2021 VIRTUAL EDITION

NDSU EXPLORE

UNDERGRADUATE EXCELLENCE IN RESEARCH AND CREATIVE ACTIVITY

NDSU NORTH DAKOTA STATE UNIVERSITY

WELCOME

Welcome to the 2021 NDSU EXPLORE Showcase of Undergraduate Research and Creative Activity! Pandemic conditions required this year's EXPLORE to be different than in years past, but much about what makes the event great really didn't change. While our students delivered their content in a web-based virtual environment, the content was extremely compelling and represented a wide breadth of disciplines at NDSU. While we couldn't all be together in a single room, we had wonderful guest speakers and a fun recognition ceremony. On behalf of my team, the faculty mentors and evaluators, I can say it was a joy to once again experience EXPLORE.

In my years at NDSU as both a researcher and a faculty member, I have had the pleasure of working with many undergraduate researchers in my lab and classroom. I can tell you firsthand that year after year, NDSU has some of the best and brightest students you will find anywhere. Our undergrads work side by side with faculty researchers and help move their work forward while providing their own unique insights and discoveries.

NDSU EXPLORE is a perfect opportunity to celebrate the latest group of these bright and brilliant people.

Thank you for your support of the 2021 NDSU EXPLORE Virtual Showcase of Undergraduate Research and Creative Activity. Our student presenters definitely appreciated your time and feedback as they continue their paths to becoming tomorrow's researchers.

JANE M. SCHUH, PH.D.
Vice President, Office of Research and Creative Activity

SCHEDULE

All events held virtually.

Monday, April 19 | 8 a.m.
Virtual Showcase opened

Wednesday, April 21 | 12 (noon) – 1 p.m.
Keynote:
Nobody Understands What You Do (And That's OK)
A Communicating Science Seminar for NDSU Graduate and Undergraduate Students
Paul M. Sutter

Thursday, April 22 | 12:30 - 1:30 p.m.
Preparing to Apply to Graduate School
Neely Benton, Director of Graduate Recruitment and Admissions, NDSU

Friday, April 23 | 12 (noon) – 1 p.m.
Virtual awards ceremony

Friday, April 23 | 5 p.m.
Virtual Showcase closed

KEYNOTE SPEAKER

Paul M. Sutter is a research professor in astrophysics at the Institute for Advanced Computational Science at Stony Brook University and the Flatiron Institute in New York City. He also is known around the world as the host of several shows, such as "How the Universe Works" on Science Channel, "Space Out" on Discovery, and his hit "Ask a Spaceman" podcast. He is the author of two books, "Your Place in the Universe" and "How to Die in Space," as well as a regular contributor to Space.com, LiveScience and more. Journalists frequently seek his expert advice, especially in his role as the Weather Channel's official space specialist. In addition to his traditional science outreach, Sutter also explores innovative science and art collaborations, such as his work with Syren Modern Dance in "Ticktock," a performance exploring the nature of time through movement and narration.

In his presentation, "Nobody Understands What You Do (And That's OK): A Communicating Science Seminar for Students," Sutter discussed his communication strategies and the lessons he's learned in his own science career.

AWARDS

ORAL PRESENTATION WINNERS

FIRST PLACE

Annie Schiro Biochemistry and Molecular Biology
Faculty Mentor: James Nyachwaya, Ph.D.
"Chemistry students' understanding of dissolving and associated phenomena: The case for sodium chloride"

SECOND PLACE

Alaina Driscoll Physical Education
Faculty Mentor: Jenny Linker, Ph.D.
"Home Fun in Physical Education"

THIRD PLACE

Jake Jenson Animal Sciences
Faculty Mentor: Carolyn Hammer, D.V.M., Ph.D.
"Relative expression and location of the neonatal Fc receptor (FcRn) in the equine gastrointestinal system"

HONORABLE MENTION

Troy Timmerman Computer Science
Faculty Mentor: Bakhtiyor Rasulev, Ph.D.
"Automating protein structure modeling to predict beta sheet content"

POSTER PRESENTATION WINNERS

FIRST PLACE

Rachel Voigt Animal Sciences
Faculty Mentor: Carolyn Hammer, D.V.M., Ph.D.
"Visualization and Measures of Intensity of the Neonatal Fc Receptor in Major Body Systems of the Horse"

SECOND PLACE

Gabe Dusek Biological Sciences
Faculty Mentor: Andrew Friskop, Ph.D.
"Evaluation of Fungicide Timing for Fusarium Head Blight in Two-row Barley"

THIRD PLACE [TIE]

Dani Douri Biochemistry and Molecular Biology
Faculty Mentor: Sathish Venkatachalem, Ph.D.
"Gender Specific Differences in Expression of DNA-Methylation Associated Markers in the Lungs of Allergic Mice"

Rebecca Tomann Chemistry
Faculty Mentor: Svetlana Kilina, Ph.D.
"Holey Graphene with Embedded Au_{13}-Cluster for H_2S Gas Sensing Applications"

HONORABLE MENTIONS

Huan Ho Computer Science
Faculty Mentor: Simone Ludwig, Ph.D.
"Handwritten Text Recognition using Convolutional Neural Networks in Deep Learning"

Helen Wax Anthropology
Faculty Mentor: Ellen Rubinstein, Ph.D.
"The Cost of Death in the Upper Midwest - An Ethnographic Analysis of the American Funeral Industry"

TOP PRESENTATIONS BY CATEGORY

AGRICULTURE

Jake Jenson Animal Sciences
Rachel Voigt Animal Sciences
Max Salzer Agricultural and Biosystems Engineering

ARTS AND HUMANITIES

Garrett Bryan Philosophy
Makayla Scherrer Music

BIOLOGICAL, HEALTH SCIENCES AND BIOMEDICAL ENGINEERING

Troy Timmerman Computer Science
Ryan Anderson Civil Engineering
Anna Marie Schornack, Anna Rudie and **Abby Voigt** Electrical Engineering

COMPUTER SCIENCE AND ENGINEERING

Joshua Gisi Computer Engineering
Tiffany Meeks Civil Engineering
Mohammed Mohammed Civil Engineering

INTERDISCIPLINARY

Macy Rennpferd Biological Sciences and **Madeline Schroeder** Biological Sciences Education

PHYSICAL AND NATURAL SCIENCES, MATHEMATICS

Annie Schiro Biochemistry and Molecular Biology
Rebecca Tomann Chemistry
Sarah Montplaisir English

SOCIAL AND BEHAVIORAL SCIENCES, EDUCATION AND BUSINESS

Alaina Driscoll Physical Education
TIE: **Kate Best** Economics
Helen Wax Anthropology
TIE: **Nicolas Rohrich** Electrical Engineering and **Kyle Berger** Finance
Halle Lipetzky Apparel, Retail Merchandising and Design

ABSTRACTS

Maryam Al-Kaabi
BIOLOGICAL SCIENCES

Isabel Kallmeyer
BIOLOGICAL SCIENCES

Project Advisers:
Jiha Kim, Ph.D. - Biological Sciences
Sangdeuk Ha - Biological Sciences

Tumor-associated Pericyte Phenotype is Significantly Influenced by Cancer Cell Derived Exosomes

Tumor-induced angiogenesis often results in abnormal blood vessel formation, which significantly contributes to pathological characteristics of Tumor Microenvironment (TME). Many solid tumors present hostile TME, such as extreme hypoxia, poor perfusion efficiency, and an immune-suppressive environment. Thus, correcting abnormal vascular phenotype is of great interest to improve therapeutic efficacy.

Ariana Allen
BIOCHEMISTRY AND MOLECULAR BIOLOGY

Project Adviser:
Glenn Dorsam, Ph.D. - Microbiological Sciences

Mouse Liver Glycogen Content within Vasoactive Intestinal Peptidase Colony Mice

The overall motivation for my project is to ascertain if there is a difference between murine hepatic glucose content within vasoactive intestinal peptidase (VIP) knockout mice, wild type mice and heterozygous mice. This is important, as the complexities of the interplay between microbiota and VIP signaling axis is of interest to diseases like obesity, cardiovascular disease and cancer.

