when the phenotype is controlled by a limited number of dominant or co-dominant loci. Freezing tolerance is a major attribute in agricultural crops such as camelina. Previous studies indicated that freezing tolerance differences between a tolerant (Joelle) and susceptible (CO46) variety of camelina were controlled by a small number of dominant or co-dominant genes. We performed whole genome homozygosity mapping to identify markers and candidate genes responsible for freezing tolerance difference between these two genotypes. A total of 28 F3 RILs were sequenced to ~30X coverage, and parental lines were sequenced to >30X-40X coverage with PacBio-HiFi technology and 60X coverage using Illumina whole genome sequencing. Overall, ~126k homozygous SNP markers were identified that differentiate both parents. Moreover, 617 markers were also homozygous in F3 families fixed for freezing tolerance/susceptibility. These markers all mapped to 2 contigs forming a contiguous stretch of chromosome 11. The homozygosity mapping detected 9 homozygous blocks among the selected markers and 22 candidate genes with strong similarity in or near those homozygous blocks. Two such genes were differentially expressed during cold acclimation in camelina. The largest block contained a cold-regulated *plant thionin* and a putative *rotamase cyclophilin-2* gene previously associated with freezing tolerance in Arabidopsis. The second largest block contains several *cysteine-rich RLK* genes and a cold-regulated *receptor serine/threonine kinase* gene. We hypothesize that one or more of these genes may be primarily responsible for freezing tolerance differences in camelina varieties.

Key words: Homozygosity mapping, freezing tolerance, cysteine-rich RLK (Receptor Like Kinase), abscisic acid (ABA), candidate genes, whole genome sequencing

Genomic Methods to Facilitate Durable Crown Rust Resistance in Oats

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PLANT SCIENCES

MENTOR: Michael McMullen, PhD – Plant Sciences

Oats are one of the most important cereal crops in the United States and occupy a health food niche in the market. Crown rust caused by *Puccinia coronata f.sp. avenae* is one of the most devastating diseases threatening the global oat production. Development of resistant oat cultivars has been the primary means of control. To investigate the genetic control of two unique sources of crown rust resistance, termed CRRSRR1 and CRRSRR3, $F_{5:6}$ recombinant inbred line populations (RILs) were developed from the crosses ND141862/ND141087 and ND130020/ND130182, respectively. In greenhouse, seedling tests were conducted for these populations inoculated with crown rust urediniospores. The infection type was scored and segregation ratio indicated single dominant gene action for resistance in both populations. DNA was extracted from leaf tissue samples and molecular markers associated will be identified using 25k single primer enrichment technology (SPET) genotyping. Linkage analysis will be performed, and quantitative trait loci will be identified. Fulfilling this objective helps in utilizing the associated markers for marker assisted selection. This leads to development of genetically resistant oat genotypes that benefit oat growers and community.

GRADUATE STUDENT COUNCIL RESEARCH SYMPOSIUM

Marker-Assisted Introgression of a Race-Nonspecific Qtl Conferring Resistance to Tan Spot into the NDSU Durum Wheat Cultivars

NAMRATA ACHARYA
PLANT SCIENCES

MENTOR: Xuehui Li, PhD – Plant Sciences

Tan spot is a fungal disease of wheat caused by necrotrophic fungal pathogen Pyrenophora-tritici-ripentis. It affects the leaves of wheat, causing a reduction in the total photosynthetic area and a subsequent decrease in production. To control the disease in an environmentally friendly and sustainable manner much current research focuses on developing wheat varieties with resistance to tan spot. From previous genetic mapping studies, a race-nonspecific QTL was discovered on chromosome 3B. In this study, we integrated the favorable allele of the 3B-QTL into the NDSU durum wheat cultivars "Grano '' and "Riveland '' via marker-assisted backcross selection. The efficiency of the 3B-QTL were tested using 21-days old seedlings of BC4F2, BC4F2:3, and BC5F2:3 progenies for multiple isolates including 331-9, DW5, and ND1 in greenhouse and found that the introgression lines with the favorable allele had significantly lower disease severity than the recurrent parents "Grano" and "Riveland". These results suggest that the 3B-QTL has been successfully introgressed into the durum wheat cultivars and improved tan spot resistance. Further research will be conducted to test efficiency of the 3B-QTL on disease severity in field conditions, as well as the effects on grain yield and quality related traits.

Keywords: Pyrenophora-tritici-ripentis, race non-specific QTL, isolates, recurrent parents, marker-assisted selection.

Factors Associated with Influenza Vaccine Uptake Amongst Pregnant Women In North Dakota

RHODA OLAIDE ADEWUNMI
PUBLIC HEALTH

MENTOR: Grace N. Njau PhD, MPH – Public Health

Pregnant women are at increased risk for severe illness and complications following influenza infection. Receiving an influenza vaccination is one of the best ways to prevent infection and influenza vaccination during pregnancy is safe in every trimester. Little information exists detailing how many pregnant women in North Dakota receive an influenza vaccination and what factors affect influenza vaccination uptake. This study aimed to examine the differences among North Dakota who received an influenza vaccination compared to those who did not.

Data on self-reported Influenza vaccine uptake amongst North Dakota women with a live birth between 2017 and 2020 was drawn from the North Dakota Pregnancy Risk Assessment Monitoring System (PRAMS). Descriptive statistics, simple association and multivariate logistic regression were used to examine the relationships between influenza vaccine uptake and potential predictors. Sociodemographic, medical, and other health factors were adjusted for in this analysis.

The sample size for this study was split between pregnant women who had received an influenza vaccine (n=19,327) and those who had not (n=6,297). A multiple logistic regression analysis that income (p-value=0.039), flu shot recommendations (p-value<0.001), type of doctor's visits (p-value=0.024), insurance paid by job (p-value=0.002), and insurance paid by military (p-value=0.008).

Vaccination against influenza should be considered a critical component of prenatal care and public health education due to the increased risk of morbidity and mortality during pregnancy and among infants in the early postpartum period.

Keywords: Influenza, Birth outcomes, Pregnancy, Vaccination, Prenatal care

The Roles of Policy, Systems and Environment in the Mitigation of Opioid-related Harms in North Dakota.

SHRADDHA ADHIKARI
PUBLIC HEALTH

MENTOR: Mark Strand, PhD – Public Health

Motivation:
The volume of opioid prescriptions in ND declined 34% from 2006 to 2020; however, the burden of opioid use disorder and overdoses/deaths have fluctuated year to year without a consistent decline. While treating individual patients is necessary, it is insufficient to improve health outcomes at the population level. A Policy, Systems, and Environment (PSE) approach assumes that policy change at the highest-level influences system changes, which then change the local environment, making it an effective way to address the health of the whole population of North Dakota.

Methods:
Shaver has identified six best practice domains for evaluating opioid-related harms at state level. Shaver's model was used to conduct a systematic review of North Dakota's opioid-related policy environment. This included online searches and depth interviews with North Dakota stakeholders from various fields. The analysis included reviewing the policies and their implementation status in North Dakota.

Results:
North Dakota opioid-related policies were found to be in close alignment with public health best practice standards, particularly opioid prescribing regulation, prevention and education indicators, and emergency response statutes. However, areas needing to be improved upon are medical practices around opioid prescribing, and opioid use data collection.

Conclusion:
Actual implementation at the community level is not well monitored or reported. Greater intersectoral communication and strategic planning according to the PSE approach are needed to improve opioid mitigation in North Dakota. In order to resume first place as the healthiest state in the nation, North Dakota will need to address deficiencies in opioid misuse prevention and treatment.

Keywords: Opioid, overdose, prescription, policy, disorder.

Role of specific root exudate compounds in chemotactic motility of Azospirillum brasilense Sp7 in the swim-plate.

FATEMA AKTER NISHA
MICROBIOLOGY

MENTOR: Birgit Pruess, PhD – Microbiology

The free-living, nitrogen-fixing bacterial species Azospirillum is one of the studied rhizobacteria that aid in plant growth by traveling toward the plant's roots, exudates, and colonizes the roots. By supporting the inoculant bacteria with specific plant root exudates, it may be possible to accelerate plant growth and health which would help to give food security. While the swimming often can be observed via a microscope, the use of the plate-based assay for the observation of bacterial motility is interesting. The swim plate assay was used to examine the chemotaxis of Azospirillum brasilense Sp7 to known compounds of plant root exudates that might serve as chemoattractants for the bacteria. The production of chemotactic rings indicates chemotaxis towards the compound. In terms of both migration and growth rate, the performance of A. brasilense Sp7 with succinate was generally better. Even though with fructose, A. brasilense Sp7 showed the highest growth out of all the tested root exudate compounds, the swimming rate was considerably slower than that seen with succinate. These findings demonstrate the dynamics of bacterial chemotaxis response that might guide the Azospirillum brasilense Sp7 in real-time in plant root colonization and help in increasing plant growth, crop yield, and root volume.

Keywords: Chemoattractants enhance rhizobacteria motility

Development of an in vitro cellular model of tumors for the study of drug resistance in melanoma.

YOUSUF ALAM
PHARMACEUTICAL SCIENCES

MENTOR: Estelle Leclerc, PhD – Pharmaceutical Sciences

The study of drug resistance in tumors typically requires the use of animals to include the effect of the tumor microenvironment. Animal studies are lengthy and costly. We propose here to develop an in vitro model of melanoma tumor that would allow us to quickly and efficiently study drug resistance in melanoma tumors. Our model consists of 3D spheroids generated from human melanoma cells, combined with fibroblasts that will mimic the tumor microenvironment. Our initial objective was to generate reproducible and consistent 3D spheroids from melanoma cells and to develop a robust assay for assessing changes in cell viability in the cells, within the 3D spheroids. From the two human A375 and WM115 melanoma cell-lines tested, only WM115 could form consistent and solid 3D spheroids. Different methods for assessing cell viability in 3D spheroids were also tested. We observed that the metabolic dye Alamar Blue could be used after dissociation of the cells within the spheroids using trypsin. We are currently testing the effect of different anti-cancer agents on the spheroids and will determine how the formation of the 3D spheroids affects the sensitivity of the cells to the drugs.

Keywords: Cancer drug resistance

Electroconductive Polymer-Primed Fluoropolymer Coatings for Corrosion Protection

MARK RIGEL ALI
COATINGS AND POLYMERIC MATERIALS

MENTOR: Eugene Caldona, PhD – Coatings and Polymeric Materials

In this study, we developed a dual-coating system, composed of poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) as primary coating and electrodeposited polyaniline (PANI) as primer, for stainless steel (SS). Prior to applying the PVDF-HFP topcoat, the undercoat PANI (either protonated emeraldine salt or deprotonated emeraldine base form) was potentiodynamically electrodeposited on both neat and etched SS surface using oxalic acid as electrolyte. Electrochemical impedance spectroscopy and potentiodynamic polarization were employed to quantitatively investigate the corrosion resistance and protective properties of the coatings in 3.5 wt% NaCl test solution. Results from electrochemical measurements showed that the dual PVDF-HFP/PANI coating system displayed higher corrosion protection than either PVDF-HFP or PANI coating alone. This result can be attributed to the additional defensive layer from the dual-layer configuration, good PVDF-HFP/PANI and PANI/SS adhesion, and combined low surface energy of PVDF-HFP and improved hydrophobicity due to increased surface roughness by etching. Furthermore, the surface topology, chemical structure, and wettability of the fabricated coatings were characterized by microscopy, spectroscopy, and contact angle measurements, respectively.

Keywords: Corrosion, coatings, electrodeposition, polyaniline, PVDF-HFP

Impact of Adverse Weather Conditions on Exhaust Emissions and Fuel Consumption in a Mixed Flow of Autonomous and Human-Driven Vehicles

MELIKA ANSARINEJAD
CIVIL ENGINEERING – TRANSPORTATION

MENTOR: Ying Huang, PhD – Civil, Construction, and Environmental Engineering

Inclement weather conditions have severe impacts on driver behavior, traffic flow, and roadway infrastructure. Although years of study have been devoted to identifying the effect of environmental conditions on driving behavior, crash risk, and traffic flow to minimize the detrimental consequences of adverse weather on infrastructure and travelers, a research gap exists on the impact of adverse weather conditions on fuel consumption and exhaust emission of vehicles. This study aims to first, evaluate fuel consumption and exhaust emission under four weather scenarios; clear sky, rain, snow, and fog by simulating the vehicles' driving behavior utilizing PTV VISSIM microsimulation software. Second, it investigates the potential of different penetration rates of automated vehicles in enhancing mobility and decreasing fuel consumption, and greenhouse gas emissions on a shared road with human-driven vehicles. The finding of this study indicates that compared to the clear sky, vehicles under adverse weather conditions consume more fuel and produce a higher amount of CO and NOx emissions. Furthermore, the gradual transition from a traditional network (100% human-driven vehicles) to a network with a 90% share of autonomous vehicles using the developed microsimulation model demonstrates improvement in the traffic flow and reduction in exhaust emissions. This research provides valuable insights into the correlation between adverse weather conditions and vehicular exhaust emissions by focusing on driving behavior parameters as intermediary variables. The findings of this study could serve as a resource for transportation engineers and policymakers to incorporate environmental factors in the design and adoption of safety and mobility countermeasures.

Keywords: Adverse weather, Exhaust Emission, Driving Behavior, Autonomous vehicle, VISSIM Microsimulation Model

Additive Manufacturing Using Reactive Resins

BIBEK ARYAL
MECHANICAL ENGINEERING

MENTOR: Chad Ulven, PhD – Mechanical Engineering

Additive Manufacturing (AM) with continuous carbon fiber is a layer-by-layer manufacturing process of objects from three dimensional models, which has numerous applications in many fields such as automotive, aerospace, sports, constructions etc. Due to its advantages, AM technique is one of the highly researched fields across a wide range of industries. AM can manufacture complex structures such as honeycomb structures which are difficult to manufacture with traditional manufacturing processes. The objective of this study is to develop and investigate the properties of 3D printed composites using reactive resins and continuous carbon fiber. Two-part reactive system uses the principle of mixing two individual components with the help of a static mixer which undergoes the fast-cross linking reaction at the point of deposition to produce the desired composite. Little to no post curing is required for this system. The printed specimen exhibits higher mechanical strength.

Keywords: Additive Manufacturing, carbon fiber, reactive resins, composites, 3D printing

Folding of Biopolymers in Crowded Environments

MAHESH ARYAL
PHYSICS

MENTOR: Alan Denton, PhD – Physics

Accurately modeling folding and predicting native structures of biopolymers (e.g., proteins, RNAs, DNAs) are grand challenges. Theories of folding suggest that proteins explore metastable intermediate states before arriving at the global minimum energy state [1]. Furthermore, folding behavior in biological cells is profoundly influenced by macromolecular crowding. We perform molecular dynamics simulations of coarse-grained models of proteins that are predicted to follow either two-state or multi-state folding pathways and explore how conformational stability and folding pathways depend on crowder properties, e.g., sizes, concentrations, and inter-particle interactions. From probability distributions of the eigenvalues of the gyration tensor in the principal axis reference frame, we determine the radius of gyration and shape of proteins in intermediate states, with and without crowding agents. The main concept is that the gyration tensor can serve as a predictor of the intermediate states of a protein and can distinguish different kinetic folding pathways. To validate our approach, we also simulate random-walk homopolymers in crowded solutions and compare against known shape distributions [2].

Keywords: Macromolecular crowding, Protein folding, Nanoparticles, Molecular Dynamics

Insights from Applying Association Rule Mining to Pipeline Incident Report Data

LEMLEM ASAYE
CONSTRUCTION MANAGEMENT

MENTOR: Chau Le, PhD – Civil, Construction, and Environmental Engineering

Pipelines are the critical component of energy infrastructure in the US for safely transporting large volumes of oil and hazardous materials over long distances. However, a considerable number of incidents occurred over the years, leading to shutdowns and disruptions and resulting in economic losses. Those incidents are reported and maintained by the Pipeline and Hazardous Materials Safety Administration (PHMSA) in a database, constituting a valuable resource for better understanding the underlying associations between those incidents' causes and shutdown durations. Most previous studies investigating pipeline incident databases are focused on bivariate statistical analyses between cause and effect variables, providing little to no insight into their associations. Also, few studies have investigated the level of disruptions caused by an incident. This study proposes a novel application of association rule mining to the PHMSA database to extract associations between causal factors (e.g., the reason for an incident), background factors (e.g., pipeline materials, diameters, or years of service), and their effects, particularly shutdown duration in this study. The results are expected to help planners, decision-makers, and engineers better understand the interrelationships between the factors and their effects, thereby improving pipeline infrastructure's planning, design, and operations.

Keywords: Pipeline incident, Causal factor, Background factors, Shutdown, Association Rule Mining

An Application of Multi-objective Optimization Technique in Green Supply Chain Network Design: A Corn Production Case Study in North Dakota

LABIBA NOSHIN ASHA
INDUSTRIAL AND MANUFACTURING ENGINEERING

MENTOR: Harun Pirim, PhD and Nita Yodo, PhD – Industrial and Manufacturing Engineering

One of the major concerns of green supply chain management is to balance costs and carbon dioxide (CO2) emissions throughout the entire supply chain network. CO2 emissions are a prime contributor to climate change, and reducing CO2 emissions is crucial for promoting a sustainable future. However, economic performance and CO2 emissions often negatively impact each other. Several studies have demonstrated that the harvesting techniques utilized in corn production can have conflicting effects on the cost of harvesting and the amount of CO2 emissions generated. This paper developed a multi-objective model that utilizes the concept of simultaneously minimizing total cost and CO2 emissions. Specifically, this model was applied to a supply chain scenario involving corn production zones and ethanol plants in North Dakota. In order to simplify the multi-objective model, the ε-constraint method was employed to transform it into a single-objective model. The model analysis results showed that the total cost and CO2 emissions associated with each scenario varied significantly based on the harvesting techniques employed in each corn production zone. This underscores the importance of carefully considering the impact of different harvesting techniques on both cost and environmental factors when making decisions about corn production and related supply chain activities for a sustainable future.

Keywords: Green supply chain, sustainability, multi-objective optimization

Improving Pregnancy-Related Outcomes: Eligible Women in North Dakota Now Have Medicaid Health Care Coverage for 12 months After Pregnancy.

VALENTINA ASIEDU
PUBLIC HEALTH

MENTOR: Ramona Danielson, PhD – Public Health

Statement of the Problem: To address the issue of postpartum-related deaths in underserved women in North Dakota, the Title V team at the North Dakota Department of Health and Human Services sought to extend Medicaid beyond 60 days postpartum and allow all eligible beneficiaries, including those in underserved communities, coverage to get the follow-up care they need care in the year after pregnancy.

Approach (Policy Amendment Process): The passing of the American Rescue Plan Act (ARPA) Legislation on April 1, 2022, gave ND the option to extend Postpartum Medicaid coverage from 60 days to 12 months by submitting a State Plan Amendment (SPA) to the Centers for Medicare and Medicaid Services (CMS).

Results: Extension of Medicaid Postpartum coverage from 60 days to 12 months went into effect January 1, 2023.

Implications: The policy change Aligns with ND DHHS's vision to make ND the healthiest state in the nation by providing extended health care for races/ethnicities that are more likely to use Medicaid coverage during pregnancy.

Next Steps: Priority is reaching eligible women about the services available to them with communication materials such as print posters, rack cards, business cards, and banners developed and distributed to Human Service Zones and WIC offices statewide as well as through digital marketing campaigns.

Keywords: Postpartum, Medicaid, extension, amendment, policy.

Response of Soybean Yield and Nodulation to Co-Inoculation and N Fertilization

JOSE BAIS
PLANT SCIENCES

MENTOR: Hans Kandel, PhD – Plant Sciences

Soybean [Glycine max (L.) Merrill] relationship with Bradyrhizobium japonicum is responsible for providing around 60% of the nitrogen (N) required for the crop; the remaining amount comes from the soil or N supplemental fertilization. To investigate if higher yields with appropriate seed quality are possible, supplemental N studies in soybean are necessary. This study was conducted testing B. japonicum inoculated soybean response to six treatments with N rates of 0, 30, 56, 112 and 336 kg N ha-1 combined with 34 kg S ha-1, and a treatment also inoculated with Azospirillum spp., across eight environments in eastern North Dakota, in 2021 and 2022. Plant height, seed yield, seed weight, protein and oil content, were measured. The treatment effect on biological N2 fixation was investigated through a nodulation study in three treatments at the full flowering and full seed growth stage, where, ten plants were randomly dug out of the soil, cleaned and, viable nodules were counted and classified by diameter size as small (< 1 mm), medium (2 to 4 mm) and large (> 4 mm). Nitrogen significantly increased grain yield, seed protein content, and seed weight. However, it decreased plant population, and nodulation. Supplemental N resulted in a yield increase but it was uneconomical. Therefore, supplemental N is not advised for most North Dakota soybean growers.

Keywords: Soybean, Nitrogen, Nodulation, Azospirillum

Predicting the Maturity of Dry Pea using Machine Learning Algorithms and Unmanned Aerial Systems (UAS) Equipped with RGB, Multispectral, and LIDAR Sensors

ALIASGHAR BAZRAFKAN
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Paulo Flores, PhD – Agricultural and Biosystems Engineering

The trait of maturity is critical in dry pea breeding programs; however, the traditional method of measuring this trait is time-consuming, labor-intensive, and prone to errors. Hence, a more efficient and accurate approach is necessary to support such programs. In this research, we propose a new approach to measure the maturity of dry pea using machine learning algorithms and unmanned aerial systems (UASs) collected data. We evaluated the performance of five machine learning algorithms based on their ability to precisely classify dry pea maturity on field plots. The machine-learning algorithms considered crop height metrics and narrow spectral bands as variables. The results indicated that the random forest model provided the most accurate predictions of pea maturity, and the sensitivity analysis showed that spectral features were better predictors of maturity than structural features. Overall, this study demonstrated the effectiveness of combining machine learning algorithms, UASs-borne Lidar, and multispectral data to accurately assess the maturity of peas.

Keywords: Dry pea phenotyping, machine learning, LIDAR, narrow spectral bands

Understanding invasive plants through microbiomes

LENNEL CAMUY-VELEZ
DEPARTMENT OF MICROBIOLOGICAL SCIENCES

MENTORS: Kevin Sedivec, PhD – School of Natural Resource Sciences; Samiran Banerjee, PhD – Microbiological Sciences

Invasive plants are a problem for native ecosystems and the world economy. Plant invasion threatens biodiversity via homogenization of the community. Evidence shows invasive plants modify soil attributes, which can affect below-ground dynamics. While previous studies have investigated the importance of physiological traits for plant invasion, our understanding of microbial contributions to plant invasion is limited. A critical question that remains to be answered is whether invasive plants secrete specialized metabolites to recruit specific microbial groups. This project aims to uncover this using Kentucky bluegrass, an invasive plant dominating the Northern Great Plains region, and comparing it to a well-known native plant Switchgrass. We conducted a greenhouse experiment by growing Kentucky bluegrass and Switchgrass across five time points. We used Illumina MiSeq sequencing of 16S rRNA gene for bacteria and ITS for fungi in both roots and rhizosphere. Additionally, we collected root exudates from both plants across different time points and analyzed them using HPLC Mass Spectrometry. In the roots, we found differences among the plants, with Kentucky bluegrass having higher diversity in both fungal and bacterial communities. Host plants and plant compartments significantly altered the fungal and bacterial communities. We also found distinct metabolite profiles for invasive and native plants that diverged over time. Our study provides insights into the mechanisms by which invasive plants like Kentucky bluegrass outcompete native plants, with microbial recruitment through metabolites playing an important role.

Keywords: invasion, microbiome, Kentucky bluegrass

Personalized optimization of room temperature and illuminance for maximum occupant performance using human physiological data

HARDIK CHAUHAN
CONSTRUCTION MANAGEMENT

MENTOR: Youjin Jang, PhD – Civil, Construction, and Environmental Engineering

Indoor room temperature (RT) and illuminance level (IL) are the top factors of indoor environment quality (IEQ) affecting Human mental performance. This impact can be observed in their physiological responses such as heart rate (HR), electrodermal activity (EDA) and skin temperature (ST). Previous research studies and technical standard guidelines have focused on studying their effects individually and generalizing their effects for everyone. However, the present study is focused on personalized optimization of RT and IL for maximum mental performance based on four mental abilities of the human brain which are attention ability, perception ability, working memory ability and thinking ability using human physiological data. This study was conducted on 17 subjects, and their physiological parameters, such as HR, EDA and ST were recorded while the subjects were performing mental cognitive tasks. We created a two-step machine learning and optimization technique-based model to predict mental performance and then optimize the RT and IL for maximized mental performance. We used Random Forest regressor for predicting mental performance and used the trained model as an objective function to optimize the room temperature and illuminance level using Particle Swarm Optimization (PSO) technique individually. The results of the optimization model have shown a similar pattern that was observed for maximum performance in experiments and show variation in optimized temperature and illuminance level for each individual, which validates the assumptions for adopting personalized models. Personalized optimization model and other results of this study will help in future guidelines of IEQ models for maximum human performance.

Keywords: Personalized IEQ, Physiological response, occupant performance, Machine-learning, PSO

Fluid-Structure Interaction of Collapsible Thin-Walled Vessel under Different Flow Conditions

SIFAT KARIM CHOWDHURY
MECHANICAL ENGINEERING

MENTOR: Yan Zhang, PhD – Mechanical Engineering

Interaction between the fluid flow and the collapsible thin-walled vessel is common in physiological systems, such as blood flow in veins and airflow in the pharyngeal channel and pulmonary airways. The underlying physics is quite complex as it involves nonlinear interactions between the flow instability and the elastic wall inertia. More specifically, thin-walled vessels such as human vein vessels and other physiological fluid transport systems could undergo significant narrowing deformation or self-excited oscillations under certain critical conditions. In this study, we conducted a series of experiments to visualize and quantitatively study the dynamics of the fluid flow and the wall deformations in a thin-walled vessel using optical analysis and Particle Image Velocimetry. Our results show that the thin-wall vessel deformation follows the classical Shapiro's tube law up to a certain Reynolds number. The maximum collapse location shifted as the Reynolds number and transmural pressure changed. A critical range of negative transmural pressure triggers self-excited oscillation, which is induced by interaction between the wall inertia and the fluctuating fluid pressure acting on the internal wall. Both chaotic and cyclic oscillations were observed under different conditions and the frequency and amplitude of the oscillation are also functions of Reynolds number and transmural pressure. The results imply that the non-linear dynamics of the vessel-flow interaction might play a vital role in the transport processes where the critical Reynolds number and transmural pressure conditions are met. The experimental study provides valuable benchmark cases for systematic theoretical analysis and computational fluid-structural interaction simulations.

Keywords: Fluid-Structure Interaction, Collapsible tube, Self-Excited Oscillation, Tube law, Flow Physics

Avian Nest Survival in a Heterogeneity-based Rotation Grazing System

JUSTIN CLARKE
NATURAL RESOURCES MANAGEMENT

MENTOR: Torre Hovick, PhD – Natural Resources Management

Rangelands comprise a large portion of global land cover and represent an opportunity to improve declining bird populations through innovative management. Current rangeland practices uniformly utilize forage which homogenizes vegetation structure, thus reducing niche diversity and nest survival for grassland birds. In 2018 we modified a common grazing practice in the northern great plains, the twice-over rotation grazing system, to create heterogeneity without the need for producers to alter existing infrastructure. Rather than uniformly grazing each paddock, we varied grazing intensity to create vegetation structural heterogeneity. Our objectives included quantifying 1) changes in vegetation structure attributed to grazing intensity and 2) impacts on avian nest survival. We located nests through systematic nest-dragging and sampled vegetation across each pasture as well as at each nest. Nest-site vegetation measurements were incorporated into a hierarchical modeling scheme to assess nest survival. We found that modifying grazing intensity creates heterogeneity which impacts nest survival by altering key structural components associated with nest survival. However, responses to these structural components were species-specific, reflecting the importance of heterogeneity. For instance, Clay-colored sparrows responded positively to increasing vegetation height whereas Western Meadowlark nest survival sharply dropped as vegetation height increased. Increases in litter depth were accompanied by increased nest survival by Gadwall but decreasing nest survival by Northern Pintails. Understanding species-specific responses can allow for more informed and directed management for imperiled grassland birds. Additionally, we demonstrate the potential of an alternative rangeland management practice to create high quality habitat for a broad spectrum of grassland birds.

Keywords: birds, grazing, conservation, rangelands, management

Multi-Endpoint Acute Toxicity Assessment of Organic Compounds Using Large-Scale Machine Learning Modeling

AMIRREZA DAGHIGHI
BIOMEDICAL ENGINEERING PROGRAM

MENTOR: Bakhtiyor Rasulev, PhD – Coatings and Polymeric Materials

In recent years, computational investigations have become increasingly important for toxicity testing, as they allow for animal testing to be minimized while also reducing costs and time. Machine learning is a significant and rapidly developing tool for in silico discovery in the fields of drug development and environmental chemical screening. The complexity of available biomedical data presents a challenge to the development of predictive models, but multi-condition descriptors offer a solution for combining data from various assays to create a more accurate and robust model. In this work, we use multi-condition descriptors (MCDs) to develop a QSTR (Quantitative Structure-Toxicity Relationship) model based on a large dataset of toxicity, comprising 59 different endpoints and more than 80,000 compounds, which comprising of 122572 data points. In this study, we provide prediction capabilities of 7 single-task machine learning models as well as a novel method to use Convolutional Neural Networks (CNN) to develop QSTR models. The results show that using MCDs significantly improves predictability power of the model and using them with CNN-1D yields the best result (R¬¬¬¬¬2¬¬¬ =0.93, R¬¬¬¬¬2¬¬¬ext =0.7). These models will enable us to predict toxicity of a variety of compounds under different conditions, giving us a better understanding of their impact on the environment.

Keywords: Toxicity, Organic compounds, Machine Learning, QSAR, Multi-endpoint

Assessing Corn Goss's Wilt Disease Using Aerial Multispectral Imagery

ANUP KUMAR DAS
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Paulo Flores, PhD – Agricultural and Biosystems Engineering

Goss's wilt is one of the most severe corn diseases in North Dakota, USA. The early diagnosis of the corn Goss's wilt disease could save yield and aid in the selection of a corn variety for the following year. Therefore, the development of an early detection system has been a top priority. In recent years, unmanned aerial systems (UASs) equipped with cutting-edge technology have achieved promising results in several agricultural domains. A UAS-based disease evaluation system could be a viable solution for detecting Goss's wilt disease in corn. Multispectral imagery data was collected from a corn field near Horace, ND. The field was flown twice in August 2022, using a DJI Matrice 200 coupled with a RedEdge-MX dual sensor, which were flown at 45 ft above ground level. The image data was stitched using PIX4DMapper (Pix4D SA, Lausanne, Switzerland). Further processing was carried out to create two multispectral mosaic images (10 bands), from which a variety of vegetation indices (NDVI, GNDVI, NDRE, among others) and textural features (homogeneity, contrast, dissimilarity, entropy, mean, variance, correlation, and angular second moment) will be derived. In-house developed tools will be used to extract plot-level imagery features, which will be used to train and validate machine learning models such as Linear Regression, Support Vector Regressor, Random Forest Regressor, and Extreme Gradient Boosting Regressor. Models will be evaluated using R Square, Mean Square Error, and Mean Absolute Error. Results will be evaluated, and a recommendation regarding Goss's wilt detection will be made based on satisfactory performance of the model(s).

Can cover crops counter the negative effect of salinity on soil microbiomes?

DEBARSHI DASGUPTA
MICROBIOLOGY

MENTOR: Samiran Banerjee, PhD – Microbiological Sciences

Soil salinity is a significant abiotic stress that limits crop growth and productivity in North Dakota. It also presents an environmental filter for microbes in soil, influencing ecosystem services and functions. We posit that cover cropping can help mitigate the negative impact of soil salinity. However, our knowledge on its influence on soil microbial diversity and complexity is limited. In this field study, we explored the soil microbial and physicochemical properties over four locations in ND, which have experimental fields comprising two levels of salinity (saline: SS, and non-saline: NS) and cover cropping with cereal rye (Secale cereale, cover-cropped: CC, and non-cover-cropped: NC). Our hypothesis was that soil microbial diversity and complexity will be lower in saline as compared to non-saline soils, and the reduction can be countered by inclusion of cover crops. Our results show that salinity influenced the way bacterial communities were structured, while cover cropping led to higher bacterial and fungal alpha diversity. Notably, inclusion of cover crop treatments also led to greater network complexity, under both saline and non-saline conditions. Members of order Thermomicrobiales stood out as a prominent keystone taxon. Overall, our results identify key microbial players under salinity stress, and underscore the untapped potential of cover crops in ameliorating salinity in agroecosystems.

Keywords: Cover crop, soil microbiome, soil salinity

Improving soil health under crested wheatgrass (Agropyron cristatum (L.) Gaertn.) to facilitate the future restoration of native plant diversity

HEATHER DAVIS
ENVIRONMENTAL AND CONSERVATION SCIENCE

MENTOR: Caley Gasch, PhD – Soil Science; University of Alaska-Fairbanks

United States land managers seek to restore diversity of native plant species in crested wheatgrass (CWG) (Agropyron cristatum) dominated areas, but have had limited success using aboveground management approaches. This study aims to find the most effective management methods for reducing CWG while enhancing the soil for future native species establishment. From 2022-2023, a field study with vegetation surveys will be conducted near Glasgow, MT in the Great Plains region of the United States to analyze 10 CWG management methods and their effects on soil and vegetation. The 4 methods analyzed alone were: no treatment, herbicide (H), cover crops (CC), and a biological soil amendment (A). In the other 6 treatments, we combined the previous methods and included tillage: amendment + herbicide (AH), cover crop + amendment (CA), cover crop + herbicide (CH), cover crop + tillage (CT), cover crop + amendment + tillage (CAT), cover crop + amendment + herbicide + tillage (CHAT). We used R to calculate means of CWG in each treatment and standard deviations. In relation to no treatment - 20% (±0.12), CWG cover was lowest in CAT – 7.1% (±0.06) and CHAT-7.03% (±0.03), while highest in CA 35.49% (±0.12) and CC- 32.17% (±0.11). In 2023, a greenhouse study and soil analyses will also be conducted. For our soil analyses results, we expect higher microbial and AM fungi abundance in cover crop and amendment treatments. Our final results will see if the addition of belowground management approaches can restore soil microbial diversity for native plant establishment.

Keywords: Invasive, Restoration, Soil, Microbial, Fungi

Vasoactive intestinal peptide (VIP) differentially drives propionate-induced gluconeogenic gene expression in mice.

RAZIA DAWLATY
DEPARTMENT OF MICROBIOLOGICAL SCIENCES

MENTOR: Glenn Dorsam, PhD – Microbiology

Human obesity is a 21st century epidemic that places an enormous societal health burden equaling 179 billion dollars annually. Evidence supports that a diverse gut microbiota is essential for positive metabolic health benefits (PMHB) by providing short chain fatty acids (SCFA) metabolized from undigested dietary fiber. Propionate, a SCFA, has been reported to improve glucose and insulin metabolism, energy expenditure and weight management by inducing intestinal gluconeogenesis through the upregulation of the rate-limiting enzyme, G6Pase. Rat studies fed a propionate-rich diet failed to induce G6Pase enzymatic activity in the presence of a neurotoxin, suggesting that neuronal factors were required. Our laboratory has shown that the gut neuropeptide, vasoactive intestinal peptide (VIP), is a homeostatic regulator for the gut microbiota, and we hypothesized that its genetic removal would "short-circuit" propionate-induced gluconeogenic gene expression at the mRNA level. To this end, we fed VIP deficient mice a propionate-rich diet for two weeks and measured jejunal expression of four gluconeogenic genes by digital PCR. Our data showed that propionate did not alter gluconeogenic gene mRNA in WT mice but did in heterozygous samples that became less effective in KO samples. Collectively, our data support that propionate induces gluconeogenic gene expression in a VIP-dependent manner that is readily observed when VIP expression is reduced but not completely abolished.

Could intestinal chemoattractant signals recruit ILC3s in a VIP-VPAC1 signaling dependent manner to regulate intestinal tissue homeostasis?

JESSICA DECUYPER
MICROBIOLOGY

MENTOR: Glenn Dorsam, PhD – Microbiology

Understanding the mechanism of type 3 innate lymphoid cell (ILC3) recruitment to the intestines would allow for a better understanding of intestinal homeostasis mechanisms regulating gut microbiota diversity, resistance to pathogen infections, inflammatory bowel diseases and colorectal cancers. Previously, our research group discovered that mice deficient for the gut neuropeptide, vasoactive intestinal peptide (VIP), or its receptor, VPAC1, drives homeostatic maintenance of the gut microbiota. Yu et al. recently demonstrated that VIPVPAC1 signaling was also required for immune surveillance cells, called ILC3s, to the intestines in postnatal mice. Dysregulation of the VIPVPAC1 signaling pathway resulted in a failure in ILC3 intestinal recruitment and was associated with microbiota dysbiosis and premature death from enteric bacterial infections. We hypothesize that VIPVPAC1 signaling in intestinal epithelial cells provides chemoattractant signals for proper ILC3 cell recruitment to maintain postnatal tissue homeostasis. This research will employ an intestinal epithelial cell conditional VPAC1 knockout mouse to test our hypothesis. We will analyze mouse fecal samples by 16S rRNA gene sequencing from prenatal and postnatal VPAC1 WT and KO mice to assess gut microbiota ecology. We also plan to harvest intestinal lamina propria cells and enumerate ILC3 numbers by flow cytometry. This research is expected to uncover the cellular source required for VIPVPAC1 dependent recruitment of ILC3 recruitment for intestinal homeostasis provide a better understanding of how VIPVPAC1 signaling works with ILC3 recruitment to aid in gut microbiota homeostasis and intestinal barrier defense against pathogens.

Keywords: Vasoactive intestinal peptide; ILC3; Gut microbiota dysbiosis; Intestines; VPAC1

RNA-seq study in stage 4 gliomas using meta-analysis.

BASANTA DHUNGANA
BIOINFORMATICS

MENTOR: Anne Denton, PhD – Computer Science

High-throughput sequencing has been used by researchers extensively over the last two decades. Despite the fact that RNA-sequencing is costly, more RNA-seq experiments are available but of small sample sizes up to now. So, we need some analysis technique which can combine the study of a small sample size from one dataset and another study from another dataset. We have used three datasets of Glioblastoma multiforme (GBM) in this analysis where two are from the NCBI-GEO and one from TCGA. GBM is the deadliest adult primary brain tumor with an average survival rate of 14-20 months. Showing limited response or resistance to the existing therapies and followed by quick proliferation and diffuse infiltration in the brain it is difficult to treat. The meta-analysis method used in this analysis considered the conflicting direction of differentially expressed genes (DEGs) along with non-conflicting direction DEGs. DEGs identification was performed separately, and individual analyses were combined together. Thus, meta-analysis using Fused Inversed Normal approach for differential gene expression analysis between isocitrate dehydrogenase (IDH)-wildtype and IDH-mutant stage 4 gliomas using publicly accessible RNA-seq data irrespective of the direction of study which is either conflicting or non-conflicting gene was performed.

Keywords: RNA-sequence, Glioblastoma, Differential expressed genes (DEGs), Meta-analysis, Isocitrate dehydrogenase(IDH)

A Framework for Remote Road Furniture Monitoring System using Smart IoT Dashcams and Digital Twin

ISRAT SHARMIN DOLA
MECHANICAL ENGINEERING

MENTOR: Inbae Jeong, PhD – Mechanical Engineering

The condition of the road furniture plays a critical role in improving road safety and driving comfort. Although it is crucial to monitor road furniture comprehensively and at regular intervals, it is challenging due to the lack of resources and the huge size of road furniture. This study proposes a framework that identifies damaged road furniture such as traffic lights, signposts, guardrails, etc. automatically and visualizes their locations on the user interface to enable inspectors to monitor road infrastructure conditions remotely. The framework leverages a road infrastructure digital twin to contain real-time information about road infrastructure, landmarks, and GPS coordinates. The proposed framework was tested on the roads of NDSU campus and demonstrated accurate detection of damaged road segments and road hazards with real-time information displayed on the user interface, reducing the need for manual inspections, and enabling proactive maintenance to improve road safety and driving comfort. The proposed framework is expected to facilitate the real-time remote monitoring of the state of road furniture, thereby minimizing the time, cost and effort required for inspections.