To obtain glucose concentration with murine hepatic samples I individually utilized 2 M hydrocholoric acid as well as 2 M sodium hydroxide to lyse the tissues with heat from a sandbath as well as mechanical disruption every 10 minutes for 60 minutes total. I then neutralized both the lysing reagents with an equal amount of the corresponding acid or base. From here I spun the neutralized lysate at 20,000xg for 20 minutes, removed 150 uL of lysate, added a dual enzymatic assay to the samples in a 96 well plate and read the absorbance at 340nm in a spectrophotometer.

As a result of this project I have learned the importance of meticulous lab book note-taking, as well as the importance of research animal health and welfare. I have had the opportunity to familiarize myself with and utilize equipment such as a spectrophotometer as well as its software, a centrifuge, and the -80° freezer within the Dorsam lab. With continuing research I expect to further elucidate the relationship of the VIP signaling axis and murine hepatic glucose content.

Ryan Anderson
CIVIL ENGINEERING

Project Adviser:
Syeed Iskander, Ph.D. - Civil and Environmental Engineering

Nanoplastics in Landfill Leachate and its Environmental Implications

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. To understand leachate nanoplastics pollution and their environmental impact, we are investigating four different landfill leachates. We first filtered the leachates through 100 nm filters. After that, we performed chemical oxidation to remove organics, reducing interference during nanoplastics identification and characterization. To remove the organics, we added 25 mL 30% hydrogen peroxide solution to 50 mL filtered leachate in triplicates. We performed two sets of experiments at room temperature and at 50°C. After oxidation was complete, we performed Dynamic Light Scattering of the samples to understand the particle size distribution. There was a higher fraction of particles greater than 100 nm size which probably resulted from the agglomeration of the organic particles during oxidation. A second set of filtrations was conducted using 100 nm syringe filters. We are performing Electron Microscopy imaging, FTIR Microscopy, and X-ray Photoelectron Spectroscopy of the samples to understand the occurrence and composition of leachate nanoplastics. With the growing concern about plastics pollution, our study will elucidate the potential of landfill leachate as carriers of nanoplastics and their potential environmental impacts.

Katherine Best
ECONOMICS

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

Co-Investigators:
Kole Nichols
Colby Warzecha

Understanding the Economic Impact of Wild Horse Management on Local Communities

Wild horses are a majestic symbol of the American West, but their presence on western rangelands is less rosy than popular representations suggest. Since receiving federal protection in the 1970s, wild horse populations have exploded, and the range is currently home to more than three times the ideal population of horses. The question of how to effectively manage them has entered the larger debate surrounding the management of federally protected lands as the Bureau of Land Management's attempts to control the horse population have made little impact. The detrimental ecological impact of wild horses has been widely studied, but little is known about the economic impact of wild horse overpopulation in counties where herd management areas (HMAs) are present. We used two cross-sectional time-series models to measure whether counties where HMAs are present are economically different from non-HMA counties while controlling for demographics and federally protected lands present in US counties. The dependent variable in model 1 is total non-farm payroll and the dependent variable in model 2 is total tax receipts. In both cases, we found a significant negative relationship between the presence of an HMA in a county and the measure of economic activity. Our results suggest that these counties, like Beaver County, Utah, are negatively impacted by current horse management decisions and that the economic impacts of wild horses are an important part of the conversation surrounding public lands management best practices.

This research is part of the Center for Public Choice and Private Enterprise's Mancur Olson Fellows Program. The full policy report is available here: https://www.ndsu.edu/centers/pcpe/research/publications/understanding_the_economic_impact_of_wild_horse_management_on_local_communities/

Garrett Bryan
PHILOSOPHY

Project Adviser:
Dennis Cooley, Ph.D. - History, Philosophy, and Religious Studies

La Mettrie: The Machine Man and Contemporary Philosophy

While it may in some cases prove indeterminable, every concept must have some genesis, even should the subtleties of this discovery prove unessential in realizing it at a later time and even if this at the expense of an applicable framework that could have otherwise arisen. This project concerns itself with one such concept: the model of man as a machine, notably and deliberately removed from preceding philosophical conceits. Drawing on the work of Julien Offray de La Mettrie, an eighteenth century French physician and philosopher, this project seeks to reconcile what was then a highly scientific concept of humankind with the technical understanding afforded by contemporary science, the goal being therein to 'modernize' the machine model of man per La Mettrie to tackle modern considerations such as those posed in bioethics by near-future technologies like genetic engineering and cybernetics. While work is ongoing, critical considerations of philosophy, like metaphysics and epistemology, can be (and have been) expanded from La Mettrie's work by applying more modern innovations in fields such as biochemistry and neurology. Ultimately, the goal of this project is to establish a framework that retains the materialist reduction of the original La Mettrie.

Makinzie Callaway
ANIMAL SCIENCES

Project Adviser:
Christopher Byrd, Ph.D. - Animal Sciences

Evaluating the Effect of Firocoxib on Dairy Calf Behavior Following Surgical Disbudding

Dairy calves commonly have their horn buds removed to ensure the safety of themselves, conspecifics, and their caretakers. Meloxicam, a non-steroidal inflammatory drug, is commonly administered to reduce disbudding pain. However, alternative drugs may be more effective than meloxicam. This study evaluates the effects of another NSAID, firocoxib, on pain-related behavior in young dairy calves. A total of 24 calves were selected, each assigned to one of two treatment groups: firocoxib (firocoxib; n=12) or meloxicam (meloxicam; n=12). Over a (4) h period each day (d -1, 0, +1, +2, +3 relative to disbudding), posture (lying, standing), pain-related behaviors (ear flicking, head shaking, foot stomping, head rubbing), and maintenance behaviors (eating, drinking, defecating, urinating) were evaluated. Data from four calves (n = 2 of each treatment) were analyzed using Proc GLIMMIX in SAS 9.4. Calves receiving meloxicam exhibited fewer head shakes than calves receiving firocoxib ($P < 0.05$). No additional behavioral differences were found between treatments. Based on the data, meloxicam may still be the most effective NSAID drug. However, more data is required to properly evaluate the effectiveness of firocoxib on pain behavior in dairy calves following disbudding.

Kaylie Carver
NATURAL RESOURCES MANAGEMENT

Project Adviser:
Jack Norland, Ph.D. - School of Natural Resource Sciences

Aquatic Survey of Macroinvertebrates in a Stormwater Basin

An aquatic survey of the macroinvertebrates was conducted within an existing storm water basin that was restored by The Fargo Project. It is located at Rabanus Park in Fargo and was created with the intention of transforming a one-function detention basin into a natural area that may be used for more than just holding storm water. The goal of the research was to gain an understanding of the macroinvertebrates present and determine the stream's water quality. The surveys were conducted in 2018-2020 which was 3-5 years after the stream restoration. Four locations were sampled three times each summer. These locations consisted of fast- and slow-moving water, with the rapid flowing water coming from an outfall pipe from the West Acres Mall and the slower flowing water from an area zoned for business. The samples were collected using D-frame dip nets and then preserved in alcohol using the Minnesota Pollution Control Agency protocols. Then they were taken to the lab and analyzed under a microscope to identify the macroinvertebrates present. The organisms were counted and documented, and the data was used to assess the water quality through the Hilsenhoff Family Biotic Index (FBI). This index assesses water quality through species presence and known disturbance tolerance. Macroinvertebrates with varying tolerances were found in the stream, and the HBI values that were calculated indicated fairly poor to good water quality in the sampled locations. The data shows that the restored stream has fair water quality and is capable of supporting macroinvertebrates.

Austin Cherkas
SOCIOLOGY / ECONOMICS

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

The Economic Cost of Marijuana Expungement

The growing trend of marijuana legalization leaves an important consideration: What should we do about the criminal records of previous marijuana offenses? With legalization, we would see that people would be labeled as a criminal for something that is no longer a crime. The common response is to expunge these individuals. This research focuses on the economic costs that are associated with the expungement process.

Expungement has two major costs: Time and Money. Each state has their own application fee and expected time for completing applications. The formula of Total Crimes / 2,000 = Years to Completion shows that thirty-three states have over seventy years to complete the status quo. Five states do not have a cost for the application. The price ranges for applications range from $10-$900. The average cost when considering all states is $214. This cost is footed to individuals who struggle to find opportunity because of their record. Job applicants with criminal backgrounds received 33% fewer call backs as opposed to those with clean records. Over 60% of employers stated they would "definitely" or "probably" not hire anyone with a criminal background. When considering the challenges that applicants face, 71% state that finding a job is a prominent struggle. When considering expungement, we can see real economic benefits. America is facing a job shortage of seven million vacancies.