Keywords: Smart dashcam, road furniture, IoT, object detection, localization, remote monitoring, digital twin

Pressure-sensitive acrylic adhesives with plant oil-based monomers

BOHDAN DOMNICH
COATINGS AND POLYMERIC MATERIALS

MENTOR: Andriy Voronov, PhD – Coatings and Polymeric Materials

Pressure-sensitive adhesives (PSAs) are polymeric materials of high interest due to visco-elastic behavior. It admits their application with light pressure, avoiding the usage of heat, solvent, or long curing time. Low glass-transition temperature, high tackiness, and easy bond formation with the substrate surface, make them so popular in various industries. In this study, we targeted the combination of conventional petroleum-based monomers used for PSAs synthesis with plant oil-based monomers (POBMs) developed in our research group. POBMs are derived from plant oils via a one step transesterification process and have an on-demand composition depending on the plant oil used for synthesis. Incorporation of these monomers into the polymer may enhance crucial properties and ensure PSA's proper performance. Previous studies showed that the presence of POBMs could bring a significant increase in hydrophobicity, the effect of plasticization, and introduce reactive sites in the form of allyl double bonds for the formation of cross-linked networks. Utilization of an aqueous medium for the synthesis permits a broad tunability in final material properties. Therefore, we employed free radical emulsion polymerization with conventional thermal initiation and redox systems to evaluate the effect of synthetic conditions on the material final properties. In this work, we addressed the correlation of POBMs content to the polymer properties and its adhesive performance on paperboard and polymeric substrates commonly used in food packaging. In summary, it was shown that an increase of POBMs content up to 40 wt.% allows to achieve the desired adhesive performance on multiple substrates.

Keywords: pressure-sensitivity, emulsion polymerization, redox initiation, latexes, adhesion performance

Mechanistic Effect of Glutathione S-Transferase Pi-1 (GSTP1) Knockdown on Redox Homeostasis and Energy Metabolism in Pancreatic Ductal Adenocarcinoma (PDAC)

JENNA DUTTENHEFNER
BIOLOGICAL SCIENCES CELLULAR AND MOLECULAR BIOLOGY PROGRAM

MENTOR: Katie Reindl, PhD – Biological Sciences

Since the late 1990s, pancreatic cancer's incidence and mortality rates have risen by about 1% and 0.2% per year, respectively. Efforts to arrest these upward trends lie in investigating novel treatments targeting cancer cells based on their unique adaptations from normal cells. Our research indicates an essential role of the antioxidant enzyme glutathione S-transferase pi (GSTP1) at the intersection of two core hallmarks of cancer, altered cellular metabolism and enrichment of the antioxidant system for continued proliferative growth in Pancreatic Ductal Adenocarcinoma (PDAC).

Methods and Results: We have evidence that GSTP1 inhibition leads to reduced PDAC cell survival and proliferation through an accumulation of reactive species and a loss of ATP with corresponding modifications in cell signaling and differential transcriptomic, proteomic, and metabolomic signatures. Cell metabolism, lipid metabolism, and ATP synthesis were among the top differentially regulated pathways in our GSTP1 knockdown cells. Among these results, significant downregulation of aldehyde dehydrogenase 7A1 (ALDH7A1), a detoxification enzyme that produces NADH to initiate ATP production through fatty acid oxidation, posed as an essential gene candidate leading to the altered energy metabolism observed in our GSTP1 knockdown cells.

Implications: By uncovering the connections between these genes and signaling pathways with GSTP1, we aim to develop a more precise mechanism of GSTP1's effect on altered metabolism in PDAC cells. This mechanism will provide an essential step towards validating GSTP1 as a novel therapeutic target and, more importantly, allow for the identification of additional drug targets and synergies to make PDAC therapy more successful.

Keywords: Pancreatic Ductal Adenocarcinoma, Multi-omics analysis, Energy metabolism, Fatty acid oxidation, Oxidative stress

Ground and Excited State Properties of Charged Non-Stoichiometric Quantum Dots

OMOLOLA ENIODUNMO
CHEMISTRY

MENTOR: Svetlana Kilina, PhD – Chemistry and Biochemistry

Colloidal Semiconductor Quantum dots are promising structures and have attracted great attention for several applications because of their ease of reproducibility and highly size-tunable properties. Experimentally, non-stoichiometric QDs are easily achievable, and we decided to focus on studying charged non-stoichiometric quantum dots. In this work, we use density functional theory (DFT) and time-dependent DFT(TD-DFT) with hybrid functional B3LYP to explore different methods (dangling bond and doping) of creating charged cation and anion-rich non-stoichiometric cadmium selenide (CdSe) clusters and how these mechanisms affect the ground and excited state properties by utilizing density functional theory and time-dependent density functional theory respectively. Our calculations show that ligand removal is similar to electron doping for Cd-rich but hole doping for Se-rich. Insights from our calculations show that electron doping leads to formation of electronic states in the core of the anion-rich structures while hole doping leads to slight formation of electronic states in the core of the cation-rich. Coupling a charge to the bright exciton states of the fully capped cation rich led to formation of optically weak states in the charged cation-rich and optically inactive states in the charged anion-rich structures when a charge is coupled to the dark exciton states of the fully capped anion-rich. The result from this study provides insights that would be useful to facilitate tunability for various applications.

Keywords: Quantum computing, nanoscience, semiconductors, optoelectronics, absorption

Dry Beans: Genomic prediction for resistance to white mold

JOSE FIGUEROA-CERNA
PLANT SCIENCES

MENTOR: Juan Osorno, PhD – Plant Sciences

In plant breeding programs, genomic predictions, when combined with other techniques, can improve selection efficiency, particularly for quantitative traits like white mold (Sclerotinia sclerotia Lib. de Bary) resistance in dry beans (Phaseolus vulgaris L.). However, screening new genotypes under field conditions is complex due to factors such as the presence of the pathogen in the soil, climate conditions, plant density, and avoidance and physiological mechanisms that interact altogether. To address this issue, this study aimed to measure the prediction ability of six genomic prediction models (RR-BLUP, Bayes A, Bayes B, Bayes Cπ, BLASSO, and BRR) using a Multiparent Advance Generation Inter-Cross (MAGIC) population. Genotypic data was obtained via genotype-by-sequencing from a subset of 500 Recombinant Inbred Lines, while phenotypic data were collected using the seedling straw method in the greenhouse. Predictive ability was calculated as the Pearson correlation between the predicted values and the observed phenotypes. Genotypic data used in the models varied depending on the reference genome. Using the Phaseolus vulgaris v2.1 reference genome (Andean), a total of 52,201 SNPs were identified, and the prediction ability ranged from 63 to 79%. On the other hand, when the Phaseolus vulgaris UI111 v1.1 reference genome (Middle American) was used, a total of 76,286 SNPs were obtained, and the prediction ability ranged from 77 to 92%. Overall, the Bayes A model demonstrated the best predictive ability for both sets of genotypic data and will be validated as a genomic selection tool in the dry bean breeding program at North Dakota State University.

Keywords: Cross-validation, Common beans, GEBVs, Genomic selection, Prediction accuracy

Insect Resource Allocation to Prepare for Overwintering During Diet Restrictions

MADISON FLODEN
BIOLOGICAL SCIENCES

MENTOR: Kendra Greenlee, PhD – Biological Sciences

This study's objective was to identify how limited resources affect an insect's energy storage and its ability to survive cold exposure. Megachile rotundata, the alfalfa leafcutting bee, was used as an insect model. In many insects, adult body size is determined by the amount of food eaten in the larval stage. Eggs and first instars were provided two diet sizes, small (50mg) and large (150mg). We found that diet size significantly affected body mass, with large-diet bees having three times the mass of small-diet bees. There was no effect of diet size or body mass on supercooling point, with an average supercooling point of (-23.06±0.29°C). Interestingly, both total water per mg and free water content per mg were higher in the small-diet bees. There was no significant difference in glycerol concentration between diet sizes. However, bees collected later in the summer had 15% more glycerol than early summer bees. From our findings, limited resources have significant effects on Megachile rotundata's water content and mass. The increased water content in small-diet bees could be related to decreased respiration rates, but additional studies would be needed to support this. The low supercooling point, combined with increases in glycerol concentrations implies overwintering preparation in all bees regardless of treatment. Together, this data suggests that preparation for overwintering in Megachile rotundata is flexible, involving multiple factors. Additional research and understanding of the effects of diet size on energy resources will help create a more complete picture of insect energetics and overwintering survival.

Keywords: Resource Allocation, Insect Overwintering, Physiology

Integrating Computer Vision, Artificial Intelligence, and Robotic Technologies in Chemical Weed Control

SUNIL G C
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Xin Sun, PhD – Agricultural and Biosystems Engineering

Herbicide blanket application is widely practiced by farmers to chemically control weeds in the field but has caused several negative issues on the environment and human beings. To overcome these negative issues precision site-specific weed control can be used to reduce the herbicide application by targeted application on only weed areas. Hence, a robotic platform containing an NVIDIA Jetson embedded device as control and processing unit was developed and tested on lab and field conditions for weed control. The average time spent for data acquisition and artificial intelligence-based computer vision tasks was tested under both lab and field conditions. Moreover, a grid map creation algorithm using YOLOv4 deep learning algorithm was evaluated to control the nozzles of the robotic platform. The comparison under lab and field conditions shows a difference of 0.035 seconds in average computer vision time. The field images took longer for weed detection and grid creation compared to the lab images, which was also supported by the larger image size in the field images. The reduction of herbicide application based on grid map was obtained 79 to 80 %, which does not include YOLOv4 algorithm failure and system synchronization failure. The study suggests the importance of field testing for real-time applications of the robotic platform by using deep learning computer vision methods for weed control.

"It's Complicated": LDS Women's Relationships with Feminism

EMILY GALBRAITH
SOCIOLOGY

MENTOR: Christopher Whitsel, PhD – Sociology and Anthropology

Because of a historical tension between conservative religions and feminist movements, this semester project explores how LDS (Mormon) women perceive feminism and their relationship to it. To answer this question, the project used a qualitative, grounded theory approach to analyze the responses of ten LDS women in four individual interviews and a six-person focus group. The results revealed complicated relationships that were nuanced and individual. However, important themes materialized describing how the women negotiate a relationship between their faith, church, and feminism. These included religiously-informed beliefs of equality, shared experiences in patriarchal social structures, critiques of their own church, and a hope for continuing progress. From an exploratory perspective, this project provides groundwork for a larger, formal study on this topic. It emphasizes the need to better understand religious women's connections to feminism to build bridges between feminist movements and religious traditions.

Keywords: Feminism, religion, qualitative, perceptions, equality

Unraveling the mechanism by which high intensity ultrasound improves the solubility of commercial pea protein isolates

KUN GAO
PLANT SCIENCES

MENTOR: Bingcan Chen, PhD – Plant Science

Although plant-based proteins potentially provide merits for long-term global food security, their poor functionality particularly solubility has hampered the utilization as functional biopolymers in the industry. High intensity ultrasound (HIUS, 20 kHz) has been researched extensively for its possible application in modifications of protein functionality. Here, we show that the solubility of commercial pea protein isolate (PPI) is drastically improved from 7.2 to 58.4 mg/mL at an intermediate power (150 W) after a sequential HIUS treatment with an elevated power (100, 150, 200, 300, and 400 W). The dynamic changes of protein structure and confirmation over the course of sequential HIUS treatment are comprehensively investigated and non-proteinaceous constituents (dietary fiber and β-glucan) were quantified to understand the mechanism of action of HIUS in improving protein solubility. These successive investigations unravel that the formation of soluble aggregates between pea proteins and soluble complex between pea protein and indigenous dietary fiber is the underlying reason that HIUS improves the solubility of poorly soluble pea protein. Our findings offer unprecedented insights into the fundamental role of HIUS on structure modification of plant protein, thus paving the way for their industrial applications as a green technique in fabricating plant proteins with improved solubility.

Keywords: Pea protein isolate, Ultrasound, Solubility, Soluble aggregates, and Soluble complex

Interpretable machine learning models – SHAP and Ensemble models analysis

SHIVANI GAUTAM
DEPARTMENT OF COMPUTER SCIENCE

MENTOR: Simone Ludwig, PhD – Computer Science

This research project compares the performance of two machine learning approaches, SHAP and ensemble algorithms, for analyzing a public dataset. The dataset used in this study contains thyroid function test data, which is commonly used for diagnosing thyroid disease. SHAP is a machine learning technique that measures the importance of features in a model, providing insights into how the model makes predictions. Ensemble algorithms, on the other hand, involve combining multiple models to improve accuracy and robustness. In this study, we train models using both SHAP and ensemble algorithms on the thyroid function test data. We evaluate the performance of each model using metrics such as accuracy, precision, recall, and F1-score. We analyze the feature importance of each model to gain insights into which features are most predictive for thyroid disease. The results will be beneficial for analyzing thyroid function test data, providing both accuracy and interpretability.

Keywords: Interpretation ML, Black box model, prediction, SHAP, Ensemble algorithms

Cold Hardy Wine Grapes Production Under Caterpillar Tunnel in North Dakota

BIJAYA GHIMIRE
PLANT SCIENCES

MENTOR: Harlene Hatterman-Valenti, PhD – Plant Sciences

Environmental constraints and a short growing season limit the production of fruits and vegetables in North Dakota. Studies have been done to extend the growing season of some fruits and vegetables, but season extension of wine grapes using tunnel structures are not reported in North Dakota. The objective of this study was to compare the phenology, yield, and quality of wine grape cultivars grown under a caterpillar tunnel and open field environment in North Dakota. Two cold-hardy wine grape cultivars (Marquette and Petite Pearl) were grown under both environments. A comparison among the cultivars within and between the environments was made. Our results showed that the caterpillar tunnel improved the microclimate and accelerated the ripening process. Compared to open field condition the tunnel promoted earliness in the accumulation of soluble solid concentration in the berries. Similarly, the caterpillar tunnel also reduced the acidity level, however, it did not reach the desired level of < 10 g L-1. The result suggests that caterpillar tunnels provide a better environment to hasten fruit ripening of cold-hardy wine grapes. However, further comparisons need to be made with more tunnels for replications.

Keywords: Season extension, caterpillar tunnel, phenology, quality, total soluble solid

3D in-vitro Cancer Model Picturing Cellular Crosstalk and Bone Metastasis

SHRINWANTI GHOSH
BIOLOGICAL SCIENCES

MENTOR: Jiha Kim, PhD – Biological Sciences

Cancer cells proliferate, adapt to the environment, and spread to adjacent or distant organs. Multi-cellular communication during this process critically impacts the tumor progression and metastasis. Aim of this study was to create an in vitro tumor microenvironment through a multicellular co-culture system to investigate the influence of vascular components on cancer cell dynamics. The 3D spheroid of breast cancer patient-derived cancer cells were co-cultured with endothelial cells and pericytes. Morphological and molecular changes of all cell types were investigated. Long-term objective of the study is to develop 3D scaffold culture systems to investigate development of tumors.

Keywords: 3D Cancer Model, Bone metastasis Breast carcinoma, Tumor microenvironment, Cellular cross communication, Nanoclay based scaffold

Effects of Cardiomyocyte Specific Knock-Out of PPAR on Cardiac Lipid Metabolism During Metabolic stress

SAVANNAH GIBSON
PHARMACEUTICAL SCIENCES

MENTOR: Natasha Fillmore, PhD – Pharmaceutical Sciences

There is a very high prevalence of not only obesity, but also Type II Diabetes in the USA. Both of these diseases contribute heavily to cardiovascular disease, however the mechanism behind this remains elusive. PPARα has been linked to development of metabolic and cardiovascular diseases. PPARα is a transcription factor known to regulate fatty acid (FA) metabolism. We used our novel cardiac specific PPAR KO (cPPAR-/-) mouse to determine the effects of PPAR on lipid accumulation in the heart. In one group, the mice either underwent 16 hours of fasting or were fed a standard chow diet ad libitum. We also fed a second group of mice a high fat diet (HFD) ad libitum for five weeks. The hearts were harvested and then used to test the expression of lipid metabolism proteins and triglyceride (TG) levels. In the mice fed a HFD the cPPAR-/- hearts have lower TG levels than control hearts. Furthermore, in the HFD mice the expression Plin2, a lipid droplet protein, is lower in the cPPAR-/- hearts compared to the controls. We also found a compensatory increase in Plin3 and DGAT1 in the cPPAR-/- hearts. This agrees with our previous findings that the cPPAR-/- hearts are protected against fasting-induced increased TG levels. These results indicate that a cardiac specific PPAR KO protects the heart from fat accumulation. In the future we aim to further understand the role of cardiac PPAR in lipid accumulation and metabolic diseases.

Keywords: Cardiac, metabolism, lipid droplet, perilipin, western blot

Tumor-targeted multi-drug therapy for pancreatic cancer management.

PARAS GIRI
PHARMACEUTICAL SCIENCES

MENTOR: Buddhadev Layek, PhD – Pharmaceutical Sciences

Pancreatic cancer is the 3rd leading cause of cancer-related death in the USA, with a 5-year survival rate of 12%. Lack of tumor specificity, dose-related toxicity, and the tumor's innate resistance to chemotherapeutic agents are significant barriers to conventional cancer therapy. Thus, to resolve this shortcoming, researchers focus on developing tumor-targeted delivery of combination therapy to treat cancer effectively. Incorporating multiple anticancer drugs that target different key pathways can reduce drug resistance and tumor growth at low concentrations. Initially, we determined the synergistic potential of the oxaliplatin/entinostat combination in both mouse (KPC) and human pancreatic (PANC-1) cancer cells. KPC and PANC-1 cells treated with different drug combinations showed synergistic potential at various combination ranges. The colony formation assay results also revealed synergism interaction of oxaliplatin and entinostat as the total number of colonies reduced to 74%, 75 %, and 29 % in entinostat (1μM), oxaliplatin (1μM), and combination (1μM entinostat + 1μM oxaliplatin) treatment, respectively, as compared to control. Western blot analysis revealed higher expression of acetylated H3, H4, and cleaved caspase 3 in combination treatment than in the individual treatments. Afterward, poly(lactic-co-glycolic) acid nanoparticles were formulated individually to improve their tumor-targeting ability. In vitro cytotoxicity study in KPC and PAN-1 cells revealed superior cytotoxicity of nano-encapsulated oxaliplatin and entinostat compared to the corresponding free drug. Finally, the synergistic combination of nanoformulations was also verified via a colony formation assay.

Keywords: Tumor targeted delivery, Pancreatic cancer, Combination therapy, Oxaliplatin, Entinostat

Sendai as a Guiding Force within Canadian Provincial Emergency Management

DYLLAN GOLDSTEIN
EMERGENCY MANAGEMENT AND DISASTER SCIENCE

MENTOR: Jessica Jensen, PhD – Emergency Management and Disaster Science

This study sought to explore the degree to which the Sendai Framework for Disaster Risk Reduction is perceived to be guiding priorities in emergency management agencies at the provincial and territorial level of government in Canada. The Sendai Framework is a consensus document representing the world's collective understanding as to why disasters occur and what should be done to manage them. Canada is one of the 187 UN member nations which has agreed to pursue the Framework. For this study, top level provincial and territorial administrative authorities, and select ministers were interviewed regarding their organizations, their work, their perceptions of emergency management, and the influences of their organization's priority setting process. Analysis revealed that the Sendai Framework is not a guiding force for priority setting within the represented (9/13) provincial and territorial emergency management organizations. Instead, priorities are understood to be set by forces outside of organizational control, such as hazard events, legislation, political direction, and resource availability. As of 2023, Canadian provincial and territorial emergency management organizations are not on track to support their jurisdictions pursuit of Sendai, nor are they meaningfully pursuing the reduction of disaster risk.

Keywords: Disaster, risk reduction, mitigation, governance

Development of a recombinase polymerase amplification assay for rapid detection of the stubby root nematode, Paratrichodorus allius.

MANKANWAL GORAYA
PLANT PATHOLOGY

MENTOR: Guiping Yan, PhD – Plant Pathology

The stubby root nematode, Paratrichodorus allius is an important pathogen that causes significant losses in potato production. Successful management requires fast and accurate identification of P. allius. The objectives of this research were to develop a recombinase polymerase amplification (RPA) assay to rapidly and reliably detect P. allius from nematode individuals and soil DNA extracted from potato fields. We designed four pairs of primers targeting the internal transcribed spacer (ITS) region of P. allius. A FAM-labelled probe to detect P. allius from soil DNA was also designed. The primer pair, MG2F/MG2R was found to perform the best. RPA conditions were standardized using P. allius DNA at varying temperatures and time intervals. RPA products were visualized using portable instruments, T-16 ISO (TwistAmp exo kit) and agarose gel electrophoresis and SYBR Green I dye (TwistAmp Basic kit). The specificity of the RPA assay was evaluated using various species of plant-parasitic nematodes. In-silico analysis was conducted to confirm its high specificity. The RPA assay could detect as low as a 1/16th portion of a single nematode inoculated into sterilized soil. This assay was validated by testing P. allius from soil samples collected from potato fields in North Dakota and Idaho. The RPA assay developed in this study requires minimal sample preparation, a low temperature (400C), and 20-40 minutes for detection. This assay can serve as an efficient tool for rapidly detecting and identifying P. allius in infested fields to effectively manage this nematode disease.

Keywords: RPA, stubby root nematode, rapid detection, efficient diagnostic

Removal of Methylene Blue from wastewater using Chitosan Beads

ADITYA GOYAL
MATERIALS AND NANOTECHNOLOGY

MENTOR: Achintya Bezbaruah, PhD – Civil, Construction, and Environmental Engineering

Cationic dyes, which are often used for their ease of use, durability, and good fastness to materials, are also associated with negative effects on the environment. When discharged as waste, cationic dyes such as methylene blue (MB) can have carcinogenic, mutagenic, and coloring effects on the ecosystem. As a result, there is a need for effective methods to remove these dyes from water.

Chitosan is a natural biopolymer obtained from the exoskeletons of crustaceans, arthropods, and insects through the deacetylation of chitin. It is a linear polysaccharide composed of randomly distributed β-(1 → 4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit). Chitosan has a number of useful properties, including biodegradability, biocompatibility, anti-microbial activity, and ease of modification, making it suitable for a wide range of applications in biomedicine, cosmetics, agriculture, wastewater treatment, drug delivery, and packaging.

In this study, we prepared pure chitosan beads by dissolving chitosan in acetic medium and then using a non-inversion phase separation technique to create beads in a basic medium. We then neutralized the beads and tested their ability to adsorb methylene blue of various concentrations from aqueous solutions. The beads absorbed the dye within 5 days and showed no release of MB in the desorption studies, demonstrating their potential as an effective method for removing cationic dyes from water.

Keywords: Methylene Blue, Wastewater, Chitosan

Charge Separation in Two-Dimensional Hybrid Lead Halide Perovskites Horizontal Heterostructures

DAVID GRAUPNER
CHEMISTRY

MENTOR: Dmitri Kilin, PhD – Chemistry and Biochemistry

Lead halide perovskites are being studied due to their favorable properties for photovoltaic and light emitting devices. Long-term stability of the perovskite solar cell, which exhibits photo, moisture, and thermal stability weaknesses, is the main challenge currently limiting their application. Two-dimensional inorganic-organic hybrid perovskites offer increased stability and higher tunability of physical properties. Adjusting the thickness of the perovskite layer in the two-dimensional hybrid perovskite allows for tuning the band gap. By combining different perovskites of different thicknesses into a single structure termed heterostructure, we hope that we can use the varied band gap to control the separation of the electron and hole. Here we are examining the effect that a horizontal heterostructure of perovskite thicknesses has on the photophysical and charge transfer properties using density functional theory and excited state dynamics. The on-the-fly approach was used to calculate nonadiabatic couplings along a molecular dynamics trajectory at ambient temperatures. Density matrix-based equation of motion for electronic degrees of freedom is used to calculate the dynamics of electronic degrees of freedom. The horizontal heterostructure perovskite, with its two different thickness perovskite layers, shows a promising effect towards charge separation due to the different sized band gaps for the different sized perovskite layers.

Greening the Organic Curriculum: Insights from a Nationwide Survey on the Integration of Green and Sustainable Chemistry in Undergraduate Organic Chemistry

KRYSTAL GRIEGER
CHEMISTRY AND BIOCHEMISTRY

MENTOR: Alexey Leontyev, PhD – Chemistry and Biochemistry

The need to integrate green and sustainable chemistry (GSC) into the chemistry curriculum has become a global focus with the fourth United Nation Sustainable Development Goal (UN SDG) stating that by 2030 "all learners acquire knowledge and skills needed to promote sustainable development." This emphasis is critical because the integration of GSC both promotes systems thinking and supports meaningful learning. Unfortunately, GSC is not well-represented within the organic chemistry textbooks. This leaves it up to individual instructors to decide what aspects and how to incorporate GSC into their curriculum.

Therefore, to discover whether and what aspects of green chemistry, planetary boundaries, and the UN SDGs are currently integrated into the organic curriculum and what factors affect its integration, we surveyed undergraduate organic chemistry faculty from across the United States. We found that most faculty were unfamiliar with the planetary boundaries and the UN SDGs, and thus they are not typically incorporated into organic chemistry. Furthermore, we found that the most frequently taught and assessed green chemistry topics were "catalysis" and "chemical hazards and exposures," and the least commonly taught and assessed topics included "efficiency metrics" and "life cycle impacts of chemicals." Finally, we found that teacher-thinking factors, including the instructor's familiarity with the topics, perceived importance of students learning the material, and whether they believed that the curriculum was too full to integrate green chemistry, held the greatest impact on its integration. Overall, these findings highlight the need for faculty training about GSC to further its integration.

Keywords: Green chemistry, organic chemistry, chemistry education research

High-throughput evaluation of bacteriophage resistance-sensitivity profiles in rhizobia

TANIA GUPTA
MICROBIOLOGY

MENTOR: Barney Geddes, PhD – Microbiology

Rhizobia live as free-living microorganisms in the soil microbiome. Through infection of legume roots, they can exist as endosymbionts within the root nodules of legume plants. Within root nodules, rhizobia fix atmospheric dinitrogen into biologically active forms in exchange for fixed carbon sources. Symbiotic nitrogen fixation by rhizobia is a crucial aspect of sustainable agriculture and alleviates requirements for chemical fertilizers. Many factors affect the growth and viability of rhizobia within the soil and hence impact this important mutualism. One such factor is bacteriophage, obligatory intracellular parasites that can influence the phenotypic as well as genotypic diversity of rhizobia. Infection by bacteriophage can result in cell lysis followed by the release of more bacteriophage into the soil microbiome. Alternatively, rhizobia may bear resistance genes that allow them to resist bacteriophage infection. In this project, the model organism Sinorhizobium meliloti, the natural symbiont of alfalfa plants, is used to study the phage-rhizobium interaction. S. meliloti isolates from 33 sites across North Dakotan were isolated and stocked. Selected soil samples were used for the isolation of bacteriophages capable of infecting S. Meliloti. The isolated phages are being employed to assess the phage resistance-sensitivity profiles across the rhizobium library. Further in the project, pan-GWAS will be used to anticipate the phage resistance genes in the rhizobium library and the potential of "phage therapy" in enhancing the competition of elite rhizobia strains will be explored.

Keywords: Rhizobia, bacteriophages, legumes, ecology

How course syllabi convey information about a learning environment

EMILY HACKERSON
BIOLOGICAL SCIENCES

MENTOR: Jenni Momsen, PhD – Biological Sciences

Fostering an inclusive learning environment begins well before a student sets foot in the classroom. Despite the ubiquity of the course syllabus, precious little research has explored whether and how course syllabi contribute to establishing an inclusive classroom community. Research suggests that syllabi can serve as a tool to equitably communicate course information including policies and expectations (Gin et al, 2021), and can also communicate an instructor's mindset or beliefs about learning (Canning et al, 2019; Kroeper et al., 2022). In this project, we are exploring the decisions faculty make when crafting their course syllabus, in particular whether their syllabus reflects their beliefs about learning and if that is an intended outcome of the syllabus design process. In addition, we are also exploring to what extent students perceive an instructors' beliefs about learning through the course syllabus and where in the syllabus they look to form these perceptions. This work will help instructors and researchers re-envision the course syllabus as a cornerstone of establishing inclusive learning communities.

Keywords: syllabi, mindset, grading

Shattering resistance in canola: A Genome-wide association studies (GWAS) Approach

MD MEHEDI H HAFIZ
PLANT SCIENCES

MENTOR: Md Mukhlesur Rahman, PhD – Plant Sciences

Canola (Brassica napus L.) has been an important cultivated oilseed crop with low erucic acid and glucocinolate content. Pod shattering occurs in canola in hot and windy weather, and during mechanical harvesting causing yield loss up to 75%. So, development of shattering resistant canola genotypes is a promising approach to mitigate this serious problem using genome-wide association studies. A few studies have been performed for shattering resistance in canola breeding programs. Therefore, this study has been undertaken to develop shattering resistant canola cultivar. The multiparent advanced generation intercross (MAGIC) populations will be developed using available shattering resistant genotypes and varieties with good seed yield and other important traits. Then those MAGIC populations will be advanced, and genome wide association studies (GWAS) will be performed to see the genomic regions conferring shattering resistance. At the same time, genomic prediction will be executed for a diverse collection of canola genotypes. Nine (9) sets of MAGIC populations have been identified already using 19 commercial varieties and genotypes of canola possessing shattering resistance and good yield. We expect that there will be some promising canola lines having high yield and shattering resistance at the end.

Keywords: shattering, resistance, GWAS, MAGIC, genomic prediction

Role of RAGE on the effect of vemurafenib in A375 human melanoma cells.

MD ZAHIDUL HASAN
PHARMACEUTICAL SCIENCES

MENTOR: Estelle Leclerc, PhD – Pharmaceutical Sciences

Melanoma is a type of skin cancer that can be aggressive and difficult to treat. The Receptor for Advanced Glycation End-products (RAGE) has been associated in the progression of melanoma, making it a potential therapeutic target. The goal of this study is to determine if RAGE participates in the resistance to the standard of care vemurafenib in melanoma cells. To reach our goal, we aim to determine the effect of vemurafenib in RAGE silenced human A375 melanoma cells. Melanoma cells were silenced for RAGE using RAGE specific shRNA. The shRNA encoding plasmids also contained genes coding for puromycin resistance, and a green fluorescent protein (GFP) to facilitate the determination of transfection efficiency. 70% transfection efficiency was observed. The level of RAGE mRNA in shRNA transfected cells were assessed by quantitative PCR. Western blot analysis and enzyme-linked immunosorbent assay (ELISA) were employed to assess RAGE protein expression levels in transfected A375 cells. We are currently comparing the effect of the BRAF mutant inhibitor drug vemurafenib on the viability of wild-type A375 and RAGE silenced A375 cells.

Keywords: RAGE, Vemurafenib, A375, Melanoma, shRNA

Deep learning-based 3D human motion trajectory prediction for close-proximity human robot collaboration

MOEIN YOUNESI HERAVI
CONSTRUCTION MANAGEMENT

MENTOR: Youjin Jang, PhD – Civil, Construction, and Environmental Engineering

Human-robot collaboration (HRC) has been increasingly adopted in construction jobsites. The robot-human awareness which allows the robot to respond appropriately to collaborative human partners is a fundamental element for organizing a productive and safe HRC environment in construction works. In this context, human motion prediction could provide information on the expected future location of a human agent. However, yet limited efforts have been made to properly address this task due to the variable nature of human actions and the challenges in converting 2D image coordinates to real-world space. This paper proposes a novel deep learning-based human motion trajectory prediction method, which aims to enhance the performance by recognizing the activity at the first step and use it when predicting the next location of the human body joints. In addition, a multi-camera vision-based pose extraction system is introduced for data collection and body joints' 3D location estimation. An experiment has been carried out to evaluate the suggested framework. The results reveal that the proposed approach can boost the human motion trajectory prediction performance by at least 6.4% and up to 16.6% in the short term by taking activity into account. Moreover, the impact of time window and joint selection on prediction results have been analyzed in various scenarios. By enhancing the robots' understanding of human behavior, the suggested approach will aid in establishing a secure workspace for humans and robots to collaborate on construction sites.

Keywords: Human-robot collaboration, Human activity recognition, Motion prediction, LSTM

Acute Traumatic Apophyseal Avulsion Fracture a Conservative Approach

DEMETRIOS HOSPIDALES
ATHLETIC TRAINING

MENTOR: Shannon David Misialek, PhD – Athletic Training

Increased adolescent sport participation increases risk to injury. A case study of an adolescent football player who sustained apophyseal avulsion fractures is described. There are two treatment approaches for this injury: a conservative and a surgical approach with the surgical approach being more common. This research project presents a conservative approach. All records and statements gathered and compared current research in the field. Results suggested the conservative may be as effective as the surgical approach. Specifically, during the rehabilitation process provided. In conclusion, the case study may provide guidance for healthcare professionals on a conservative approach when treating apophyseal avulsion fractures.

Keywords: Fractures, Sport, Adolescent, Rehabilitation, Treatment

Transfer Kinetics of Cargo Items among Mobile Nanocarriers

MD FARUK HOSSAIN
PHYSICS

MENTOR: Sylvio May, PhD – Physics

Nanocarriers such as micelles, liposomes, nanoshells and nanocages, dendrimers, carbon nanotubes, and nanoparticles are used in applications to transport cargo items--often drug molecules--to a target site. When nanocarriers collide with each other, cargo items are able to migrate from one to another nanocarrier. We employ chemical reaction kinetics to characterize how the distribution of cargo items among all nanocarriers in a mixture of different nanocarrier types depends on time. In the continuum limit, valid when each nanocarrier contains a sufficiently large number of cargo items, we express the kinetic equations as a system of partial differential equations--diffusion equations with additional demixing terms--that evolve into Gaussian distributions over time. We solve the partial differential equations and thus determine the kinetic behavior for any initial distribution of cargo in this multi-type nanocarrier system. The model can be generalized to address related problems, including the account of sink conditions, spatial variations analogous to diffusion-reaction phenomena, the release of cargo directly into the solution, and aggregation of cargo items inside carriers.

Keywords: transport, kinetics, nanocarriers, cargo transfer, rate matrix

Riverbank Instability Analysis of the Red River in Fargo, North Dakota

MUHAMMAD SHAHID IQBAL
ENVIRONMENTAL AND CONSERVATION SCIENCE

MENTOR: Stephanie S. Day, PhD – Earth, Environmental, and Geospatial Sciences

Riverbank failures are an important geomorphological factor changing Earth's surface features. However, often such riverbank failures become a significant concern when surrounding civil infrastructure and land-use are at risk. Therefore, it is important to delineate potential regions prone to such hazards in urban regions. The Red River of North meanders on glaciolacustrine deposits of Lake Agassiz at the boundary of North Dakota and Minnesota, USA. Riverbank failures recorded in this region are rotational and slow-moving. The size, type and speed of failure depend on the soil's engineering characteristics and the river water level changes. The current work is an effort to develop a riverbank instability map around the Red River reach passing through the urban section of Fargo, North Dakota, USA. Riverbank instability is assessed in terms of Factor of Safety (FoS) computed by traditional Slope Stability Analysis (SSA). In total, 65 locations around the Red River are subjected to SSA, and FoS are computed by using FLAC Slope 8.1 (freeware) and Hyrcan 2.0 (freeware). To produce the riverbank instability map, the spatial interpolation technique, Kriging, is employed on the computed FoS.

Keywords: Riverbanks, Red River, GIS, Numerical Modeling

Mechanical Characterization and Production of Complex Shapes using Continuous Carbon Fiber Reinforced Thermoset Resin Based 3D Printing.

MD ZAHIRUL ISLAM
MECHANICAL ENGINEERING

MENTOR: Chad Ulven, PhD – Mechanical Engineering

Due to design flexibility and superior mechanical strength, 3D printing of continuous carbon fiber reinforced polymer composites has received significant attention in recent years. However, 3D printing of continuous carbon fiber reinforced thermoset composites has suffered from not having a reliable printing process. The objective of this study was to demonstrate the 3D printing of complex shapes using continuous carbon fiber reinforcement within light curable thermoset resin. This printing process enabled 3D printing of continuous carbon fiber reinforced thermoset composites using very low viscosity, commercially available resin. The printed composite specimens exhibited a fiber volume fraction of 18%. Mechanical characterization of printed specimens showed comparable strength with conventionally manufactured composites. Because of the excellent wet-out of fiber with the matrix resin, the printed composites showed higher interlaminar shear strength compared to thermoplastic counterparts. Moreover, this study also demonstrated the 3D printing of some complex shapes and grid structures using this proposed printing process.

Keywords: 3D printing, Carbon fiber, continuous fiber

Genome-Wide Association Study and Genomic Selection for Seed Yield, Seed oil, and other Agronomic Traits in Canola (Brassica napus L.)

MOHAMMAD JONY
PLANT SCIENCES

MENTOR: Md Mukhlesur Rahman, PhD – Plant Sciences

Canola (Brassica napus L.) is an important oil-producing crop in the world, having low erucic acid with moderate to high levels of omega-3 and omega-6 fatty acids. As an oilseed crop, seed yield and seed oil content are the major traits for crop improvement. Other agronomic traits, such as days to flowering, days to physiological maturity, pods per plant, seeds per pod, and 1000 seed weight directly contribute to seed yield and seed oil. Multi-parent breeding populations serve as an excellent tool to increase genetic diversity and to identify the quantitative trait loci (QTL) with Genome-wide Association Studies (GWAS). This study has been designed to explore the underlying genomic regions of seed yield, seed oil, days to flowering, days to physiological maturity, pods per plant, seeds per pod, and 1000 seed weight through GWAS analysis based on single nucleotide polymorphism (SNP) and haplotypes effect. Marker-assisted selection is not an effective way to improve polygenic traits. Therefore, genomic prediction will be performed using significant SNP markers using the best genomic prediction model. We have developed a multi-parent breeding population from three different ecotypes (winter, semi-winter, and spring) to ensure the highest possible recombination. Currently, we are advancing the F5 population in the greenhouse. Genotyping and phenotyping will be performed for GWAS and genomic prediction. The present study will help to explore deep insights of multi-parent populations to develop elite breeding lines of canola.

Keywords: SNPs, Haplotype, GWAS, Genomic selection

Reproduction of soybean cyst nematode on commercial cultivars and breeding lines of dry edible bean

HARKAMAL KAUR
PLANT PATHOLOGY

MENTOR: Guiping Yan, PhD – Plant Pathology

Soybean cyst nematode (SCN; Heterodera glycines) is emerging as an important pathogen of dry bean (Phaseolus vulgaris L.) in the U.S. It can cause up to 60% yield loss in the field. There is a need to evaluate host resistance and better understand the reproduction of SCN populations on dry edible beans. One way to achieve this is to screen dry bean germplasm for resistance to SCN populations. In this study, dry bean commercial cultivars and breeding lines were tested for resistance to SCN populations HG type 0 and HG type 2.5.7, respectively. Trials were conducted in controlled growth chamber conditions with soybean cultivar Barnes as the susceptible check. SCN reproduced on all dry bean cultivars and breeding lines tested. Female Index (FI= average number of females on the test line/average number of females on Barnes x100) calculations showed that the cultivars and breeding lines had varying resistance responses to SCN infection. Only one cultivar ND Falcon was classified as moderately resistant to HG type 0. No breeding line was found to be resistant or moderately resistant to HG type 2.5.7. Results from this study indicate that HG type 2.5.7 is a more virulent SCN population than HG type 0. More trials and statistical analysis are being conducted to understand SCN reproduction on dry beans comprehensively. This can help breeders develop new cultivars with better resistance to SCN and help growers choose less susceptible cultivars to suppress the SCN disease in dry beans.