This research project will show the economic impact that is holding expungement applicants and our national economy back.

Dani Douri
BIOCHEMISTRY AND MOLECULAR BIOLOGY

Project Advisers:
Sathish Venkatachalem, Ph.D. - Pharmaceutical Sciences
Nilesh Ambhore, Ph.D. - Pharmaceutical Sciences
Sumali Pandey, Ph.D., MTech, BPharm - Biosciences, Minnesota State University, Moorhead

Gender Specific Differences in Expression of DNA-Methylation Associated Markers in the Lungs of Allergic Mice

The pathological cause of asthma is the airway inflammation along with increased airway smooth muscle contractility and airway remodeling. Furthermore, gender and sex hormones play a crucial role in the prevalence and severity of asthma. Sex steroid mediated signaling or exposure to environmental stimuli allows for epigenetic reprogramming in cells. We hypothesize that epigenetic modification (DNA methylation) in the murine model of allergic asthma are associated with changes in airway phenotype and remodeling. Our study was done on wild type male, female and ovariectomized (OVX) mice housed and mixed allergens (MA) regimen were used to induce asthma. We used Sirius Red and Fast Green staining to examine collagen deposition of lung sections. LCM, RT-qPCR, and ELISA were used to examine methylation associated genes and DNA methylation markers. Our results showed MA exposed asthmatic mice had significant deterioration of airway structure compared to vehicle mice particularly in females compared to males and OVX. Interestingly, OVX mice showed reduction in MA-induced deterioration of lung structure which suggests the potential role of sex-steroids in regulating airway functions. Furthermore, expression of methylation associated genes (Tet1 and DNMT3b) and DNA methylation markers (5-mC and 5-hmC) increased in MA exposed female mice lungs. These data suggest that DNA methylation is a major epigenetic modification that accompanies airway remodeling associated changes in the airway epithelium of allergic mice. In conclusion, early detection of these DNA methylation markers may provide novel diagnostic and therapeutic tools for allergic asthma associated airway remodeling in gender/sex-specific manner.

Alaina Driscoll
PHYSICAL EDUCATION / HEALTH EDUCATION

Project Adviser:
Jenny Linker, Ph.D. - Health, Nutrition, and Exercise Sciences

Home Fun in Physical Education

As a future physical educator, I am writing an article on how to effectively implement homework into physical education class, under the guidance of my adviser Dr. Jenny Linker. The oral presentation for NDSU Explore contains my work in progress of the main ideas to be submitted to "Strategies: A Journal for Physical and Sport Educators." My motivation stems from my love for physical activity and the desire to inspire a similar appreciation and knowledge in students through addressing the problem of unused, boring, and irrelevant homework in physical education class. As I started researching the topic, I encountered the term "Home Fun" by Judy Rink. This caught my attention because Dr. Linker had also used this term in one of my classes. Home fun is a way to promote homework so that students are excited to be active, rather than dreading another assignment. Through the process of writing this article, I have analyzed different journal articles, interviewed students and teachers on their experiences with homework, and created innovative examples of home fun assignments. I found that homework is often not used appropriately in physical education, and compiled 3 important concepts for teachers to use when creating homework. Upon completion, I hope to share my findings with physical educators around the country and help students to obtain the knowledge, skills, and confidence to develop a lifelong habit of being physically active.

Isaac Dubovoy
ECONOMICS

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

An Uncertain Future: A Review of the Florida Retirement System

There is a large amount of pension debt in the United States right now. The last decade should have been a time where most of the retirement systems saw growth and recovered from the financial crisis. Our research focuses on the state of Florida and the health of their system instead of every system in the country. Florida has one of the largest retirement systems in the United States and they are currently underfunded which causes money to be withdrawn from other funds. The data collected for this project was received directly from the Department of Management Services in Florida, and the data is evaluated to attempt to find some of the problems in the Florida Retirement System (FRS). We expect to communicate these problems by informing policymakers of the status of the FRS and some solutions to pension reform. This project will help reform one of the largest retirement systems in the country by informing the public and policymakers of our research.

Gabe Dusek
BIOLOGICAL SCIENCES / CROP AND WEED SCIENCES

Project Adviser:
Andrew Friskop, Ph.D. - Plant Pathology

Evaluation of Fungicide Timing for Fusarium Head Blight in Two-row Barley

Fusarium head blight (FHB) is one of the most devastating diseases in two-row barley production. The goal of the research is to provide efficacy data on a new fungicide (Miravis Ace), create a two-row barley disease severity scale and demonstrate fungicide coverage in regards to application timing. The combination of these objectives will be used to inform farmers on FHB management. A greenhouse experiment was conducted to evaluate four treatments including a non-treated non-inoculated, non-treated inoculated, Miravis Ace applied at half-head emergence and Miravis Ace at full-head emergence. All fungicide applications were conducted using a belt-driven spraying booth and *Fusarium graminearum* inoculum was delivered with a Preval Air Sprayer approximately 24 hours after fungicide application timings. Disease severity and incidence was assessed on barley heads at 7, 10 and 14 days after inoculation. Infected heads were collected and used in the development of an FHB severity scale for two-row barley. Spray coverage at application at half-head and full-head was assessed using a highlighter solution and photos were taken in the presence of a black light. Results from the study suggested that half-head applications had the lowest FHB index values. However, results between fungicide timings could have been impacted by the lack of height adjustment in the spray booth. For example, half-head barley plants were shorter and benefited from a more uniform application compared to the full-head plants. A robust severity scale was developed and is expected to be used in both research and Extension activities. Similarly, the highlighter solution demonstrating spray coverage will be further optimized to help with future visual aids on fungicide coverage.

Sydney Dykhuizen
PHARMACY

Project Adviser:
Julia Muzzy Williamson, PharmD, CNSC, BCPPS, BCNSP - Pharmacy Practice

Pharmacist's Role in Medication Management for Breastfeeding Women: Addressing Barriers and the Need for Continuing Education

Breastfeeding offers a multitude of benefits for infants, mothers, and society. Exclusive breastfeeding of infants is recommended for at least the first six months of life by the American Academy of Pediatrics. Pharmacists are regarded as the most accessible healthcare professionals and recognize their role as medication specialists for breastfeeding women. However, pharmacists cite a lack of formal and continuing education on medication use during lactation. This often results in pharmacists providing the unnecessary recommendation to disrupt breastfeeding during medication use. In addition, other barriers pharmacists experience in providing patient care during lactation include identifying breastfeeding status and inconsistency in recommendations between scientific resources. Pharmacists must take action to address barriers to patient care for lactating women and to close the knowledge gap through continuing education.

Skyla Folden
AGRICULTURAL EDUCATION

Project Adviser:
Brooke Thiel, Ph.D. - School of Education

The State of Supervised Agricultural Experience in North Dakota

The purpose of this research is to assess Supervised Agricultural Experience (SAE) engagement in the state of North Dakota.

Goal 1: Determine the level of FFA Chapter involvement in SAE through the use of the Agricultural Experience Tracker (AET).

Goal 2: Determine the number of entrepreneurship, placement, agriscience research, service learning, and school-based enterprise SAEs are currently being conducted in North Dakota.

Goal 3: Determine the predominant academic interests of participants in SAE, as well as the most common skills they have documented.

Joshua Gisi
COMPUTER ENGINEERING / COMPUTER SCIENCE

Project Adviser:
M. Zubair Malik, Ph.D. - Computer Science

Natural Language to Code

Developing useful code requires time, resources, and a human who is knowledgeable in computer science fundamentals. This paper presents a system that automatically synthesizes Python code for general computer science problems based on a natural language prompt. The approach collects code from online knowledge bases and then uses a CEGAR loop to evolve the code into a working solution. Inputs, data types, outputs, and actions are predicted from the natural text of the user prompt. That information is used to create the query for retrieving partial solutions from resources like the Python documentation and Stack Overflow. The collected code is pooled together and sent to a CEGAR loop which combines the code in different ways. After each evolution the predicted code is compiled and if successful the system runs the code on user-provided test cases.