Keywords: SCN, Dry bean, Reproduction, Resistance

Effect of Milling, Storage and Vacuum Steam Pasteurization on Soft Red Wheat Flour Functionality and Final Product Quality

HEYMANT KAUR
CEREAL SCIENCE

MENTOR: Anuradha Vegi, PhD – Cereal Science

Historically, low moisture foods including wheat flour were not associated with food safety concerns. However, recent flour based foodborne illness outbreaks indicate that they harbor pathogenic microorganisms. Thermal treatments such as vacuum steam pasteurization (VSP) can reduce the amount of enteropathogenic microorganisms on grain and thus, can be used to treat the grain without impacting the flour functionality. In the current study, VSP (75oC for 8 min) treated and untreated soft red wheat samples were single and double milled using a stone mill. Whole wheat flour samples obtained were then stored in individual kraft-paper bags for 84 days at room temperature. At specific time intervals (Day 0 through 84) the stored flour bags were taken out and flour and final product quality analyses were done; specifically, solvent retention capacity (SRC), enzymatic activity (alpha-amylase, polyphenol oxidase (PPO), xylanase), color, protein content, cookie and cake quality changes were measured. All flour and final product quality analyses were done following AACCI approved methods. VSP treated stored flour samples had improved SRC (water, lactic acid, sucrose), and decreased enzyme activity compared to untreated stored flour samples. There were changes in color, protein, and final product quality also. Thus, this study can help understand quality changes in soft wheat flour after VSP treatment during storage. This information is useful to millers and food scientists alike as it can help decide whether VSP should be used as a treatment for microbial reduction while minimally affecting the flour functionality and final product quality.

Keywords: Vacuum steam pasteurization, storage, quality, soft wheat, milling

Comparative study of photoluminescence of single and ensembles of cis-polyacetylene semiconductor materials

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CIVIL, CONSTRUCTION AND ENVIRONMENTAL ENGINEERING

MENTOR: Wenjie Xia, PhD – Civil, Construction, and Environmental Engineering

Photoluminescence (PL) is one of the key observables in experimental characterizations of optoelectronic materials, including CPs. In this study, two different models of cis-polyacetylene are used to explain the mechanism of PL of the CPs. The photo-induced excited state dynamics are computed using a combination of the ab initio electronic structure and time-dependent density matrix methodology. We explore the phonon-induced relaxation of the excited states. Here, the dissipative Redfield equation is used with the nonadiabatic couplings as parameters. The simulated results for both models show that the relaxation rate of the electron is found to be faster than the relaxation rate of the hole. The dissipative excited-state dynamics are combined with radiative recombination channels to predict the PL spectrum. The simulation results reveal similarities and differences in the absorption and emission spectra for single and multiple oligomers. The main result of the single oligomer is that the computed PL spectrum demonstrates two mechanisms of light emission originating from (i) the inter-band transitions, corresponding to the same range of transition energies as the absorption spectrum and (ii) intra-band transitions which are not available in the absorption spectra2,3. This work compares spectroscopic signatures of single cis-PA oligomers versus ensembles of such oligomers. Formation of an ensemble results in noticeable changes in transition energies and intensities of transitions for both absorption and emission spectra. These results can be used for improving organic semiconductor materials for photovoltaic and LED applications.

Keywords: cis-polyacetylene (cis-PA); photoluminescence (PL); nonadiabatic coupling; relaxation

Comparative phylogenomic study by engineering nitrogen-fixing nodulation trait in non-rhizobia through CRAGE

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MENTOR: Geddes Barney, PhD – Microbiology

Rhizobia are the nodule forming nitrogen-fixing bacteria that make atmospheric nitrogen available to the leguminous plants. Several studies have been conducted to unravel the basis of this profitable rhizobia-legume symbiosis and to explore the possibility of transferring the capacity of nitrogen-fixing nodulation to non-leguminous crops to meet nitrogen demand in agriculture. Until now, most of the research has been centered around a few rhizobia and plants and led us to significant understanding of genetic, molecular, biochemical, physiological, and morphological basis of rhizobia-legume symbiosis. Despite of our extensive knowledge, engineering of nitrogen-fixing nodulation in non-leguminous plants is still a struggle. One of the possible ways to achieve this goal is to mimic existing rhizobia-legume symbiosis in closely related non-rhizobia of proteobacteria. This approach is based on shared evolutionary origin and involves dealing with genetic adaptation in non-rhizobia that can hinder engineering of nitrogen-fixing nodulation trait. Chassis-independent recombinase-assisted genome engineering (CRAGE) is a genome engineering tool that enables rapid engineering of non-domesticated bacteria with single step integration of large gene clusters. In our study, we are aiming to transfer nitrogen-fixing nodulation trait to non-rhizobia that are closely related to rhizobia to trace the evolutionary origin of rhizobia-legume symbiosis. This comparative phylogenomic study will provide a lead for designing approaches to engineer nitrogen-fixing nodule symbiosis in non-leguminous plants.

Keywords: nitrogen, rhizobia, CRAGE, symbiosis, engineering

Degradation of Plastics in Landfills

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Plastic production has been on the rise with the rapid development of industrialization. The staggering figures from Europe and the rest of the world indicate that plastic production is far from slowing down, with an expected doubling in the next two decades. However, the limited rate of recycling causes a great percentage of plastics ending up in landfills and natural environments. This presents a significant environmental concern. This study aims to investigate the degradation mechanisms of plastics in landfills using advanced crack pattern analysis techniques. Samples of plastics from different depths in landfills were collected to represent distinct organic degradation stages and physicochemical environments. Through videoscope and microscope imaging, crack patterns of different parameters were analyzed to determine the underlying mechanisms of plastic degradation. Machine learning was employed to develop a model that predicts the crack patterns in different types of polymers, based on their physicochemical properties and the environment within landfills. Advanced chemical characterization techniques are employed to understand the chemical degradation of plastics in landfills affected by different environments. Overall, the findings from this study will contribute to a better understanding of plastic degradation in landfills and their conversion to micro and nanoplastics.

Keywords: Plastics, Landfills, Crack, Physicochemical, and Polymers

Kentucky Bluegrass Removal Promotes Native Plant Diversity

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MENTOR: Torre Hovick, PhD – Range Science

Rangelands were historically heterogeneous with large patches of varying vegetation composition and structure that supported a diverse assemblage of native plants. In recent years, diverse plant communities in the northern Great Plains have been lost due to invasion by Kentucky bluegrass (hereafter bluegrass), suppressing native plant diversity and landscape-level heterogeneity. Reductions in bluegrass abundance may promote native plants, increasing the variety and availability of forage, cover and food resources for wildlife. To determine how bluegrass reduction may potentially promoting native plants, we established 18 plots and manually removed live bluegrass, bluegrass litter, and bluegrass thatch from half of the plots, leaving the other half as controls in a working landscape in south-central North Dakota and then monitored the plant community over three years. Bluegrass abundance was consistently lower in removal plots than control plots (46.4% and 58.2% cover in year three, respectively). Native forb and grass abundance and richness was higher in removal plots than in control plots (15±3.1 and 5.2±0.8 species versus 9.8±1.9 and 3.8±0.5 species per plot, respectively). Additionally, non-native plant abundance was either not different or lower in removal plots than control plots. These results suggest that removal of live bluegrass and bluegrass thatch and litter decreases bluegrass abundance, and promotes native plant communities across multiple years, suggesting that a single instance of bluegrass removal will promote native plant communities and benefit wildlife over multiple years. Conservation efforts should favor management practices that initially reduce bluegrass abundance and promote native plant diversity over several years.

Keywords: Kentucky bluegrass, ecology, rangeland management, invasive species, biodiversity

Role of Estrogen Metabolites in Regulating Airway Smooth Muscle Cell

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MENTOR: Sathish Venkatachalem, PhD – Pharmaceutical Sciences

Rationale: Airway remodeling is an irreversible process involving structural change caused by an increased airway smooth muscle (ASM) mass. We previously showed that chronic exposure to 17β-estradiol (E2) via ERα enhances ASM proliferation and ECM production, while ERβ has an inhibitory effect. These discrepancies suggest that estrogen may not be the sole driver in regulating ECM deposition and migration in ASM relevant to asthma.

Methods: The experiments were performed by treating the cells with estrogen metabolites (2-HE and 16αHE2) with/without PDGF (2ng/mL). A separate set of cells were treated with E2 alone, CYP3A4 inhibitor (PF49), and CYP1A1 inhibitor (Rhapontigenin) prior to E2 (1nM) exposure with/without PDGF (2ng/mL). The in-Well western analysis evaluated ECM depositions by measuring fibronectin and collagen-III. Further, ASM cell migration was performed by LFx live cell imaging.

Results: ASM cells treated with PDGF significantly increased ECM proteins (Fibronectin and Collagen-III) deposition. The PDGF-induced ECM depositions were further upregulated by 16αHE2. Further, PDGF-induced ECM protein depositions were significantly inhibited by E2 in the presence of PF49 (CYP3A4 inhibitor). In addition, 16αHE2 treatment significantly increased PDGF-induced MMP activity in conditioned media of human ASM cells. Human ASM cells exposed to 2-HE and treated PDGF showed decreased migration compared to PDGF alone, whereas 16αHE2 tends to increase PDGF-induced migration.

Conclusion: Overall, these data show the differential effect of estrogen metabolites, thereby dictating the net effect of E2 in regulating the ECM deposition and ASM cell migration.

Keywords: Estrogen, Airway, Remodeling, Metabolites, Asthma

Crumpling Defective Nanosheets

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MENTOR: Wenjie Xia, PhD –
Civil, Construction, and Environmental Engineering

Upon crumpling, nanosheets yield intriguing hierarchical structures with high resistance to compression and aggregation, garnering a great deal of attention in recent years for their remarkable potential in a variety of applications. Here, we aim to understand the effect of Stone–Wales (SW) defects, i.e., a typical topological defect of two-dimensional (2D) materials, on the crumpling behavior of nanosheets at a fundamental level. By employing atomistically informed coarse-grained molecular dynamics (CG-MD) simulations, we find that SW defects strongly influence the sheet conformation as manifested by the change in size scaling laws and weaken the self-adhesion of the sheet during the crumpling process. Remarkably, the analyses of the internal structures (i.e., local curvatures, stresses, and cross-section patterns) of crumpled nanosheets emphasize the enhanced mechanical heterogeneity and "glass-like" amorphous state elicited by SW defects. Our findings pave the way for understanding and exploring the tailored design of crumpled structures via defect engineering.

Keywords: Coarse-grained molecular dynamics simulations, Stone–Wales defect, Crumpled nanosheet, Structural behavior, Mechanical state

Migrant and Breeding Birds Along the Red River Corridor

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NATURAL RESOURCES MANAGEMENT

MENTOR: Torre Hovick, PhD –
Natural Resources Management

As urban areas expand, so does the importance of urban green spaces for biodiversity conservation, outdoor education, and human well-being. The Fargo-Moorhead metro area began an urban green space project in the late 1990's in response to severe flooding along the Red River corridor. Audubon Great Plains restored native prairie vegetation in over twenty of these green spaces in a project called the Urban Woods and Prairies Initiative. To better understand the value of restored urban green spaces for biodiversity, we used point counts to monitor spring migrant and breeding birds in twenty Urban Woods and Prairies sites from April through mid-July in 2022. Our main objectives were to 1) quantify migrant bird diversity and abundance, and 2) quantify the breeding status, diversity, and abundance of birds using the Urban Woods and Prairies sites during the breeding season. During the 2022 field season we detected 154 species including eight species of North Dakota conservation priority and 66 potential or confirmed breeding species. Point counts are continuing in 2023 and we seek to demonstrate the relationship between breeding birds and surrounding land cover, green space size, and site vegetation characteristics. Our results will inform future site management by identifying landscape and vegetation characteristics that promote the diversity and abundance of birds.

Keywords: Birds, migration, breeding, urban, green spaces

Effects of an Essential Oil Spray on the Nasopharyngeal Microbiota of Feedlot Cattle

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MENTOR: Samat Amat, PhD –
Microbiological Sciences

The increase in animal food production demand leads to higher risk for infectious diseases. Bovine respiratory disease (BRD) leads to approximately $1 billion in losses annually and feedlot cattle are at greater risk. The application of antibiotics to prevent/treat BRD leads to antimicrobial resistance (AMR). There hasn't been a new antibiotic class in 40 years and, with AMR on the rise among human and animal pathogens, there is a need to find alternatives. Essential oils (EO) are plant extracts with antimicrobial activity that were proven effective in vitro against BRD pathogens but not in animals. Here, EOs were evaluated for their potential to reduce BRD pathogens and modulate nasopharyngeal microbiota in feedlot cattle. Five EO were used in an intranasal spray. Forty calves received either an EO spray or a control (no EO) on day 0. Swabs were collected on days -1, 1, 2, 7, 14, 28, and 42, microbiota were characterized using the 16S rRNA gene, and animal performance was evaluated. The nasopharyngeal microbiota was different between EO and control groups ($P = 0.02$) and day ($P = 0.001$). The BRD pathogen Mannheimia was 3.9-fold higher in control animals ($P < 0.05$) from d-1 (2.66%) to d2 (10.4%) than the EO group. Both groups had similar performances. Overall, a single dose of intranasal EO spray could potentially alter nasopharyngeal microbiota and the abundance of Mannheimia was reduced post EO administration with no negative effects on production.

Keywords: essential oils, cattle, microbiota, BRD, antimicrobial

Comparison of Soil Moisture Sensors for Irrigation Water Management

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AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Dean Steele, PhD – Agricultural and Biosystems Engineering

The efficient management of irrigation water is critical for sustainable agriculture, and soil moisture sensors are a useful tool for determining when crops need to be irrigated. There are many different types of soil moisture sensors, each with its own advantages and limitations. However, the calibration functions offered by the manufacturers of these sensors are usually designed and tested in laboratory conditions, while the sensors' performance in field conditions, especially over extended periods, in comparison with other sensors, and in commercial production settings, is rarely examined. This study aims to compare the performance of different soil moisture sensors with calibrated Acclima TDR-310H (Acclima Inc., Meridian, ID, USA) sensors in the context of irrigation water management. The sensors evaluated include Valley Aqua Trac Pro and Aqua Trac Lite (Watermark and Sentek sensors, respectively; Valmont Industries, Valley, NE, USA), FieldNet (Watermark sensors; Lindsay Corporation, Omaha, NE, USA), FarmQA (AquaSpy sensor; AquaSpy Inc., San Diego, CA, USA), and CropX (CropX Inc., Anaheim, CA, USA). The study assesses the accuracy, reliability, and ease of use of each sensor type and compares their performance under different soil and environmental condition in three different field sites in ND, USA. The expected results of this study will provide valuable insights into the strengths and weaknesses of each sensor type and help farmers and agronomists make informed decisions about which sensor to use for their specific irrigation management needs.

Keywords: Irrigation, Soil moisture, Sensor comparison, Water management, TDR

Soybean Seeds Sorted by Hyperspectral Imaging Spectroscopy for Producing High-Quality Tofu.

AMANDA MALIK
CEREAL SCIENCE

MENTOR: Minwei Xu, PhD – Cereal Science

Tofu, a soymilk byproduct, is popular in Asia and growing in America. Soybean variety, chemical composition, and functioning affect its quality. Soybeans are classified by kernel damage, color, and size, which may not affect tofu quality. Hyperspectral imaging (HSI) is a non-destructive method for soybean seed compositional analysis. Machine learning can accurately automate HSI-based evaluation. This study sorted soybean seeds for high-quality tofu using HSI and machine learning. Two hundred varieties of soybean seeds were processed into tofu. Soybean seeds were classified with hierarchical clustering analysis (HCA) based on the tofu quality, such as water uptake rate, tofu yield, and textures. Meanwhile, the hyperspectral properties of soybeans were obtained through HSI scanning and image preprocessing. The processed images were fed into XGBoost for the selection of featured wavelengths. Images scanned at the featured wavelength, coupled with HCA classes, were fed into Convolutional Neural Network (CNN) to train the machine learning model. Furthermore, the CNN model was verified with the prediction of tofu quality based on the processed HSI images of unknown soybeans.

Test results showed 99% accuracy for CNN based classification. Verification of the test accuracy by CNN indicated an accuracy of 96-99% for all four classes. Finally, the tofu qualities of four unknown soybean seeds were successfully predicted by CNN model with the HSI image of the soybean seeds.

The results demonstrated that HSI scanning coupled with machine learning can predict tofu quality rapidly and effectively. This research will lead to a novel sorting technology in the food industry.

Keywords: Hyperspectral Imaging, Soybean, Sorting

Identification of quantitative trait loci associated with resistance to Bacterial leaf streak in spring wheat

FAZAL MANAN
PLANT PATHOLOGY

MENTOR: Zhaohui Liu, PhD – Plant Pathology

Bacterial leaf streak (BLS), caused by Xanthomonas campestris pv. undulosa, is an important disease on wheat in the Upper Midwest region of the United States. Breeding for BLS resistance in wheat has been hampered by a lack of knowledge regarding the sources and genetic basis of resistance. In this study, we conducted disease evaluations and QTL mapping of BLS resistance in spring wheat recombinant inbred line (RIL) populations. The RIL population (RBP938) was derived from the cross between 'RB07' (susceptible) and PI193938 (resistant) with 75 individuals. This population was evaluated in the greenhouse for disease reaction and also evaluated under field conditions. The RBP938 population was subjected to GBS, generating 2,614 SNP markers across the genome. In this population, two QTLs were identified for seedling resistance, one on chromosome 3DS and the other on 5DS. In the field trials, QTL for adult plant resistance were identified on chromosomes 5AS, 3BS and 1BS, with the latter one having the greatest effect. We are in the process to conduct additional disease phenotyping assays for the population. The locations of identified QTL and linked markers will be useful in breeding programs aiming at improving BLS resistance in spring wheat cultivars.

Keywords: Bacterial Leaf streak, Host resistance in wheat

Green bio-based fire-retardant additive and cure agent in epoxy coating

SIAVASH MANSOURI
COATINGS AND POLYMERIC MATERIALS

MENTOR: Mohiuddin Quadir, PhD – Coatings and Polymeric Materials

The destructive nature of fire causes a significant loss of human life and property. Epoxy resins have excellent mechanical, and chemical resistance. This class of coating is used for coating floors, home interiors, and many other household appliances. However, flammability of epoxy-based coating materials is an unmet danger and therefore, adding flame-retardant (FR) chemicals to epoxy formulations is a lucrative approach. A variety of chemicals are usually used as FR-additives. For example, halogenated compounds, oxides of metals, such as zinc, and phosphorus-rich compounds such as triethyl phosphates have been frequently used as FR-additives for coating resins. However, many of these compounds decompose and emit harmful gases during the ignition process. These gases are oftentimes carcinogenic and cause injury to the respiratory systems. In this study, we investigated the FR-activity of two green, biobased compounds, namely, phytic acid and phenalkamine. Chemically, phytic acid, having a unique and natural FR-properties, is a dihydrogen phosphate ester of inositol found naturally in a wide variety of grains, and cereals. In addition, phenalkamines are biobased curing-agent and have some similar properties to its petroleum-based equivalents: ethylenediamine, diethylenetriamine, and triethylenetetramine. In this work, we evaluated the effect of phytic acid on fire spread rate across a metal surface that has been coated with epoxy resins. These epoxy resins were enriched with different concentrations of phytic acid. The coatings were characterized in terms of their mechanical, chemical, and fire-resistant qualities. Our work will pave the way for improving the green footprints of FR-products developed from epoxy resins.

Keywords: Bio-based epoxy coatings, fire retardant

Elevating The Common Bean Industry: Investigating the Agronomic and Cooking Traits of Bruchid-Resistant Genotypes, Genetic Mapping and Molecular Marker Development

MARIA MAZALA
PLANT SCIENCES

MENTOR: Juan M. Osorno, PhD – Plant Sciences

The common bean (Phaseolus vulgaris L.) is an important crop worldwide, but it is susceptible to post-harvest damage from pests such as the bean weevil/bruchid (Acanthoscelides obtectus Say) and Mexican bean weevil/bruchid (Zabrotes subfasciatus Boheman). Bruchid-resistance is linked to the APA locus on chromosome Pv04, and identifying bruchid-resistant genotypes is a time and labor-intensive process. The aim of this study was to develop and validate a molecular marker for tracking APA introgression in common bean, and to evaluate the agronomic and cooking characteristics of 30 bruchid-breeding-lines from Zambia. Agronomic evaluations were conducted in 2022, and the lines were evaluated for cooking-time. An INDEL marker was screened on the breeding-lines to assess its effectiveness, and GBS libraries were constructed on recombinant inbred lines to identify accurate molecular markers closer to the APA locus. The ANOVA indicated significant differences for all traits ($P<0.05$), and the lines showed considerable genetic variation. Cooking-time results suggested that the APA introgression does not affect cooking-time. The marker amplified a DNA fragment with a 45 base pair insertion/deletion at the locus and was 100% accurate, making it a useful tool for marker-assisted-selection. The availability of this marker will accelerate the development of bruchid-resistant varieties, and further analysis of GBS data will identify more accurate molecular markers closer to the APA locus. Overall, the results of this study highlight the potential of these bruchid-resistant breeding-lines as new cultivars or improved germplasm, and provide valuable insights for improving common bean production and food security.

Keywords: Bruchids-resistance, Arcelin, phytohemagglutinin, α-amylase inhibitor

Utility Value Interventions in Organic Chemistry

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CHEMISTRY

MENTOR: Alexey Leontyev, PhD – Chemistry and Biochemistry

Utility value interventions (UVIs) are small exercises that aim to improve students' view of the usefulness of their course material. They can be implemented in courses to help students realize that their course content is relevant to their own personal lives and real-world applications. In this study, the students in a Survey of Organic Chemistry course were randomly divided into two groups, utility value and content summary. As part of three homework assignments preceding three course exams, the students were given a list of topics discussed during class that would be relevant to the upcoming exam. The students in the utility value group were asked to write about how the topics were relevant to their everyday lives or future career path, and the students in the content summary group were asked to summarize the topics. We aimed to seek if the implementation of these interventions had an effect on their exam scores, attitude towards chemistry, and motivation. The results show that the effectiveness of UVIs may be contextual. This presentation will address the findings of this study and its applicability across disciplines.

Key Words: utility value, content summary, organic chemistry, attitude, motivation

Variable Impact of Arbuscular Mycorrhizal Fungi across Different Genotypes of Field Peas

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ENTOMOLOGY

MENTOR: Deirdre Prischmann-Voldseth, PhD – School of Natural Resource Sciences

The use of root-associated mycorrhizal symbionts is a promising approach for developing more resource-efficient and sustainable agricultural systems. Arbuscular mycorrhizal fungi (AMF) are beneficial soil microbes that exchange mineral P from the soil for sugars and lipids provided by their host plants. Although the plant-AMF association can improve plant growth, depending on the functional diversity of the species involved and the environmental context, neutral or negative effects can also occur. We hypothesized that AMF performance would vary across genotypes of a single plant species, namely field pea, a legume and important food crop. In this greenhouse study, we analyzed the impact of AMF on growth and vigor of 20 diverse genotypes of field peas within four groups (organic, modern, historically important, and protein-rich lines). Half of the plants were inoculated with AMF while the other half were non-inoculated controls. Half of the plants were sampled at flowering stage to assess percent root AMF colonization and the rest sampled at plant maturity. Effect of AMF on plant performance was assessed by measuring leaf chlorophyll content, plant vigor, and plant biomass. Our findings indicated that the positive effects of AMF on field pea varies according to genotype. This research emphasizes the importance of considering the genotype-specific effects of AMF to optimize the use of mycorrhizal symbionts in agricultural systems.

Keywords: Arbuscular mycorrhizal fungi, field pea, plant-AMF association, AMF performance, plant genotypes

Self-reflection on collaborative piano practice and performance

GUILHERME MONTENEGRO
MUSIC

MENTOR: Tyler Wottrich, DMA – Challey School of Music

Collaborative pianists are largely required to practice and perform ensemble repertoire such as duo sonatas, art songs, and arias. Collaborative piano contrasts with solo masterworks in that a second instrument or vocal line demands more focused musical skills such as balancing and tuning the piano part with the soloist, uniform articulation, and precise rhythm. Furthermore, the repertoire is eventually given in a short period, and different schedules may reduce rehearsal frequency. Finally, non-piano related skills are required such as knowledge of compositional styles and foreign languages diction and translation. This abstract presents a self-reflection about the author's daily practices at the piano in order to perform a graduate recital. According to recent literature, the musician can widely benefit from achieving an optimal, motivational music profile as long as their formal practice integrates four criteria: self-regulated learning, deliberate practice, focused attention, and goal directed. Along with the practice sessions, a journal was used to register goals and identify needs of technique improvement. Second, recordings were made to facilitate self-regulated learning at the piano. Finally, auditioning was incorporated as a deliberate strategy that can predict difficult passages and avoid repeated, unfocused practices. Enhancing qualitative and quantitative aspects of piano practice throughout the semester may lead to the best performance on stage. Findings suggest that formal practice is a fundamental key for musicians to further their skills with high levels of motivation and confidence, leading to music achievement

Keywords: collaborative piano, music performance, formal practice, self-regulated learning, motivation

Natural Language Processing for Infrastructure Resilience to Natural Disasters: A Scientometric Review

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MENTOR: Chau Le, PhD – Civil, Construction, and Environmental Engineering

New solutions are needed to enhance infrastructure resilience in response to global warming and increasing natural disasters. Recent studies demonstrate the excellent potential of natural language processing (NLP) for mining unstructured human language during a natural disaster to assist with emergency decision-making, such as identifying infrastructure damages. NLP-based social sensing is an example of detecting disruptions and gaining situational awareness about critical infrastructure. Nonetheless, few studies have attempted to map the global research on applying NLP for infrastructure resilience. This paper aims to fill this gap by presenting a scientometric review of current knowledge using networks derived from the bibliographic records of the Scopus and Web of Science core collection. Specifically, this review highlights the top trends, spatiotemporal variations, significant developments, challenges, and future opportunities in NLP-based infrastructure resilience research. This study intends to improve scholars' and practitioners' understanding of using NLP for infrastructure resilience against natural disasters.

Establishing Alfalfa in Corn or Sorghum Intercrops to Increase Diversity

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ENVIRONMENTAL AND CONSERVATION SCIENCE

MENTOR: Marisol Berti, PhD – Plant Sciences

Over time, traditional cropping systems will be less productive as high inputs and low diversity alters the soil microbiome and physicochemical properties. Cropping system diversification by including perennial legumes such as alfalfa (Medicago sativa L.) can improve soil and increase yields. However, despite the benefits it can have on soil quality, alfalfa production is declining because its establishment year is often less productive. The objectives of this study are to reduce economic loss in the seeding year and determine whether intercropping corn (Zea mays L.) or sorghum (Sorghum bicolor (L.) Moench) with alfalfa can increase overall yield and quality of the perennial system. Corn (C), sorghum (S), and alfalfa (A), alone or intercropped, (corn (CA) or sorghum (SA) + alfalfa) were planted under different management strategies: traditional and 0.6m gaps every 1.8m within cornrows (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). Protein was greater in S2 (94.0 g kg-1) and SA2 (89.9 g kg-1) than S (71.8 g kg-1) and SA (61.2 g kg-1). Biomass was similar across all sorghum treatments, and the reduction of grain yield in G and GA was less than 17% compared to C and CA. Alfalfa failed to establish under SA, however, it maintained similar stands in SA2 compared with A. Yields and nutritive value for alfalfa in year two are expected to be similar across GA and SA2 when compared to A.

Keywords: biodiversity, forages, cropping systems, intercropping

Investigating the role of extracellular matrix aging in tumor cell adhesion to 3D-scaffolds.

ANUPOM DEB NATH
PHARMACEUTICAL SCIENCES

MENTOR: Stefan W. Vetter, PhD – Pharmaceutical Sciences

Motivation: The development of novel cancer therapeutics depends on in-vitro models that closely resemble tumor properties in the human body. There is substantial evidence that extracellular matrix (ECM) is critical in tumor growth and metastasis. ECM molecules are biologically long-lived, and they accumulate chemical modifications known as glycation. Current cell culture methods use recombinant or animal-derived ECM, which lacks the properties of aged ECM found in cancer patients. We hypothesized that chemical aging of ECM protein would provide a growth substrate for cancer cells that influences proliferation and migration compared to non-aged ECM supports.

Methods: As an initial model of matrix aging, we compared native collagen and collagen modified by the metabolite methylglyoxal (MG) as a growth support for breast cancer cells. We used continuous, real-time holographic imaging to observe cellular properties on different growth substrates. We also investigated differences in gene expression induced by glycated collagen.

Results and conclusions: Our study found that chemically aged ECM influences cancer cell adhesion and proliferation. We showed that collagen proteins glycated with methylglyoxal (MG) significantly changed cell spreading area, eccentricity, cell migration and motility, cell optical thickness and optical volume. Along with this, qPCR analysis investigated differences in gene transcription for specific genes involved in epithelial-mesenchymal transition and cancer cell stemness. From our experiments, we can say that the aging of ECM proteins affects cellular behavior. In conclusion, using aged ECM proteins in in-vitro model systems of cancer may offer advantages over current cell culture methods.

Keywords: Extracellular matrix, glycation, cell adhesion, cancer

Influence of orally-dosed Megasphaera elsdenii culture on cattle performance, carcass characteristics, and frequency of boat in heifers rapidly adapted to a finishing diet.

MADELIENE NICHOLS
ANIMAL SCIENCE

MENTOR: Zac Carlson, PhD – Animal Science

Ruminal acidosis is a metabolic disorder that can occur in cattle consuming high-concentrate diets, affecting their growth performance and overall well-being. The objective of this trial was to determine the effect of Lactipro NXT, a probiotic drench containing live cultures of Megasphaera elsdenii NCIMB 41125 (ME), on feed intake, rate of gain, frequency and severity of bloat, microbial populations, and carcass characteristics of cattle adapting to a high-concentrate finishing diet. Two-year-old heifers (n=32; initial BW=462±34kg) were utilized in a 70-day randomized design with animals being the experimental unit. Treatments were 1) a conventional 21-day step-up protocol consisting of four step-up diets, receiving 0mL of ME (CON), 2) an accelerated 11-day step-up protocol consisting of three step-up diets, receiving 40mL (2×1010 CUF/dose) of ME on day one. Heifers were fed via Calan headgates (American Calan Inc., Northwood, NH) to measure daily intakes. Body weights were recorded days -1, 0, 1, 15, 28, 56, and 70; rumen fluid and fecal samples were collected days 1, 15, 28, 56 and 70; and bloat scores were recorded twice daily. Post experiment, heifers were processed at Tyson Meats (Dakota City, NE) to evaluate carcass characteristics and liver abscesses. There were no differences ($P \geq 0.18$) in final body weight, average daily gain, dry matter intake, gain to feed ratio, carcass characteristics or liver abscess rate. Thus, utilizing Lactipro NXT allows us to accelerate cattle onto high-concentrate diets without experiencing adverse effects.

Keywords: Megasphaera elsdenii, Beef Cattle, FeedLot, High-Concentrate.

Real-Time Inspection using Unmanned Aerial Vehicles and Virtual Reality

KYLE NIETFELD
MECHANICAL ENGINEERING

MENTOR: Inbae Jeong, PhD – Mechanical Engineering

This research project investigates the feasibility of combining Virtual Reality (VR) technology to control Unmanned Aerial Vehicles (UAVs) for real-time remote inspection of buildings, bridges, and other civil infrastructure. The project is motivated by the need to improve the efficiency and safety of inspections by providing a cost-effective and more efficient way to inspect for damages and cracks. While this project is ongoing, we have made great progress and can demonstrate the success of all individual components. Using a DJI Mavic 2 Pro and its associated Mobile Software Development Kit, we can precisely control all motion of the drone, including its position, rotation, and camera angle. Additionally, we have demonstrated successful real-time image processing using the onboard camera to detect objects of interest. Much progress has also been made to develop a framework for using an Oculus VR headset to receive the head's positional and rotational movement. Lastly, a remote server able to wirelessly send commands to the drone via Wi-Fi has been achieved. The next steps of this project are to 1) combine all working components and 2) implement a control algorithm to control the drone safely and easily with only head movements. While this technology can improve the efficiency and safety of building inspections, it can also be valuable in other applications such as agriculture and search-and-rescue missions.

Keywords: Inspection, Unmanned Aerial Vehicles, Virtual Reality, Real-Time.

Concomitant pesticides in bumble bees: the effects of thiamethoxam and glyphosate on circadian rhythmicity and activity in the Bumblebee, Bombus impatiens

HEATHER NORTH
BIOLOGICAL SCIENCES

MENTOR: Julia Bowsher, PhD – Biological Sciences

Bumblebees (Bombus) are significant wild pollinators in temperate regions of North America. Pesticides of known toxicity to bees are in the nectar source of pollinator preferred crops, when present in conjunction with other pesticides their combined effect on many bumblebee behaviors is still poorly understood. Neonicotinoids are a concern because of their use on commercial crops bumblebees are known to visit. Neonicotinoid pesticides act as agonists of insect nicotinic acetylcholine receptors (nAChR) in the central nervous system that mediate neurotransmission within the insect brain. Glyphosate is of interest because commercially available crops are known to be genetically modified to withstand the application of roundup. Glyphosate, the active ingredient in roundup, disrupts the production of essential amino acids produced in the shikimate pathway; a pathway believed to be only in plants. Circadian clock neurons use light to correspond with the clock through nAChR signaling. Our goal is to measure circadian rhythms and activity under different doses of ad libitum oral consumption of field-relevant sublethal levels of thiamethoxam and glyphosate individually and combined. A locomotor activity monitors recorded activity of individual bees for 8 consecutive days. Thiamethoxam treatments included 1nM, 10nM, 100nM. Glyphosate treatments included 3.2nM, 32nM, 320nM. Combined treatments were 1nM/3.2nM, 1nM/32nM, 1nM/320nM, 10nM/3.2nM, 10nM/32nM, 10nM/320nM, 100nM/3.2nM, 100nM/32nM, 100nM/320nM respectively. Reduced activity levels were observed with increasing concentrations of thiamethoxam, while glyphosate had little effect on activity. Only the combination of thiamethoxam and glyphosate shifted the most active time of day but only at the highest concentrations of each.

Keywords: Pollinators, Toxicology, Bumble bees, Pesticides

Multi-band Wearable Metasurface Antenna for Wireless Body Area Network Applications

MD ASHIF ISLAM ONI
ELECTRICAL AND COMPUTER ENGINEERING

MENTOR: Shuvashis Dey, PhD – Electrical and Computer Engineering

This research investigates the performance of a metasurface (MTS) based multi-band wearable antenna. The antenna is designed on the flexible and stretchable polydimethylsiloxane (PDMS) polymer substrate having a compact dimension of 100 × 100 × 0.3 mm3. This antenna resonates at 4.23 GHz, 5.76 GHz, 7.3 GHz, and 8.85 GHz. A simple effective technique has been utilized to achieve circular polarization. By using MTS, a directive radiation pattern has been achieved. The simulated performance of the designed antenna is analyzed with respect to different antenna parameters, including reflection coefficient, radiation pattern, directivity, voltage standing wave ratio, and electric-field distribution. From the performance metrics, it can be said that the proposed antenna will essentially be exploited for the application of wireless body area network (WBAN) applications.

Keywords: Wearable antenna, Multi-band, Metasurface, Wireless Body Area Network (WBAN), Flexible

Mapping Rk, the Red Kidney Color Gene, in Common Bean

CAROLINE OSBORNE
GENOMICS, PHENOMICS, AND BIOINFORMATICS

MENTOR: Phil McClean, PhD – Plant Sciences

There are multiple genes controlling seed coat color in common bean (Phaseolus vulgaris L.). The Rk gene is one of two genes that controls red seed coat color. Classical linkage analysis determined that the I gene for virus resistance was linked to the B gene on chromosome Pv02. Further linkage analysis found that B and Rk are linked. These genes were physically mapped using a GWAS analysis. Nineteen PCR Allele Competitive Extension (PACE) markers surrounding a GWAS peak near the Rk gene were developed based on SNP variation between G122 (dominant Rk) and Montcalm (recessive rkd), the parents of an F5-derived recombinant inbred mapping population. A candidate gene model, Phvul.002G218700, was identified near the Rk GWAS peak and within the mapping interval. The gene encodes anthocyanidin reductase (ANR), an enzyme that catalyzes the reaction that converts anthocyanidins into flavan-3-ols within the flavonoid pathway. Amplicon primers were developed for the gene, and the sequence for multiple Rk alleles were obtained. These alleles control seed coat color of multiple market classes including dark red kidney (rkd), light red kidney (rk), Durango red (rkcd) and pinks (rkp). The alleles differed by unique amino acid substitutions. The phenotypic, genotypic, and mapping data all confirmed that Rk cosegregated with the ANR gene. Currently, these rk markers, along with markers linked to other relevant color genes, are being used to select for breeding progeny with a specific red seed coat color along with the desirable slow darkening seed coat phenotype.

Keywords: Mapping, dry bean, genetics, color

Worker's Physiological/ Psychological Responses During Human-Robot Collaboration in An Immersive Virtual Reality Environment

ALI PAKBAZ
MECHANICAL ENGINEERING

MENTOR: Inbae Jeong, PhD – Mechanical Engineering and Youjin Jang, PhD – Civil, Construction, and Civil Engineering

The construction industry is facing problems with low productivity rates, safety concerns, and labor shortages, leading to the adoption of robotic technologies. While robots can replace tasks requiring repeatability, power, speed, and precision, tasks requiring intelligence, flexibility, and problem-solving still need skilled human workers. For effective human-robot collaboration on highly dynamic and uncertain construction job sites, robots must be designed and controlled to earn workers' trust. To identify trust mechanisms facilitating collaboration, this study aims to analyze human physiological/psychological responses to construction robots Using wearable sensors, this study measured responses during virtual reality experiments in which humans worked collaboratively with robots. The results showed that robot movement speed, proximity distance, and worker engagement significantly affected human responses, but the robot's direction of approach did not. These findings can improve collaborative task design and guidelines for improving safety and productivity in human-robot collaboration from a human-centered perspective.

Keywords: Human-robot collaboration, Human-robot trust, robotics, and Virtual reality

Soil Health Index in North Dakota Farmlands: The Influence of Management Practices and Weather Patterns

SAKSHI PAUDEL
MICROBIOLOGICAL SCIENCES

MENTOR: Samiran Banerjee, PhD – Microbiological Sciences

Soil health is critical to maintaining ecosystem functioning and nutrient cycling processes while sustaining agricultural productivity. However, intensive agriculture has been shown to adversely impact soil health in many parts of the United States. To better understand the effects of agricultural practices on soil health, we conducted a large-scale study modeling soil health across 201 farmlands in 51 out of 53 counties in North Dakota. To understand temporal dynamics, we also included three crop growth stages (seedling, mature, and harvest). We then used spatial interpolation, management information, and soil health modeling to evaluate the impact of weather patterns, soil properties, and agricultural management practices on soil health. Our study found significant variations in soil parameters, including dissolved organic carbon, salts, dissolved total nitrogen, ammonium, and nitrate. Spatial interpolation revealed distinct differentiation in three different cropping regions of North Dakota - the red river valley, drift prairie, and Missouri plateau - for soil properties such as base saturation carbon and total organic carbon across all three crop growth stages. The most productive region of the state, the Red River Valley, showed distinct differentiation for soil properties such as total dissolvable nitrogen, plant-available phosphorus, and zinc. Agricultural practices had a spatial influence on soil health properties across the three different crop-growing regions, and weather patterns such as rainfall had an impact on total nitrogen availability to the plants. Our study highlights how soil health indices can be used to investigate the impact of agricultural practices and weather patterns on soil properties.