Mia Haugan
MICROBIOLOGY

Project Adviser:
Barney Geddes, Ph.D. - Microbiological Sciences

Developing an Alfalfa Root Associated Synthetic Community (SynCom) for Studying the Plant Microbiome

The purpose of this project was to create an Alfalfa plant-associated synthetic community (SynCom) with representatives from different root-associated environments such as the rhizosphere, roots, and nodules. The SynCom members were isolated from field grown alfalfa samples. Bacterial strains were chosen based on their relative abundance in different compartments throughout the root structure. The first step once the SynCom was assembled was to standardize the cell count to culture turbidity (OD_{600}). This process allows for an accurate number of cells from each bacteria to be combined into the SynCom during an experiment. Next the SynCom members were grown individually in minimal media with different carbon sources. This was done to learn their growth rates and to explore root exudate as a method for plants to select microbes. Then select SynCom members were grown together in minimal media with different carbon sources to investigate microbe-microbe interactions. An interesting result from these two experiments was that the growth rate was a poor predictor of abundance in the community environment. Next the SynCom was added to living plants to see if it would reassemble in the plant-associated environments they were isolated from, such as the rhizosphere, roots, and nodules. Future projects will include more plant experiments, refining the synthetic community, and dropout experiments where one member is excluded from a community culture.

Abigail Henderson
MECHANICAL ENGINEERING

Project Adviser:
Ali Amiri, Ph.D. - Mechanical Engineering

Improving Mechanical Properties of Polypropylene Reinforced with Natural Fibers

In this study, biocomposites with reinforced natural fibers are developed and characterized to aid in improving cost effectiveness and environmental impacts. This study focused on flax, maple, and pine natural fibers reinforced in polypropylene (PP) thermoplastic.

Huan Ho
COMPUTER SCIENCE

Project Adviser:
Simone Ludwig, Ph.D. - Computer Science

Handwritten Text Recognition using Convolutional Neural Networks in Deep Learning

There is a large demand for storing handwritten paper documents into computer-readable formats to allow people to access them more easily later, and for allowing users to handwrite words on technological platforms and convert them into text. Thus, in order to reduce the inaccuracy rate in recognition and identify the handwriting more efficiently, implementing a handwritten recognition machine that can be trained is crucial. In this project, I use TensorFlow and Keras in Python to build the Convolutional Neural Network (CNN) model, and implement the handwritten text recognition machine with 3 different datasets, MNIST, EMNIST, and CASIA-HWDB. The results show that the MNIST dataset reaches the highest accuracy and has the simplest model; EMNIST achieves an 87.53% accuracy, but it can be improved if the model is trained for more epochs; CASIA-HWDB only reaches 42.5% accuracy in testing images due to the limited number of samples for each character in the test image set. One major conclusion from the project is that complex models do not mean greater accuracy. Complex models might diverge while training. Sometimes, a simpler model can provide better accuracy. In the future, I can also train the model for more epochs to determine whether the models improve, or use different types of neural networks to train the model and test if it will achieve better accuracy.

Jake Jenson
ANIMAL SCIENCES

Project Advisers:
Carolyn Hammer, D.V.M., Ph.D. - Animal Sciences
Pawel Borowicz, Ph.D. - Animal Sciences

Relative expression and location of the neonatal Fc (FcRn) receptor in the equine gastrointestinal system

The neonatal Fc receptor (FcRn) is an important receptor in the immune system. It has multiple functions, such as bi-directional transport of immunoglobulin G (IgG), antigen presentation, and protection of IgG from lysomal degradation. The objective of this study was to determine the location of the FcRn along the equine gastrointestinal tract. Tissues from two mature horses (H1, H2) were collected and fixed in 10% NBF fixative solution prior to the paraffin embedding and sectioning. Cross sections (5 µm) were mounted onto glass slides, deparaffinized, stained for FcRn (Avia Systems Biology, San Diego, CA) and counterstained with DAPI. Large areas of tissue cross sections were taken using tiling module of the Zeiss ZEN software and Plan-Apochromat 20x/0.8 lens (air). Images were analyzed using ImagePro Premiere software (Media Cybernetics, Silver Spring, MD, USA). Data are presented as relative fluorescence units within the areas of interest as an indicator of FcRn abundance. These data demonstrated that the FcRn can be observed and quantified in the stomach, small intestine, cecum, large colon, liver, and pancreas of the horses. Results were grouped based on staining intensity. Low intensity (<100) included the pancreas (H2) and dorsal colon (H1). High intensity (>1000) included the duodenum and jejunum (H1 and H2). In conclusion, the FcRn was visualized in all sections of the equine gastrointestinal tract, with greater intensity in the small intestine versus the large colon's crypts, villi, and vessels. The duodenum showed the highest receptor intensities and could be a focus of future studies for FcRn.

Hannah Khan
BIOLOGICAL SCIENCES

McKenzie Weigel
MICROBIOLOGY

Elena Linster
BIOLOGICAL SCIENCES

Project Adviser:
Katie Reindl, Ph.D. - Biological Sciences

Pancreatic Cancer Research

The Reindl Lab studies how drugs that alter oxidative stress levels can kill pancreatic cancer. Pancreatic ductal adenocarcinoma (PDAC), is the most common form of pancreatic cancer. It is lethal and extremely difficult to diagnose because it does not present with distinct symptoms, spreads rapidly to the surrounding organs, and develops resistance to currently used chemotherapies. Pancreatic cancer can present with symptoms that include, but are not limited to, jaundice, weight loss, and abdominal or mid-back pain. The objective of our research is to understand the underlying mechanisms of how oxidative stress inducers influence cancer cell behavior, with the purpose of using similar agents for cancer therapy.

Justin Lester
AGRICULTURAL AND BIOSYSTEMS ENGINEERING

Project Adviser:
Xinjua Jia, PE, Ph.D. - Agricultural and Biosystems Engineering

Smart Irrigation Technology for High Value Crops

Agriculture is a major contributor to the economy of North Dakota. Dryland farming currently is the dominant method since the precipitation is normally sufficient for field crops, such as corn, soybeans, and wheat. However, for high value specialty crops, such as potatoes, tomatoes, and watermelons, the precipitation is either insufficient or distributed unevenly when it is needed to produce a guaranteed yield in North Dakota. Therefore, irrigation is much needed and is the future of the high value specialty crops in ND.

When applying irrigation, scheduling at a precise time and with an accurate amount is more important than no irrigation. Using irrigation controllers for irrigation scheduling, namely smart irrigation, has become a key player for water conservation in the last 20 years. Several states in the US (e.g. California, Texas, Florida) have implemented smart irrigation technology into their water management practices mandatorily, or with incentives (Dukes, 2012). The smart controller technology, most commonly based on evapotranspiration (ET) (Al-Ajlouni et al., 2012), crop coefficient (Gong et al., 2020), or soil moisture sensor (SMS) (Haley and Dukes, 2012) can determine when and how much to irrigate. With additional electronic controls, it can automatically manage the irrigation based on weather, rainfall, soil, and crops. Even with the technology's great potential, its use in agriculture has been minimal due to a variety of factors, including ease of use, power supply, cost, and few systems for farmers to follow based on their climate, soil, and crop conditions.

Halle Lipetzky
APPAREL, RETAIL MERCHANDISING AND DESIGN/RETAIL MERCHANDISING

Project Adviser:
Jaeha Lee, Ph.D. - Apparel, Merchandising, Interior Design, and Hospitality Management

How Small Businesses Are Surviving COVID-19

Small businesses make up a huge majority of all businesses throughout the United States. Without them, many individuals would struggle to find jobs and become unemployed. Through this project, I was able to analyze how small businesses can survive hard times catalyzed by COVID-19. With data, research, journals and more I could conclude what the secrets are to surviving a pandemic while running a small business in America. The purpose of my research was to understand what small businesses can do to survive hardships such as COVID-19, and I was able to develop an effective conclusion. To begin my research, a series of questions were asked in a Qualtrics survey to analyze what consumers are drawn to when shopping both before COVID-19 and during COVID-19. We found that providing high quality products for a good price as well as great customer service are some things that are extremely to very important for small businesses to implement. The stores should willingly take exchanges, respond to what the customer needs, and understand what their target market is missing and obtain the merchandise promptly. Keeping a clean and sanitized store is also crucial in the unknown times of COVID-19. They should organize their stores so their customers can find exactly what they are looking for in a timely manner. Small businesses' most effective strategies to survive hard times, according to our literary research, are to be very engaged and active in all the different social media platforms and to encourage consumers to shop online and do curbside pickup if it is available. Small businesses should apply for federal aid such as SBA loans and PPP loans to receive help through hard financial times. With all these strategies implemented, small businesses can better succeed through difficult and unknown times such as COVID-19.

Emily Lucus
HOSPITALITY AND TOURISM MANAGEMENT

Project Adviser:
Jeongdoo Park, Ph.D. - Apparel, Merchandising, Interior Design, and Hospitality Management

Resort Demographic Industry Trend

Although the exact dates of the millennial generation have had slight debate, generally they are considered to be people who were born between the years of 1980 and the early 2000s. What is not debated, however, as it is considered to be unanimously true, is that millennials, both as consumers and employees, have significantly impacted all business industries. This presentation will have four sections. The first is an introduction of the characteristics of millennials and statistics on how they have impacted the tourism industry. Next will be a review detailing the consumer trends of millennials, how they have changed the workforce, describing millennials as travelers, and the changes the hospitality industry has made or should make to adapt to this generation. Next will be a case study reporting the findings from interviews from two hotel managers in regard to how their property has changed in response to this demographic shift. Finally, recommendations for resorts' futures will conclude this presentation.

Brianna Maddock
BIOTECHNOLOGY / MICROBIOLOGY

Project Advisers:
Glenn Dorsam, Ph.D. - Microbiological Sciences
Justin Daniels - Microbiological Sciences

Characterizing Fecal Microbiota Dysbiosis in Vasoactive Intestinal Peptide Deficient Mice

Vasoactive intestinal peptide (VIP) is a 28 amino acid neurotransmitter that plays pivotal biological roles as a gut hormone, master circadian regulator, and anti-inflammatory molecule, among others. In 2019, the Dorsam lab published a study showing a significant shift in the fecal bacterial composition (e.g. dysbiosis) from mice lacking VIP (KO) compared to wild type (WT) or heterozygous (HET) littermates. Notably, the relative percent abundance of the Gram-negative, genus *Bacteroides* was significantly increased in VIP knockout samples, representing nearly half of all rRNA reads. However, a limitation to this report was that the 16S rRNA sequencing method by which bacteria taxa was determined could only distinguish to the genera level. Therefore, the goals of this study were two-fold. First, we set out to confirm the aforementioned 16S rRNA sequencing data by traditional polymerase chain reaction (PCR) and matrix-assisted laser desorption/ionization (MALDI), and second, we aimed to utilize these culturable and non-culturable methods to further resolve the taxonomic characterization of *Bacteroides* from genus to species. We hypothesized that there would be a "reshuffling" of species within the *Bacteroides* genus based on our previously published results. MALDI spectrometry showed the presence of *Bacteroides vulgatus* in both WT and KO samples with greater prevalence in KO samples. PCR results showed the presence of *Bacteroides ovatus* in the WT sample. No other species signals were obtained. Further studies will expand on this research by employing digital PCR to quantify the presence of the *Bacteroides* species and isolation of isolates for further characterization.

Tiffany Meeks
CIVIL ENGINEERING

Project Adviser:
Beena Ajmera, Ph.D. - Civil and Environmental Engineering

Co-Investigators:
Muhammad Shahid Iqbal

Predicting Strength Drops in Soils Resulting from Earthquakes

Seismic or cyclic loadings, also known as earthquakes, often cause damage to structures, their foundations, and various landforms. Such loadings cause the water pressure to build up between soil particles (known as the pore water pressure), causing a drop in the strength of the soil. The foundation failures in Wufeng, Taiwan caused by the 1999 Chi-Chi earthquake along with the Anchorage Landslide caused by the Anchorage Earthquake of 1964 are among a few examples where the loss of soil strength after an earthquake was the dominating factor for these disasters. While there is a great deal of research on the immediate loss of strength after a seismic loading, there are few that have observed and analyzed the rebound in soil strength as the pore water pressure dissipates over time. In order to do this, cyclic direct simple shear tests were conducted on mixtures of specific clay minerals of kaolinite, montmorillonite, and quartz. The strength of the soils was measured at varying degrees of dissipation of the pore water pressure following the cyclic loading. Additionally, the strengths of the soils subjected to multiple cyclic events were also measured. The results showed that a relationship previously proposed by Ajmera et al. (2019) could be used to determine the strength loss after multiple cyclic events. However, a key component to the use of this relationship is an estimate of the pore water pressure. To obtain this pore water pressure under different cyclic loading conditions, a machine learning algorithm that predicts the outcomes of cyclic loading (namely, pore water pressures and strength reductions) was developed.

Mohammed Mohammed
CIVIL ENGINEERING

Project Adviser:
Beena Ajmera, Ph.D. - Civil and Environmental Engineering

The Strength of Over-Consolidated Soils

Soils that were under higher pressures than the pressures they are subjected to currently are called overconsolidated soils. The strength of these soils plays a significant role in natural and human-made soil stability, such as earth retaining walls, abutments of bridges, and embankments. An example of soil shear strength failure is the collapse of a saddle dam at Fujiyama, Japan, in 2011 after the Tohoku earthquake. Another example is the construction at the location of the World Trade Center after the 9/11/2001 terrorist attacks in New York City. Both of these required an understanding of the strength of the underlying overconsolidated soils. Although there are many research studies on soil strength, not many specifically take a closer look at the soil strength of fine-grained soils that are overconsolidated. In this study, direct simple shear tests conducted using different mixed fine-grained soil samples to study their behavior when they are overconsolidated. The results were analyzed using the SHANSEP (Stress History and Normalized Soil Engineering Properties) technique. The SHANSEP method is used to relate the strength of soil normalized to the vertical pressure in terms of the overconsolidation ratio of the soil. The overconsolidation ratio relates the maximum pressure experienced by the soil to the current vertical pressure. The results build on previous findings to develop a unique relationship between the normalized undrained strength ratio and the overconsolidation ratio. This relationship is found to depend on the type of clay minerals in the soil mass.

Sarah Montplaisir
ENGLISH / BIOLOGICAL SCIENCES EDUCATION

Project Adviser:
James Nyachwaya, Ph.D. - School of Education

Adding Relevance: How textbooks attempt to make the abstract real

Many concepts in the discipline of Chemistry are abstract, a fact that makes the subject challenging to students. It also makes students perceive the discipline as a collection of facts to be memorized. To address this challenge, textbook authors have included special sections that showcase how different chemistry concepts are applied in the real world, as well as how some of the knowledge in the discipline came about. This research study sought to look into the content of such special connections, with a goal of uncovering the different ways authors add relevance to otherwise abstract content. Results show that textbook authors connect content to the environment, industry, technology, medicine and health. They also make explicit connections to other disciplines such as biology, physics, and geology. There are also sections highlighting the history and nature of science.

Macy Rennpferd
BIOLOGICAL SCIENCES

Madeline Schroeder
BIOLOGICAL SCIENCES EDUCATION

Project Adviser:
Danielle Condry, Ph.D. - Microbiological Sciences

Application of Microbiology Concept Inventories to Identify Student Misconceptions and Improve Programmatic Curriculum

Learning does not follow a direct path; each student takes an individualized route to master content. However, the development of misconceptions can often lead students down incorrect paths, delaying or derailing their learning success. The Microbiology Concept Inventory (MCI) is an assessment tool derived from the fundamental statements and guidelines created by the American Society for Microbiology (ASM). This two-tier, multiple-choice question inventory requires students to choose the most correct answer for each question, and provide a brief justification of their reasoning. Educators can utilize this tool to identify common misconceptions held by students and adjust curriculum to better correct student misconceptions and prevent their persistence. Over the course of two years, the MCI was annually administered to undergraduate students enrolled in entry level and senior capstone microbiology courses at a midwestern university. Upon completion of the inventories, thematic coding was performed to categorize student responses. These codes were correlated back to the ASM fundamental statements, as well as published findings, to aid in identifying perceived misconceptions in student understanding. Analysis was also completed to compare between each course, year, majors and minors, gender, and GPA. The identification and analysis of the concept inventory in association with core concept areas creates recommendations for course instructors regarding potential curriculum changes. Implementation of revised curriculum can guide students back on their path to learning success.