Keywords: Soil health, agricultural practices, weather patterns, soil properties.

Oxidative damage and age-related declines in locomotion

JACOB PITHAN
BIOLOGICAL SCIENCES

MENTOR: Kendra Greenlee, PhD – Biological Sciences

Aging is a progressive deterioration of physiological function that leads to senescence and death. Aging is thought to occur due to an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defense, which leads to age-dependent accumulation of damage in lipids, proteins, and DNA. Most current knowledge about aging mechanisms stems from vertebrates. However, focusing on a few species ignores natural variation in aging. Insects offer this insight, because they exhibit phenotypic plasticity, high-levels of activity, and aging intervention. To increase our understanding of aging in alternative species, we use the solitary bee, Megachile rotundata. We hypothesized that M. rotundata experienced age-related performance declines, due to increasing oxidative damage and reduced antioxidant capacity. Adult M. rotundata were reared from emergence and tested at day 0, 7, 14, or 21. For each age group, we assessed walking performance, flight performance, oxidative damage of lipids (TBARS) and proteins (protein carbonyls), and antioxidant capacity (TEAC). Walking activity doubled from day 0 to day 7, but remained constant to 21 days. Flight performance decreased with age, with only 34% of females and no males able to fly by day 21. Both lipid and protein damage increased with age, however the amount of damage plateaued at day 7. The plateau of oxidative damage is likely due to the effectiveness of antioxidant defenses which increased at that time and remained high.

Keywords: Aging, Oxdiative Stress, Locomotion, Pollinators

Development of a CRISPR/ Cas9-mediated Genetic Tool for Functional Genomics of Bipolaris sorokiniana

ALIREZA POURSAFAR
PLANT PATHOLOGY

MENTOR: Shaobin Zhong, PhD – Plant Pathology

Bipolaris sorokiniana is a hemibiotrophic fungal pathogen with a wide host range infecting a number of economically important cereals and wild grasses. There is limited information with respect to the molecular interactions of the fungus with its host plants and the molecular regulations involved in its establishment, transition from biotrophic to necrotrophic phase, secondary metabolite biosynthesis, and pathogenicity variability. The mutant generation is a fundamental step for Pathogen-Host interactions and Functional Genomics studies. In recent years, the development of CRISPR/Cas9 technology has facilitated genome editing and mutagenesis processes in fungi. In this study, the efficacy of the CRISPR/Cas9 system in generating Polyketide synthases 1 (PKs1) gene knockout mutants for B. sorokiniana was evaluated and compared to the conventional spilt marker system. The results showed that introducing specific double-stranded breaks in PKs1gene using the CRISPR/Cas9 system in presence of an exogenous donor DNA with 40 bp or 60 bp flanking sequences homologous to the target gene is a powerful approach with an easier procedure and higher efficiency for gene knockout/replacement in the fungus. Additionally, applying exogenous donor DNA with 60 bp flanking sequences was shown to be more efficient in the gene knockout process compared to donor DNA with 40 bp flanking sequences. Based on the preliminary results, this research can speed up functional genomics studies in B. sorokiniana.

Keywords: Fungal pathogen, Wheat, Genome editing, Mutation, Plant disease.

Characterization of SARS-CoV-2 present in wastewater using whole genome and targeted sequencing

BEENA PUN
MICROBIOLOGY

MENTOR: John McEvoy, PhD – Microbiological Sciences

Monitoring wastewater has been proven as an effective way to track the virus in communities, independently of health-seeking behavior. The importance of this approach is increasing as disease diagnosis shifts from healthcare settings to at-home rapid testing, which is not reported. Whole genome sequencing (Illumina sequencing based approach, Amplicon-based target enrichment) is effective at identifying SARS-CoV-2 variants in wastewater, but a significant limitation of this approach is that it is insensitive to low-prevalence variants. Detecting such low prevalent variants before they emerge as a major cause of clinical cases in communities can help to inform the public health response. In this study, we used a targeted sequencing approach by amplifying the epidemiologically important receptor binding domain (RBD) of SARS-CoV-2 spike protein. Using this approach, we were able to identify low-prevalence variants in wastewater samples from several municipalities in the upper Midwest United States. In conclusion, targeted sequencing of the RBD can be used as a cost-effective and sensitive alternative to whole genome sequencing to characterize SARS-CoV-2 variants in wastewater.

Key words: Wastewater, SARS-CoV-2 variants, Whole genome sequencing Targeted sequencing

Towards Chipless RFID based Temperature Sensing for IoT Applications

MD MIRAZUR RAHMAN
ELECTRICAL AND COMPUTER ENGINEERING

MENTOR: Shuvashis Dey, PhD – Electrical and Computer Engineering

This project presents a novel technique to measure temperature by using a chipless RFID tag and smart material in view of IoT application. The proposed technique incorporates a unique design of a chipless RFID resonator and a novel chipless technique for sensing temperature by combining an ETFE fluoropolymer with the resonator. The simulated material is placed on the top of the tag and dielectric parameters are varied. Initially, the original RCS response of the resonator is simulated which is then observed while varying the values of permittivity to obtain a correlation between different frequencies and dielectric constants. This correlation is further compared with the dielectric parameters of the material and the corresponding temperatures found from the literature. Finally, a calibration curve obtained where any temperature within the range can be measured by simply mapping the frequency of operation of the chipless resonator.

Keywords: chipless, RFID, Temperature, sensing, IoT

β-sheet Richness of Extracellular Vesicles for Pancreatic Cancer Screening

KOMILA RASULEVA
BIOMEDICAL ENGINEERING

MENTOR: Dali Sun, PhD – Electrical and Computer Engineering

Pancreatic cancer patients predominantly present with advanced disease at the time of diagnosis, which is the reason for its high mortality. A noninvasive fast-screening method to detect asymptomatic disease is an unmet need. Tumor-derived extracellular vesicles (EVs) bearing information from parental cells were believed to be a good candidate for noninvasive diagnosis biomarkers. Many pancreatic cancer diagnostic assays use only a single cancer-associated marker/signature, which are either subtype-specific or could be easily masked by high background signals. The purpose of this research is to develop a fast method of noninvasive diagnosis biomarkers for pancreatic cancer screening as collective attributes by analyzing the secondary structure of the EV proteins using circular dichroism (CD), Fourier transform infrared (FT-IR), and fluorescent staining. We developed a high-throughput noninvasive assay by using the β-sheet richness (BR) of the tumor-derived EVs as a target in order to recognize EVs originating from malignant and nonmalignant cells. Extracellular vesicles bearing information from parental cells play important roles in cell–cell signaling, immune response, and metastasis. We were able to indicate that pancreatic cancer EV proteins were more β-sheet-rich than their healthy counterparts. A fast method assay was developed that combines immunoprecipitation (IP) and Thioflavin T (ThT) fluorescent dye, termed as EvIPThT, that binds directly to β-sheet-rich proteins into EVs. This assay readout of a review pilot companion showed adequate biased power contrasting samples from cancer cases, disease controls and healthy controls. This method appeared to be the simple, inexpensive, low sample, less time consuming, high-throughput, and automatable, since no β-sheet richness change was observed in the treated and nontreated cells, EvIPThT assay shows promising results as a pancreatic cancer screening assay, filling the translational gaps left by current EV detection methods.

Keywords: Extracellular vesicles, protein structure, β-sheet, collective attribute, PDAC, noninvasive

Arylhydrocarbon Receptor in Airway Smooth Muscle

MOHAMMAD IRSHAD REZA
PHARMACEUTICAL SCIENCES

MENTOR: Sathish Venkatachalem, PhD – Pharmaceutical Sciences

The airway smooth muscle (ASM) is well known to regulate airway tone and remodeling in asthma pathophysiology. The aryl hydrocarbon receptor (AhR) is an intracellular sensor for organic compounds and toxins that regulates cellular homeostasis. Recent studies suggest an important role for AhR in regulating airway epithelial and immune cell responses, however, how AhR influences ASM per se, particularly in inflammation/asthma, are not known. Thus, we aimed to explore the expression and function of AhR in baseline and during inflammation and asthma. Primary human ASM cells isolated from surgical lung resections were cultured in DMEM-F12 medium and treated with TNFα (20 ng/mL) for 2h and single cell RNA sequencing was done. Immunofluorescence of human airway was done to determine the baseline AhR expression. The AhR expression was determined in non-asthmatic/asthmatic cells and in inflammatory conditions by qPCR and immunoblotting. Furthermore, ASM cell proliferation was done using PDGF (2 ng/mL) by MTT assay. Subsequently, the AhR activation was confirmed by measuring XRE luciferase activity and CYP1B1 expression using AhR agonist and antagonist. RNA seq, qPCR, and Immunoblotting data showed increased AhR in TNFα treated ASM cells. Interestingly, we found ubiquitous baseline AhR expression in human ASM. Moreover, AhR expression was higher in asthmatic ASM than non-asthmatics. Also, we found, AhR activation mitigates PDGF-induced ASM cells proliferation. Further, nuclear translocation of AhR, enhanced XRE luciferase activity, and CYP1B1 was observed in TCDD-treated cells, confirming AhR activation. Altogether, our findings demonstrated AhR is expressed in human ASM and altered during inflammation and asthma.

Keywords: Airway smooth muscle, Arylhydrocarbon receptor, AhR, Asthma, Airway disease

Ti3C2 MXene and in situ HAPclay-Based Biosensor for Early Diagnosis of Pancreatic Cancer

MAHEK SADIQ
BIOMEDICAL ENGINEERING

MENTOR: Danling Wang, PhD – Electrical and Computer Engineering

The demand for more precise medical equipment is rising at the same time as medical technology advances. One of the numerous illnesses that is almost impossible to treat is "cancer." The lack of technology for diagnosis in the early stages is one of the causes of failed attempts to fight cancer. Our research focuses on biosensors for pancreatic cancer diagnosis based on a composite material made of novel 2-dimensional Ti3C2 MXene and in situ HAPclay. The purpose of our work is to develop an intelligent sensor combining the two materials which can respond immediately to cancer samples to provide in-time guidance for cancer diagnosis. The MXene-HAPclay composite-based biosensor has advantages of reliability, easy usability, affordability, adjustability, and good sensitivity that can be miniaturized as a portable device for point-of-care applications. The rationale of this research relies on that MXenes, having tailorable surface functional groups, are very sensitive and selective, and thus can sense trace amounts of different analytes, which is immensely helpful in diagnosing cancer at an earlier stage. By observing the distinctive pattern in resistance change of these sensors, we can track their reaction and tell cancerous samples apart from non-cancerous samples. Additionally, MXene's selectivity aids in the 'identification' of particular analytes from a variety, making them more trustworthy. The in situ HAPclay on the other hand, possesses osteoinductive and osteoconductive properties and thus has the ability to influence the differentiation of mesenchymal stem cells (MSCs). In the future, we hope to use our expertise in tissue engineering to regenerate new tissues while keeping an eye on the emergence of malignant tis sues.

Keywords: Nanomaterial, Biosensor, Cancer, Nanocomposite, Regeneration

Molecular Mapping of Resistance to Fusarium Head Blight in a Spring Wheat Mapping Population

SHAHED SAFAR
PLANT PATHOLOGY

MENTOR: Shaobin Zhong, PhD – Plant Pathology

Fusarium head blight (FHB), mainly caused by Fusarium graminearum, is a devastating disease in wheat worldwide. The disease causes significant yield losses and reduce grain quality. Resistance to FHB is a complex trait controlled by quantitative trait loci (QTL) and affected by environmental conditions. In this study, we aimed to map QTL for FHB resistance in the spring wheat cultivar Glenn and a spring wheat line GP112 using a recombinant inbred line (RIL) population derived from the cross between Glenn and GP112. Glenn was derived from a cross between ND2831 and Steele-ND and exhibits moderate resistance to FHB. GP112 is a RIL derived from a cross between Grandin and PI 277012 with two FHB resistance QTL mapped on chromosome 5A. The RIL population was evaluated for FHB resistance in three greenhouse experiments, and in two field disease nurseries located in Fargo and Langdon in 2021 and 2022, respectively. Genotyping by sequencing (GBS) of RILs and their parents (Glenn and GP112) was conducted to generate SNP markers for construction of genetic linkage maps. Identification of QTL associated with FHB resistance is in progress. This study will validate previously identified QTL for FHB resistance in Glenn and also examine additive effect of the combination of Glenn QTL with GP112 QTL on FHB resistance. The findings will help to improve wheat resistance to FHB using marker-assisted selection in wheat breeding programs.

Keywords: Fusarium head blight (FHB)- QTL- Glenn- GP112- GBS.

Microplastics and PFAS in yard waste compost: occurrence and degradation

BIRAJ SAHA
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

MENTOR: Syeed Md Iskander, PhD – Civil, Construction, and Environmental Engineering

Microplastics and PFAS pollution are significant environmental problems of the 21st century. Compost is a dominant source of microplastics and PFAS in the environment. Our analysis demonstrated that low/high-density polyethylene, polypropylene, and polyethylene terephthalate microplastics are prevalent in yard waste compost. We investigated 42 different PFAS in yard waste compost and identified 21 PFAS species with the predominance of Perfluorocarboxylic acids (6305 – 7789 ng kg-1) and Fluorotelomer sulfonates (439 – 745 ng kg-1). Additionally, by investigating total PFAS concentrations in an idle compost pile at different depths, we found that the total PFAS concentrations at 1ft depth were 30% greater and at 2ft depth were 59% greater than the total PFAS concentrations at the surface of the pile. This indicates volatilization loss of PFAS from the surface of the compost pile. To elucidate the co-occurrence of plastics and PFAS, we investigated the PFAS content in incoming and composted plastics. Perfluorocarboxylic acids dominated in incoming (4386.96 – 4681.67 ng kg-1) and composted (1596.03 – 5989.24 ng kg-1) polyethylene. We further conducted lab-scale organic waste composting with ultraviolet and sunlight-weathered polyethylene and polymethyl methacrylate (PMMA) microbeads. Our analysis demonstrated that the C/O ratio decreased from 23.30 to 7.60 for polyethylene microbeads indicating surface oxidation. The molecular weight of polyethylene remained stable after composting, while the molecular weight of PMMA decreased by 35 – 70%, meaning the more significant degradation of amorphous polymers. This study improved our understanding of the pathways and degradation of microplastics and PFAS in compost and will help develop control and remediation measures.

Keywords: microplastics, PFAS, degradation, volatilization loss, organic waste.

Anterior Gradient 2 (AGR2) knockdown increases endoplasmic reticulum proteotoxic stress in pancreatic cancer cells

PHILIP SALU
CELLULAR AND MOLECULAR BIOLOGY

MENTOR: Katie Reindl, PhD – Biological Sciences

Anterior Gradient 2 (AGR2) is a proto-oncogene involved in the tumorigenesis of many cancers, including pancreatic ductal adenocarcinoma (PDAC). AGR2 is localized in the endoplasmic reticulum, where it is involved in protein-disulfide isomerase reactions to ensure proper protein folding, thereby preventing proteotoxic stress resulting from the very high transcriptional output by cancer cells. AGR2 is overexpressed in PDAC and we hypothesize AGR2 promotes tumor cell survival.

To test this hypothesis, HPAF-II and PANC-1 cell lines with stable AGR2-inducible knockdown were generated using lentiviral constructs. We demonstrate that AGR2 knockdown decreases cell viability and increases endoplasmic reticulum stress leading to an unfolded protein response. RNA sequencing analysis has also revealed an enrichment in the hallmark pathways, including reactive oxygen species, E2F targets, and G2M checkpoint. Our goal is to investigate further how the regulation of proteostasis in PDAC cells can help to ameliorate tumor progression and metastasis.

Keywords: Pancreatic cancer, Anterior Gradient 2 (AGR2)

Developing tools for high throughput assessment of symbiosis phenotypes between Lotus japonicus using Mesorhizobium japonicum strain R7A

GAYATHRI SENANAYAKE
MICROBIOLOGY

MENTOR: Barney Geddes, PhD – Microbiological Sciences

Nitrogen fertilizer production in agriculture relies on the Haber- Bosch process which involves a high level of energy consumption and negative ecological. Nitrogen fixing bacteria that for symbiosis with legume plants are a sustainable alternative to chemical N fertilizers. Lotus japonicus is a legume model plant that is widely used to study the legume biology, nodulation, and symbiotic interactions, especially with its symbiont Mesorhizobium japonicum strain R7A. In the high-throughput assessment of this symbiosis relationship, barcoded plasmids with fluorescent bioreporters can be utilized to evaluate the Rhizobial competitiveness and N2 fixation effectiveness. In this study, four plasmids were constructed using two different PnifH promoters (Div_meso_psnifH, CP_meso_psnifH) to express sfGFP and two different plasmid vector back bones derived from RK2 and pBBR1 origins of replication (pNDGG003, pNDGG004. Assembled plasmids were transformed into E. coli ST18, introduced to M. japonicum R7A by conjugation, and inoculated onto L. japonicus. Plasmid performance was evaluated by measuring the fluorescence levels, shoot dry weight and plasmid stability. It was evident that the construct which had the Div_meso_psnifH promoter and the pNDGG004 vector backbone had the highest fluorescence levels and stability. These findings can be further adapted to about the genes in the Integrative and Conjugative element (ICE) in M. japonicum strain R7A required for effective nitrogen fixation.

Keywords: Plasmid ID; Nitrogen fixation; fluorescence; symbiosis; tools.

Effect of Different Irrigation Treatments on Yield of Watermelon, Muskmelon and Squash in a Mulched Sandy Soil

BHUWAN SHAH
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Xinhua Jia, PhD – Agricultural and Biosystems Engineering

Horticultural crops have limited production in North Dakota due to a short growing season, low soil temperature, variable weather conditions, and lack of access to high-quality irrigation water. A precise application of irrigation water is needed to maximize water use efficiency and increase crop yield. A field study was conducted in 2022 near Oakes, North Dakota to study the effect of four irrigation treatments on the quality and yield of different commercial varieties of watermelon, cantaloupe, and squash under clear plastic mulch. Two drip lines located under the mulch were used to apply the irrigation water. Throughout the growing season, four treatments were initiated automatically namely 10% MAD, 30% MAD, 60% MAD and Time-based irrigation. The experiment was designed as a Randomized Complete Block Design split-plot arrangement with four replications, and four varieties for each crop. Soil moisture and temperature sensors were installed to control the irrigation and measure the soil moisture conditions. A system consisting of a remote-controlled irrigation controller, soil click, solenoid valve, and flowmeter was designed and installed to control the irrigation system automatically and remotely. The effect of different irrigation treatments was analyzed based on the samples' average fruit weight, length, diameter, electrical conductivity (EC), pH, and sugar content.

Unlocking the potential of wheat wild relatives: A promising solution for wheat improvement and global food security

JATINDER SINGH
PLANT PATHOLOGY

MENTOR: Upinder Gill, PhD – Plant Pathology

Wheat has been a key element in shaping human civilization for the past 10,000 years. It provides stable sustenance for billions of people in all cultures worldwide. Globally, plant diseases and pests cause approximately 21.5% yield losses in wheat annually, potentially escalating global food insecurity. Wheat wild relatives (WWRs) play a crucial role in providing many useful stress resilience traits for wheat improvement. The current project aims at exploring novel biotic and abiotic stress tolerance in one of the WWRs, Aegilops umbellulata (UU genome) and transferring these traits in cultivated wheat. Screening of diverse Ae. umbellulata lines with different wheat rusts revealed high levels of disease resistance in this species, with 70% of the lines resistant to leaf rust (Puccinia triticina), and 39-82% resistant to stem rust (P. graminis f. sp. tritici) and stripe rust (P. striiformis f. sp. tritici). Further, lines with tan spot (Pyrenophora tritici-repentis) resistance (42%) and bacterial leaf streak (Xanthomonas translucens pv. undulosa) resistance (2%) were also identified. To identify resistance genes against these diseases, we have developed the whole genome (4.28 Gb) chromosome scale assembly of the most resistant accession, PI554389 using PacBio, Hi-C (Chromosome conformation capture), and oxford nanopore technologies (ONT) sequencing. The direct transfer of resistance traits from wild to cultivated wheat is difficult. Therefore, we are developing synthetic hexaploid bridging species (AABBUU) which will facilitate the future transfer of resistance traits into cultivated wheat (AABBDD).

Keywords: Wheat, Wild wheat relatives, Rust, Whole genome sequencing, Introgression.

No Place Like Home: Deciphering How Ammonia-Oxidizing Microbes Share Niche Space.

ALAN SNAVELY
MICROBIOLOGY

MENTOR: Samiran Banerjee, PhD – Microbiological Sciences

Ammonia-oxidizing archaea and bacteria are vital to the global nitrogen cycle. Ammonia-oxidizing microbes break down ammonia into nitrate, making them pertinent to agriculture as ammonia oxidation modulates nitrogen availability for plants. Since these microbes compete for the same resource, ammonia, the literature traditionally held that bacterial ammonia-oxidizers tend to prefer niches high in ammonia while archaeal ammonia-oxidizers prefer niches low in ammonia. However, recent research refutes this domain-level niche partitioning, with various counterexamples arising. In this study, we aim to determine what abiotic soil factors drive the niche partitioning of ammonia-oxidizers – hypothesizing that closely related phylogenetic groups will prefer similar niches. Our approach utilized Illumina MiSeq amplicon sequencing to target the amoA gene of archaeal and bacterial ammonia-oxidizers in soils collected from a 35-year crop rotation field trial comprising various levels of tillage and fertilizer amendments. Our results indicate that the overall community structure of both archaea and bacteria is significantly impacted by the fertilizer regime. Interestingly, we found that archaea tend to be less affected by soil factors while bacteria are very sensitive to them. We also found a tendency for a small subset of bacterial specialists to be adapted to a given nitrogen, pH, or micronutrient level, while the archaea tend to be generalists and are less affected by nitrogen, pH, and micronutrient levels. Overall, our study reveals the factors that shape ammonia-oxidizer distribution in agricultural soils and provide insights into microbial niche partitioning.

Keywords: Microbiome; ecology; agriculture; soil.

Investigating the Role of KISS1R's Signaling on Airway Smooth Muscle Cells in Inflammation

JACOB TESCH
CELLULAR AND MOLECULAR BIOLOGY

MENTOR: Sathish Venkatachalem, PhD – Pharmaceutical Sciences

Asthma is a condition of the lower airways that involves inflammation and structural remodeling of lung tissue resulting in dyspnea. Several medications have been developed that temporarily relieve symptoms. A portion of asthmatics are non-responsive or develop resistance to these medications, leaving little available to treat their condition.
G-Coupled Protein Receptors (GPCRs) are a group of proteins that contain a significant portion of the current therapeutic targets for many conditions. Our lab initially identified a GPCR previously unknown to be expressed in the lung called KISS1R. KISS1R has traditionally been linked to sexual development and is typically expressed in brain and sex organ tissues. Primary cell samples collected from clinical samples were used for in vitro testing. Through western blots, RT-qPCR, and calcium imaging, our lab has begun to identify the currently uninvestigated role of KISS1R in Airway Smooth Muscle Cells (ASM).
Early testing has found that the expression of both KISS1R and its associated ligand Kp are reduced in inflamed conditions. In both acute and chronic treatments with Kp, KISS1R was seen reducing some of the cellular changes that inflammation induces in ASM cells. Further work is being done to detail these interactions and outline the potential of KISS1R's signaling to reduce the effects of asthma.

Keywords: GPCR, KISS1R, Asthma, Inflammation

Corrosion Resistant Fluoropolymer Composite Coatings Containing Organo-Functionalized Clay Particles

SZEEMAINE TIGNO
COATINGS AND POLYMERIC MATERIALS

MENTOR: Eugene Caldona, PhD – Coatings and Polymeric Materials

In this study, we prepared fluoropolymer composite coatings on mild steel by inclusion of varying amounts of organo-modified montmorillonite (OMMT) particles in poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) polymer matrix. In order to increase the compatibility with PVDF-HFP and achieve a homogeneous clay platelet dispersion within the polymer matrix, conventional montmorillonite (MMT) was organically surface functionalized through a typical ion exchange approach using cetyltrimethylammonium bromide as cationic surfactant. The effect of OMMT on the surface adhesion and corrosion protection of PVDF-HFP polymer matrix was studied using standardized adhesion tests and electrochemical approaches, respectively. Results showed that PVDF-HFP coatings containing OMMT exhibited stronger metal adhesion and higher corrosion resistance than those containing unfunctionalized MMT. These results were supported by performing: spectroscopy, which confirms, not only the composite coatings' chemical structure, but also OMMT's intercalated structures; microscopy, which reveals the coatings' surface topology, presence of clay particles, and any physical coating delamination; and contact angle measurements, which describe the coated samples' wettability.

Keywords: Corrosion, clay, PVDF-HFP, polymer, composite coating

Biodegradable Mulches for Sustainable Weed Management in Fruit and Vegetable Crops.

ANDRES TORRES
PLANT SCIENCES

MENTOR: Greta Gramig, PhD – Plant Sciences

Polyethylene (PE) films are used to control weeds in crops. However, their use is questionable in organic agriculture because they are non-biodegradable polymers. We evaluated two biodegradable cellulose-based hydromulches (HM) as potential PE mulch replacements. Field experiments were conducted in 2022 in Fargo ND in cabbage and day-neutral strawberry. Treatments included white-HM, black-HM colored with activated-charcoal, sheets of commercial paper mulch (PM) and PE mulch. HM was made of shredded paper mixed with water and sprayed onto the soil surface using a flat fan nozzle. Weed density was quantified at peak weed emergence (PWE) and peak weed vegetative growth (PWVG). Total yield and soil nutrient content were evaluated at the end of the season. In both crops, more weeds were found in HM compared to PE and PM. On average, between PWE and PWVG, 493.5 m2 weeds were counted in black-HM, 248.86 m2 in white-HM, and 7.12 m2 in PM. PE had 100% control. The number of weeds was 47.2% to 53.2% greater in black-HM compared to white-HM. Greater weed density in HM was associated with a reduction in soil nitrogen. Cabbage yield in white-HM (38.7 ton/ha) did not differ from PE and PM (49.9 ton/ha; 57.4 ton/ha). However, black-HM was lower (20.45 ton/ha). Strawberry yield was greater in PE (5535.9 kg/ha) and PM (4169.5 kg/ha) compared to 157.2 kg/ha in black-HM and 289.3 kg/ha in white-HM. To improve HM performance for weed suppression, factors such as application timing, use of tackifiers, soil microtopography, and application rate should be considered.

Keywords: Hydromulch; biodegradable; organic; spray-mulch

Machine Learning and Artificial Intelligence Techniques for Predicting Yield in Cereal Crop Management

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AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Igathinathane Cannayen, PhD – Agricultural and Biosystems Engineering

The use of machine learning (ML) and artificial intelligence (AI) has been successful in solving complex problems in various scientific fields, but its application in agriculture is still in its infancy. Such advanced methodologies have been shown to positively impact cereal crop management. Cereal crops, such as wheat, corn, rice, and barley can be managed effectively using technologies to improve crop yield and product quality. Effective technology application also reduces input costs and environmental issues. Computer vision techniques coupled with ML and AI can be more efficiently utilized for monitoring crop production operations and managing crop production operations. A variety of algorithms can be applied based on weather, soil, and crop data, to monitor or predict disease outbreaks and yield, as well as optimize irrigation and fertilization. In this study, multiple computer vision algorithms in cereal crop management used to detect pests and diseases, determine chlorophyll contents, and predict grain and biomass yield, will be employed. Their effectiveness of different approaches will be compared. This study will also provide information on pests, crop diseases, and severe weather conditions that affect cereal crop production. The collection of image data from various sources (handheld cameras, unmanned aerial vehicles, and satellites) will be processed, and models will be developed and validated against ground truth data. Furthermore, the study will identify research gaps for future research opportunities and determine the limitations of applying these advanced methodologies to cereal crop management. The innovative methods developed for cereal crops can also be applied to other crops.

Keywords. Machine learning, Artificial intelligence, Cereal crop, Crop yield, Crop management, Plant health.

Development of machine vision-based herbicide spraying system for precision weed management using deep learning

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AGRICULTURAL AND BIOSYSTEMS ENGINEERING

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Weed management using blanket herbicide spraying technique is popular for reducing manual labor and costs, but traditional practices of treating entire fields with uniform dose are wasteful and harmful to the environment and human health. Excessive use of herbicides can negatively impact soil, groundwater, and the air quality. To minimize these negative impacts, a smart herbicide spraying system was designed and developed in this research for weed management in row crops. The smart sprayer robotic system utilizes Deep learning techniques for real-time weed/crop identification and decision support system for spot application of herbicides on identified weeds. Image was captured in real-time by using a FLIR RGB camera and then processed by the Nvidia Jetson AGX Orin for weed identification. The spraying unit consists of a boom sprayer with 3 nozzles, which are controlled individually by a Tejeet 12V solenoid valve for spraying action. Once the image processing unit detects weed, the nozzle covering the field of view is turned on and sprayed precisely onto the target weed. Herbicides application accuracy rates were determined to be approximately 93% and 85% for indoor and field experiments respectively. These test results suggest that this machine vision-based sprayer system has a great potential for spot application of herbicides, thereby reducing the use of chemicals on the agricultural field to ensure sustainable weed management practices.

"There's a lot of factors": Utilizing I-Poetry to Understand Vaccine-Hesitant Decision Making

BRYCE VAN VLEET
DEVELOPMENTAL SCIENCE

MENTOR: Heather Fuller, PhD – Human Development and Family Sciences

Despite higher vaccination rates as compared to other age groups, many US older adults remain under-vaccinated against common, preventable diseases leaving them at increased risk of serious illness, hospitalization, or death posed from diseases including shingles, pneumonia, influenza, and novel coronavirus. This study investigates the underlying reasons older adults have for not getting vaccinated. Eight older adults (Mean Age = 73.86) selected from a larger interview study conducted in North Dakota were identified as being vaccine hesitant as indicated by receiving two or fewer vaccines from a list of five common vaccines including influenza, shingles, pneumococcal, and initial and booster doses of the COVID-19 vaccine. Participants were asked, "How do you decide about whether or not to get a specific vaccine?" Their open-ended responses were analyzed using the I-poetry qualitative methodology which combined participants' "I" statements into a poem for all eight participants that reflected their underlying motivations of vaccine hesitancy. This poem was structured in stanzas to highlight and convey overarching themes including: practical barriers, vaccine-alternatives, and skepticism. Practical barriers included allergies and concerns about side effects. Vaccine-alternatives highlighted a belief in natural immunity, vitamins, and exercise. Skepticism was directed at government agencies and the efficacy of a vaccine. These findings highlight potential benefits to providing medical professionals with first-person narratives from vaccine hesitant older adults which could help clarify sources of unease. Implications can be drawn for better understanding this at-risk population and developing tailored and effective interventions to bolster older adults' vaccine uptake.

Keywords: qualitative methods, public health behaviors, gerontology

Pesticides and Soil Microbial Communities

MIRANDA VANDERHYDE
MICROBIOLOGICAL SCIENCES

MENTOR: Samiran Banerjee, PhD – Microbiological Sciences

Modern agriculture relies on agrochemicals for protection against various pests and to maximize crop yield. A variety of pesticide effects on ecosystems has long been debated, including the soil microbiome, though is unsolved. Microorganisms have a critical role in agroecosystems including contributing to biogeochemical cycles necessary for crop production. Here we aimed to assess the impact of commonly used agrochemicals (fungicide, herbicide and insecticide) on bacterial and fungal dynamics using a time-course experiment. Microcosm chambers were prepared with 100g of native grassland soil that was never exposed to pesticides. A standard concentration of the pesticides was then applied onto the soil microcosms. Microcosms were sampled at five timepoints with five replicates for each treatment-timepoint sample. Bacterial and fungal abundance was assessed using quantitative PCR of 16s rRNA and ITS genes. Illumina MiSeq sequencing was preformed to evaluate microbial diversity and community composition. For both bacteria and fungi, a trend of decreasing abundance from days 0 to 21, and an increase from 21 to 42 was observed, except for bacteria in insecticide-treated soil, suggesting a revival of bacterial communities. We found differences in microbial community structure in response to agrochemicals (PERMANOVA p value of 0.0876, 0.0001 for bacteria and fungi respectively) across time points (PERMANOVA $p \leq 0.0001$ for both bacteria and fungi), and this difference was more pronounced in fungi. As fungal abundance, diversity and community showed significant changes in response to commonly used pesticides, our study indicates that such agrochemicals may have consequences for fungi-derived ecosystem services.

Keywords: Agriculture, Pesticides, Microbiome, Soil

Singled Out. Challenges that single mothers navigate in order to remain employable.

EMILY VIEWEG
INTERDISCIPLINARY

MENTOR: Leretta Smith, PhD – Sociology and Anthropology

Single mothers face a number of challenges as they navigate raising children without a partner. While the non-custodial parent may provide some relief and support for custodial parents, there are challenges specific to custodial single parents, particularly regarding employment. Whether a woman becomes a single mother by chance or by choice still makes a difference in the eyes of society (Heffernan, 2018). While US employers are legally barred from asking about family and marital status during an interview, single mothers know that their familial situation may hinder a full-time work environment. Single mothers must tread carefully during interviews (Lifshitz, 2019).

Three major challenges to a single mother's working life are childcare, transportation, and paid-time-off. When a single mother considers employment, she must navigate these treacherous waters. Will her supervisor understand if she is late because the bus didn't pick her children up on time? Will she be able to get to work on time if she has to depend on public transportation? If the youngsters are sick, what are the call-in procedures? Will she be able to call in, or will she have to spend hours looking for someone to carry her shift? Shift work vs Fixed hours? What about children with special needs? Will the mother be able to take time off to get to Individual Education Plan (IEP) meetings and therapy appointments? The list of 'what ifs' are difficult for any parent, but for single parents, responsibility falls squarely on the single individual's shoulders.

Keywords: Single Mothers, Challenges, Work, Childcare, PTO.

Remote-controlled drip irrigation for high tunnel tomato and pepper productions in North Dakota

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AGRICULTURAL AND BIOSYSTEMS ENGINEERING

MENTOR: Xinhua Jia, PhD – Agricultural and Biosystems Engineering

In North Dakota, vegetable productions in high tunnels rely on irrigation, while irrigation scheduling for the right amount at the right time is the key. Irrigation scheduling using controllers (smart irrigation) based on either weather condition, or soil moisture sensors (SMS), can make the decision easier and more reliable, and has become a common practice for water conservation in the last twenty years. In the current research, a soil potential sensor based remote-controlled drip irrigation system with different management allowable depletion (MAD) treatments (Time based, 10% MAD and 30% MAD) were designed and installed inside and outside a high tunnel to study their effects on tomato and pepper growth. Eight cultivars of peppers and tomatoes inside/outside the high tunnel were compared and evaluated near Absaraka, ND in 2022. For the field experiment in 2022, the highest yield for tomatoes using drip irrigation was under the 30% MAD treatment at 38.16 Mg ha−1 inside and 5.23 Mg ha−1 outside the high tunnel. The highest yield for peppers using drip irrigation was under the 10% MAD treatment at 48.62 Mg ha−1 inside and 10.13 Mg ha−1 outside the high tunnel. The results showed that for tomatoes and peppers, the average diameter and weight were significantly higher under 30% MAD and 10% MAD both inside and outside the high tunnel, respectively. Our research demonstrated that peppers and tomatoes required different management allowable depletion to optimize yield even though they were grown under identical conditions.

Keywords: Remote controlled irrigation, Drip Irrigation, Automation, High tunnel, Horticulture crops.

Cutting boards: an overlooked source of microplastics in human food?

HIMANI YADAV
CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

MENTOR: Syeed Md Iskander, PhD – Civil, Construction and Environmental Engineering

Human intake of microplastics can occur through different routes, notably via inhalation and ingestion of food and water. There are multiple ways by which food can be contaminated with microplastics, and plastic chopping boards are a potentially significant pathway. Thus, we investigated the impact of chopping styles and board materials on microplastics released during chopping. As chopping progressed, the effects of chopping styles on microplastic release became evident. Although the mass and number of microplastics released from polypropylene chopping boards were greater than polyethylene by 5 – 60% and 14 – 71%, respectively, the difference was insignificant due to high variability within the samples. Chopping on polyethylene boards was associated with a greater release of microplastics with a model vegetable (i.e., carrots) than chopping without carrots. Microplastics showed a broad, bottom-skewed normal distribution of particle size, dominated by deformed, spherical-shaped microplastics below 100 μm size. Based on our assumptions, we estimated a per person annual exposure of 7.4 g to 50.7 g of microplastics from a polyethylene chopping board and 49.5 g of microplastics from a polypropylene chopping board. We further estimated that a person could be exposed to 14.5 to 71.9 million microplastics annually when using polyethylene chopping boards, compared to 79.4 million polypropylene microplastics. The preliminary toxicity study of the polyethylene microplastics did not show significant adverse effects on the viability of mouse fibroblast cells for 72 hours. This study identifies plastic chopping boards as a substantial source of microplastics in human food, which requires attention to limit the exposure.

Keywords: Polyethylene; Polypropylene; Human Exposure; FTIR; Toxicity.

Investigating the Influence of Temperature on the Weight-In-Motion Measurements Using In-Pavement Strain Sensors

XINYI YANG
CIVIL ENGINEERING – TRANSPORTATION

MENTOR: Ying Huang, PhD – Civil, Construction and Environmental Engineering, Pan Lu, PhD – Upper Great Plains Transportation Institute

Road quality is one of the most important factors that influence the behaviors of vehicles. There are millions of car crashes recorded due to the deterioration of road conditions, which leads to tremendous life and economic losses. To increase the safety of the drivers at a low cost, this study tends to use smartphones to collect data and generate a road roughness index called the road impact factor (RIF) to quantify the ride quality for unpaved roads. However, when collecting data using smartphones on unpaved roads, significant amounts of noise exists, which makes it hard to extract useful information for ride quality analysis. To denoise the data collected from smartphones on unpaved roads, this paper introduced wavelet families including Haar, Daubechies, and Symlets with different thresholding techniques, and evaluated the results with mean square error (MSE), peak-to-noise ratio (PSNR), and percentage residual difference (PRD). Integrated with the denoising process, an application was developed and designed to generate the RIF through the most suitable wavelet filter to support the drivers' decisions for safe driving experiences on unpaved roads.

Keywords: Wavelet Transform; Unpaved Road; Road Roughness; Road Impact Factor; Noise Reduction

Enhancing Restaurant dining experience: Design and evaluation of a mobile app for Personalized Menu Item Selection in Restaurants

KIMIA TUZ ZAMAN
COMPUTER SCIENCE

MENTOR: Jen Li, PhD – Computer Science

Picking the right food item from a restaurant menu can be challenging for people, especially for those who are unfamiliar with local cuisine and those with specific dietary requirements. Existing menus often lack essential information, making it difficult for diners to make quick and confident decisions. In this paper, we propose a mobile app that offers a user-friendly interface to allow users rank menu items based on their preferences and concerns. Using personalized ranking algorithms, the app analyzes the ingredients and nutritional content of menu items, providing users with valuable information to make informed choices. Preliminary tests suggest that the app is easy to use and effective in providing relevant information to users. Overall, the proposed system has the potential to improve the dining experience of individuals with various dietary needs and preferences.

Keywords: Food Restrictions, Restaurant Dining, Artificial Intelligence, Menu Ranking

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