Isnala Nanjin Roan Eagle
MECHANICAL ENGINEERING

Project Adviser:
Nita Yodo, Ph.D. - Industrial and Manufacturing Engineering

Utilizing Deep Learning to Classify Materials for Future 3D Printing

Artificial Neural Networks (ANN) are models designed for a specific application intended to process a given dataset. They have been designed after our own biological neural network where we process images through our eyes into our brain. These models are governed by a mathematical function where each input is mapped to a desired output through hidden layers of neurons. To utilize these models, they must be trained initially. This is done by using a dataset and identifying which inputs, outputs, weights, and sigmoid functions are to be valued. Multiple programming languages allow for the creation of neural networks and the process of choosing one is up to the user. This study was to classify a given dataset of fifty common materials and identify how to relate their properties to given mechanical properties as inputs to the model. A validation plot for the plot is shown and signifies the models fitting. The purpose of the research is for future application for the synthesis of a biopolymer using already existing commercial 3D printing filaments. Conclusions drawn indicate the need for a dataset using already existing commercial filaments and the investigation of different algorithms for neural networks to see which best would fit the latter dataset.

Nicholas Rohrich
ELECTRICAL ENGINEERING / FINANCE

Kyle Berger
FINANCE

Project Advisers:
Jun (Jeffrey) Chen, Ph.D. - Transportation, Logistics, and Finance
Fariz Huseynov, Ph.D. - Transportation, Logistics, and Finance

Co-Investigators:
Connor Laughridge
Derek Phelps
Aiden Schutt

Equity Investment Research, Apogee Enterprises, Inc.

Apogee Enterprises, Inc. ("Apogee", "The Company", "APOG") is a Minneapolis, Minnesota based company that was originally established as a small, downtown glass shop. Since then, Apogee has grown and acquired nine subsidiary businesses to help structure themselves as an industry leader in architectural products and services operating in the United States, Canada, and Brazil. They provide glass and aluminum window, storefront, and curtainwall systems to commercial, institutional, and multifamily buildings. Their team of engineers, designers, installers, and other key employees allows the company to design and complete a wide variety of projects in an efficient and timely manner with their vertically integrated business structure. This research project was done for the CFA International Research Competition.

Max Salzer
AGRICULTURAL AND BIOSYSTEMS ENGINEERING / COATINGS AND POLYMERIC MATERIALS

Project Adviser:
Nurun Nahar, Ph.D. - Agricultural and Biosystems Engineering

Innovative Strategies to Improve Glucose Yields from Corn Stover at High Pretreatment and Enzymatic Hydrolysis Loadings

Biochemical conversion of lignocellulosic biomass at high solid loadings (≥20% w/v) has proven to be an effective solution to overcome the barriers currently inhibiting biorefinery viability. Specifically, utilizing high substrate loadings reduces heating requirements, wastewater production, and the reactor size required to produce yields sufficient for cost-effective distillation. However, the required processing stages, specifically pretreatment and enzymatic hydrolysis, are heavily dependent on the biomass utilized, mixing, and severity. For this reason, the goals of this research involved determining the synergistic effect of increasing temperature and solid loadings of loose and pelleted corn stover during pretreatment, designing a laboratory-scale hydrolysis method to provide sufficient solubilization and enzyme binding at high solids, and identifying the viability of a systematic high solid pretreatment and hydrolysis. These goals were approached by soaking loose and pelleted stover in 18% (w/w) aqueous ammonia for 4 hours at 60 °C, 90 °C, and 120 °C and solid loadings of 20%, 30%, and 40%. Following these pretreatments, samples were taken for a 1% glucan (~3% solids) hydrolysis, composition, FTIR, and SEM analysis. To develop a sufficient high solid hydrolysis system, three reactor methods were then investigated. Using the optimized system, hydrolysis was performed at 10%, 20%, and 30% solids. Promising results from experimentation showed pretreatment loadings could be increased from 20% to 40% at 90 °C without significantly reducing glucose yields for pelleted stover and 87%, 73%, and 55% conversion could be achieved at 10%, 20%, and 30% hydrolysis loadings, respectively.

Jacob Schepp
PHARMACY

Project Adviser:
Yagna Jarajapu, MPharm, Ph.D., FAHA - Pharmaceutical Sciences

Aging-Associated Vasoreparative Dysfunction in A Mouse Model

he risk for ischemic vascular diseases increases with age. Hematopoietic stem progenitor cells (HSPCs) are known to have a potential of vascular regeneration, which is impaired with aging. Here we optimized a mouse model for aging-associated vasoreparative dysfunction. We tested the beneficial effects of Angiotensin-(1-7) (Ang-(1-7)), which is known to stimulate vasoreparative functions by acting on Mas receptor. C57Bl/6 mice of age 3-4 months or 20-22 months were used in the study. Hind limb ischemia was induced by femoral ligation. Circulating stem/progenitor cells (Lineage-negative and Sca-1- and cKit-dual positive cells, LSK) and blood flow recovery following ischemia were monitored for four weeks. Circulating LSK cells were increased in response to ischemia in Young mice impaired with aging. Young mice recovered blood flow to the areas of ischemia completely while in Old mice, the recovery was greatly decreased suggesting impaired regeneration of vasculature. Treatment with Ang-(1-7) (1µg/Kg/day, s.c) by using an osmotic pump for four weeks reversed aging-associated dysfunctions. Collectively, a mouse model of aging-associated vasoreparative dysfunction is optimized that can be used for pre-clinical evaluation of novel pharmacological approaches for the treatment of vascular disease with aging.

Makayla Scherrer
MUSIC

Project Advisers:
Kyle Vanderburg, D.M.A. - Music
Patricia Burt, Ph.D. - University of Delaware

Exploring the Underrepresentation of Female Composers in the Opera World

In recent years, the importance of representation of diverse composers has been at the forefront of many involved in the classical music world. With the increase in the representation of diverse composers, the art songs of female composers such as Fanny Hensel and Alma Mahler are being performed across the world stage. However, other female composers, such as those that wrote opera, are continuing to be underrepresented among the classical world. This presentation argues that operas by female composers contain the same merit as operas by other composers while also displaying the strides some opera houses have taken to improve their representation of the female composer. I hope this presentation will open a dialogue on the issue of representation of female opera composers and help to forge a solution that can solve this underrepresentation issue in the future.

Annie Schiro
BIOCHEMISTRY AND MOLECULAR BIOLOGY

Project Advisers:
James Nyachwaya, Ph.D. - School of Education
Krystal Grieger

Chemistry students' understanding of dissolving and associated phenomena: The case for sodium chloride

Chemistry is generally represented at three levels: macroscopic, sub-microscopic and symbolic. In order to fully understand chemistry, it is necessary to fluently navigate between and within these levels. This study sought to uncover students' understanding of the process of dissolving by asking them to describe, represent, and explain both the process of dissolving and associated phenomena. The study took place in a second-semester general chemistry class (n=160). Students worked in groups of 3-4 to complete a worksheet activity. Student responses were scored for correctness and then analyzed for conceptual understanding. Results show that a number of groups struggled to describe and provide an appropriate sub-microscopic representation of dissolving. While most groups correctly predicted how phenomena such as entropy are affected by dissolving, most did not provide correct explanations for their predictions. The findings of this study have implications for assessment and instruction.

Anna Marie Schornack
ELECTRICAL ENGINEERING / BIOMEDICAL ENGINEERING

Anna Rudie
ELECTRICAL ENGINEERING

Abby Voight
ELECTRICAL ENGINEERING

Project Adviser:
Danling Wang, Ph.D. - Electrical and Computer Engineering

Blood Glucose Breath Analyzer

Patients who suffer from diabetes rely on blood glucose monitoring to live a healthy lifestyle. As of right now, there is no monitoring procedure that is noninvasive. It has been found that acetone in the breath acts as a biomarker to monitor blood glucose levels. Due to the low concentration of acetone, detection becomes difficult. The challenge was to find a material that would allow for such sensitivity. The synthesis of a new nanomaterial K2W7O22 (KWO) exhibits the required sensitivity and detects breath acetone due to the properties of the material at room temperature. The sensitivity of the nanomaterial is tested using a vapor generator. The resistance change of the sensor slide is read to analyze the sensitivity. Using the results of these tests, a device will be designed to output the results to the patient. The hope is that the device will be connected to a mobile phone and store the data in a cloud accessible to both the patient and the physician.

Chloe Spoden
HUMAN DEVELOPMENT AND FAMILY SCIENCE

Christian Reedy
ACCOUNTING

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

The Role of Oil and Gas and Amenities in County Economic Development

North Dakota, as a state economy, is heavily reliant on the production of oil and gas. A few counties in North Dakota, particularly in the western portion of the state where oil production occurs, have placed great emphasis on developing this portion of their economy. When oil prices are high, these counties do well; when oil prices are low, their local economies can suffer greatly. This study is designed to provide insight to local stakeholders and public officials in counties with high levels of oil as to the state of the oil and gas sector. We hope to help our audience approach diversifying their local economy by helping to understand their agricultural production and recreation and amenity sectors; two other major portions of these economies. We used labor force, production and economic data in our analysis of these counties to provide insight into these sectors. Upon completion, we expect to learn that some counties are too focused on oil and gas production. We are hopeful that we will be able to identify "problem" counties that are too focused on oil and gas and give them suggestions for how they can diversify their county.

Zachery Tiedeman
BIOTECHNOLOGY / ECONOMICS

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

Beyond Good Intentions

Environmental policy has become a large concern both politically and socially. Pro-regulation individuals are concerned about achieving the benefits, while anti-regulation ones are concerned with reducing the costs. Given the political environment, change appears to be on the horizon. In order for this change to be productive rather than detrimental, both approaches need to consider the costs AND the benefits involved in currently existing policy. "Beyond Good intentions" is a book project designed to serve as a primer on the USA's environmental policy in order to facilitate this understanding. The approach taken is a mix of a qualitative and quantitative analysis of each of 6 major environmental policies in the US. Each policy is broken into three parts: An overview of the policy, a broad discussion on the benefits, and an examination of the costs. Finally, this book will discuss possible alternatives to current regulation. My role in this larger collaborative project has been the benefits section for each policy. My work has been two-fold. The first is an analysis of each policy to determine its goal. The second is a qualitative argument for the ways this goal has been met in the real world, with quantitative evidence for support.

Troy Timmerman
COMPUTER SCIENCE

Project Adviser:
Bakhtiyor Rasulev, Ph.D. - Coatings and Polymeric Materials

Automating protein structure modeling to predict beta sheet content

A current research study is investigating the beta-sheet content of a protein in the blood. Beta-sheet content could be useful for predicting whether that protein is an indicator of the presence of cancerous cells, and thus could be used to identify from blood tests whether there are cancerous cells in the body. While the amino acid sequence of these proteins can be easily extracted, reconstruction and modeling of a secondary structure (3D structure) is more difficult. Creating 3D models of proteins from lab techniques such as x-ray crystallography or nuclear magnetic resonance spectroscopy (NMR spectroscopy) is time consuming and expensive. Many *de novo* modeling techniques exist but have a high computational expense. To fill this gap, this project attempts to leverage the computationally cheaper homology modeling that already exists by automating it so that thousands of proteins can be modeled quickly with a meaningful structural accuracy.

To create this automated modeling pipeline, the project began by automating existing Swiss-Model web servers using Selenium libraries and a two-fold process to model proteins and extract the created structures.

The initial pipeline is promising for producing models that predicted beta-sheet content of proteins. However, certain limitations exist. Since it relies upon a web server, modeling large sets of proteins risks programs being terminated on the Swiss-Model side. Certain proteins also lacked good homologs, and the initial modeling did not remove those models – while their beta-sheet content appears to be useful, it could poison the reliability of the structures. Overall, the automated pipeline appears to be a useful tool, and further efforts are underway to create a complete modeling pipeline on local servers.

Rebecca Tomann
CHEMISTRY

Project Adviser:
Svetlana Kilina, Ph.D. - Chemistry and Biochemistry

Holey Graphene with Embedded Au_{13}-Cluster for H_2S Gas Sensing Applications

We have modeled nanopatterned holey graphene (HG) substrate electronically hybridized with Au nanoparticles, using density functional theory. Adsorption of H_2S on the HG-Au distorts H_2S molecules. Such conformational changes significantly affect the electronic states near the energy Fermi, which are reflected in DC-conductivity. The results prove the ability of HG/Au-nanoparticle systems working as an electronic sensor for detecting toxic H_2S gas even at its small concentrations, when only a few H_2S molecules are present.

Miranda Vanderhyde
MICROBIOLOGY

Project Adviser:
Samiran Banerjee, Ph.D. - Microbiological Sciences

North Dakota Agricultural Microbiomes

North Dakota is in second place for the state producing the most wheat in the US, generating about 333 million bushels per year. The soil microbiome is proven to be important for plant health, growth, and stress resilience, but we are harming the soil communities that help the plant with excessive use of agrichemicals. There is little knowledge of the plant and soil microbiomes due to limited in-depth reports on this topic. We are aiming to fill this knowledge gap by assessing soil and plant microbiome communities in North Dakota. Our goal is to understand how the microbiome affects crop growth and how crops affect the microbiome across the seedling, mature, and harvest developmental stages. In the summer of 2020, our lab collected samples from fields across North Dakota in 50 out of the 53 counties. In total, this ended up being 201 fields sampled three times, matching up with the wheat developmental stages. We believe this is the largest wheat microbiome project ever done. We collected bulk soil, rhizosphere, and root samples and calculated grain and biomass for every field three times. We expect microbiota to increase in wheat roots over time and we expect a strong link between soil health and microbial communities. We will be analyzing this change by comparing the three timepoints by calculating colonization and analyzing DNA extraction. Our end goal is to create a database of microbiomes and ecosystem functions for researchers and the North Dakota agriculture community to use.

Rachel Voigt
ANIMAL SCIENCES

Project Advisers:
Carrie Hammer, D.V.M., Ph.D. - Animal Sciences
Pawel Borowicz, Ph.D. – Animal Sciences

Co-Investigators:
Jake Jensen

Visualization and Measures of Intensity of the Neonatal Fc Receptor in Major Body Systems of the Horse

The neonatal fragment crystallizable receptor (FcRn) plays a key role in antigen presentation and movement of IgG across cell membranes. Research regarding the neonatal FcRn in livestock species, specifically horses, is limited. Therefore, the objective of this study was to identify FcRn in various equine tissues. Tissue samples were collected from two mature horses and fixed in 10% NBF fixative solution prior to the paraffin embedding and sectioning. Cross sections (5 µm) were mounted onto glass slides, deparaffinized, stained for FcRn (Avia Systems Biology, San Diego, CA) and counterstained with DAPI. Large areas of tissue cross sections were taken using tiling module of the Zeiss ZEN software and Plan-Apochromat 20x/0.8 lens. Images were analyzed using ImagePro Premiere software (Media Cybernetics, Silver Spring, MD, USA). Data was presented as relative fluorescence units within the areas of interest as an indicator of FcRn receptor abundance. Data demonstrated that FcRn can be reliably observed and quantified in respective areas of the cardiovascular, skeletal, nervous, respiratory, reproductive, and lymphatic systems. After evaluation of the tissues, categories were determined based on relative intensity: low (0-100), medium (101-999), and high (1000+). The highest intensities were observed in the bronchi-alveoli, bronchioles, and bronchi. Very low intensities were observed in ovarian and retina samples. Intensities were recorded as whole sections and specific cell differentiation was not accounted for. While further investigation is necessary for better understanding of specific cellular FcRn location, this research provides the initial knowledge of FcRn presence in equine tissues.

Helen Wax
ANTHROPOLOGY

Project Adviser:
Ellen Rubinstein, Ph.D. - Sociology and Anthropology

The Cost of Death in the Upper Midwest - An Ethnographic Analysis of the American Funeral Industry

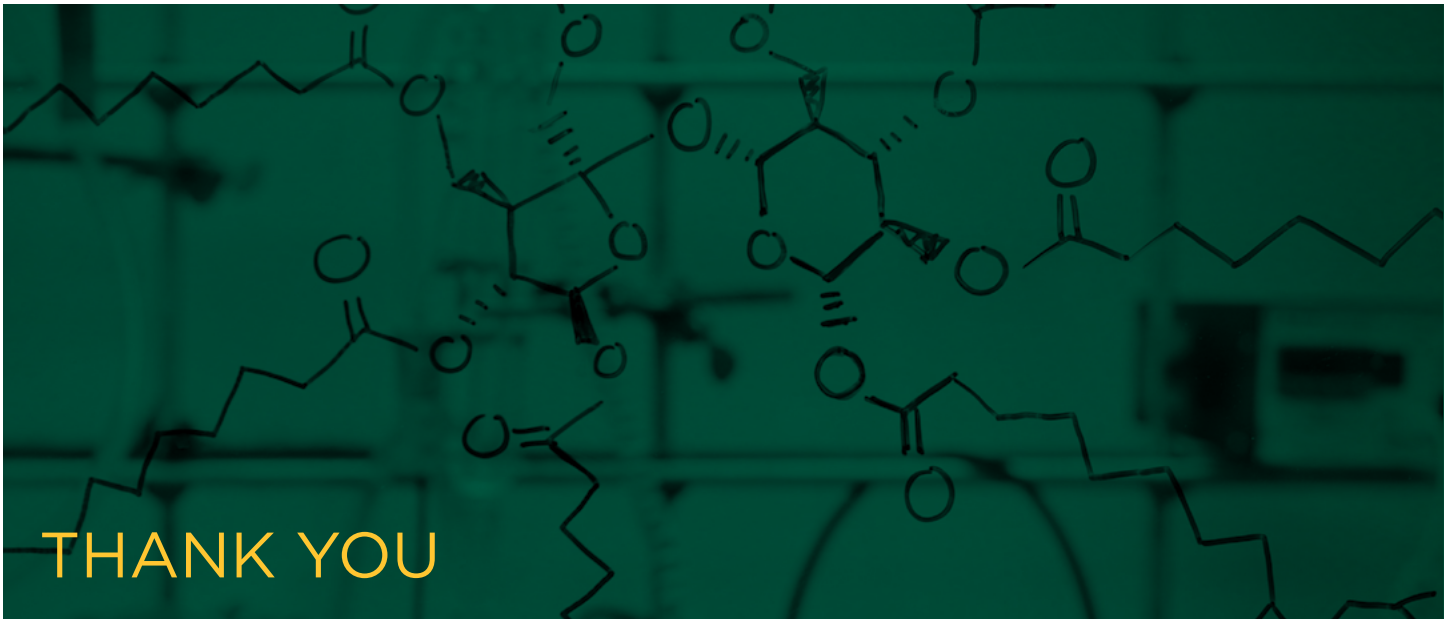
The rapid industrialization that occurred throughout the late 19th and early 20th centuries left no corner of industry untouched, including death. Prior to this, funeral rituals before burial were done in the home and the body was cared for by loved ones. Today, formal funeral rituals in the US have become more expensive, commercial, and regulated due to the development of skilled industry, such as commercialized funeral care using mortuary technology (embalming and restorative work, etc.). This ethnographic research looked into how commercializing the American funeral, specifically in the upper Midwest, may have changed our relationship with death rituals. I particularly focused on how commercial funeral workers interact with grieving families, how the development of skilled funeral labor has altered the public's relationship to the dead, and ultimately how funeral industry professionals perceive their work. The results of this research demonstrated two distinct themes regarding the commercial funeral industry. The first is that funeral workers have an expected authority over funeral rites derived from industry enculturation, and this extends toward dead bodies. The second is that funeral workers perceive their work as a "ministry". The greater significance of this research project is that it created a more robust social science knowledge of mortuary rituals as a modern commercialized practice within the upper Midwest.

Caden Wurzbacher
ECONOMICS

Project Adviser:
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

North Dakota Legacy Fund: A Public Choice Analysis

From at least 2006, Western North Dakota experienced an oil boom that resulted in a dramatic increase in economic activity. As a result of this boom, North Dakota, through a constitutional ballot measure, established the Legacy Fund that reserved 30% of monthly oil revenue taxes collected by the state in a separate fund. The principal and the resulting interest payments have increased with a total balance of over 5.6 billion at the beginning of 2019 and the interest accumulated amounted to $737,399,531 over the course of the year, with a total value of over $6.8 billion at the end of the year (including tax the oil tax income transfer payments). The total amount in terms of earnings from the Legacy Fund over the 2017-2019 biennium totaled $455,263,216. This amount of money, annualized, could have a significant impact on the fiscal health of the state, the state spending patterns, or on the well-being of its citizens. As such, how to allocate those funds has become a statewide political issue. In 2019, it dominated the Legislative Session when Governor Doug Burgum proposed a variety of ways of using the funds on public projects and tax relief. As a result of the 2019 Legislative Session, lawmakers established an interim committee to gather public input and examine various proposals put forward for the Legacy Fund. With the number of ideas for the use of the fund that have been proposed, there are decisions that must be made about what the purpose of the fund is, and how best to use the principal and the earnings of the fund. This process is both a fiscal and political one, where numerous interests and actors must sort out how the fund will be utilized, if at all. This paper will explore these elements from a Public Choice perspective.



THANK YOU

Thank you to the following mentors for encouraging and supporting undergraduate research and participation in NDSU EXPLORE.

College of Agriculture, Food Systems, and Natural Resources

Samiran Banerjee, Ph.D. - Microbiological Sciences
Pawel Borowicz, Ph.D. - Animal Sciences
Christopher Byrd, Ph.D. - Animal Sciences
Danielle Condry, Ph.D. - Microbiological Sciences
Glenn Dorsam, Ph.D. - Microbiological Sciences
Andrew Friskop, Ph.D. - Plant Pathology
Barney Geddes, Ph.D. - Microbiological Sciences
Carolyn Hammer, D.V.M., Ph.D. - Animal Science
Xinhua Jia, PE, Ph.D. - Agricultural and Biosystems Engineering
Nurun Nahar, Ph.D. - Agricultural and Biosystems Engineering
Jack Norland, Ph.D. - School of Natural Resource Sciences
Ryan Yonk, Ph.D. - Agribusiness and Applied Economics

College of Arts, Humanities and Social Sciences

Dennis Cooley, Ph.D. - History, Philosophy, and Religious Studies
Ellen Rubinstein, Ph.D. - Sociology and Anthropology
Kyle Vanderburg, D.M.A. - Music

College of Business

Jun (Jeffrey) Chen, Ph.D. - Transportation, Logistics, and Finance
Fariz Huseynov, Ph.D. - Transportation, Logistics, and Finance

College of Engineering

Beena Ajmera, Ph.D. - Civil and Environmental Engineering
Ali Amiri, Ph.D. - Mechanical Engineering
Syeed Iskander, Ph.D. - Civil and Environmental Engineering
Xinhua Jia, PE, Ph.D. - Agricultural and Biosystems Engineering
Simone Ludwig, Ph.D. - Computer Science
M. Zubair Malik, Ph.D. - Computer Science
Nurun Nahar, Ph.D. - Agricultural and Biosystems Engineering
Danling Wang, Ph.D. - Electrical and Computer Engineering
Nita Yodo, Ph.D. - Industrial and Manufacturing Engineering

College of Health Professions

Yagna Jarajapu, MPharm, Ph.D., FAHA - Pharmaceutical Sciences
Julia Muzzy Williamson, Pharm.D., CNSC, BCPPS, BCNSP - Pharmacy Practice
Sathish Venkatachalem, Ph.D. - Pharmaceutical Sciences

College of Human Sciences and Education

Jaeha Lee, Ph.D. - Apparel, Merchandising, Interior Design, and Hospitality Management
Jenny Linker, Ph.D. - Health, Nutrition, and Exercise Sciences
James Nyachwaya, Ph.D. - School of Education; Chemistry and Biochemistry
Jeongdoo Park, Ph.D. - Apparel, Merchandising, Interior Design, and Hospitality Management
Brooke Thiel, Ph.D. - School of Education

College of Science and Mathematics

Svetlana Kilina, Ph.D. - Chemistry and Biochemistry
Jiha Kim, Ph.D. - Biological Sciences
James Nyachwaya, Ph.D. - School of Education; Chemistry and Biochemistry
Bakhtiyor Rasulev, Ph.D. - Coatings and Polymeric Materials
Katie Reindl, Ph.D. - Biological Sciences

Thank you to North Dakota EPSCoR for providing support to NDSU EXPLORE 2021.