NC State University
Summer Undergraduate Research & Creativity Symposium

Tuesday, July 31, 2018

11:45a to 12:30p  Doors Open – All Presenters Check In (Session 1 & 2)
12:30p to 12:50p  Poster Set Up – Session 1 (Odds)
12:50p to 1:00p   Welcome: Bret Smith, Senior Associate Dean of University College
1:00p to 2:15p    Poster Session 1 (Odds)
2:15p to 2:30p    Poster Take Down – Session 1 (Odds) & Poster Set Up – Session 2 (Evens)
2:30p to 3:45p    Poster Session 2 (Evens)
3:45p to 4:00p    Close: Chris Ashwell, Director of the Office of Undergraduate Research (OUR)
4:00p to 4:30p    Poster Take Down – Session 2

Event Sponsored by: The Office of Undergraduate Research (OUR), the Undergraduate Research Club (URClub), and the Division of Academic and Student Affairs (DASA)

FULL ABSTRACT BOOK CAN BE FOUND AT: http://go.ncsu.edu/abstractbook
ASSIST - Nanosystems ERC for Advanced Self-Powered Systems of Integrated Sensors and Technologies

**Poster Number: 140**

**Electrically Conductive Fabrics Through the Use of Carbon Nano-tube Sheets**

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The development of flexible electronics will impact the future by creating a future where an individual can wear a watch, or a t-shirt, that can monitor chronic illness, or help prevent individuals from getting sick. Current approaches for flexible electronics are printing a silver film, engraving patterns, and the use of carbon nano-tube thin films. Carbon nano-tubes are grown through chemical vapor deposition and have previously provided favorable results when tested for its mechanical properties, electric properties, and tensile properties. The thought process behind using carbon nano-tubes is that they are naturally slightly conductive and very ductile because they adhere to each other on the nano-scale. If carbon nano-tube films can be made more electrically conductive, there could be a practical application to the flexible electronics movement by acting as ‘wiring’ for devices connected to the flexible electronic to communicate with each other. In this work, we have developed a method for permanently adhering carbon nanotube carbon nanotube sheets to knit fabric for use as electrical interconnects. Carbon nanotube sheets are naturally fairly conductive, and their conductivity changes when a binder is used to adhere them to a fabric. We studied how the electrical conductivity changed as a function of the amount of binder used. In addition, we employed a method of combining silver nanoparticles with the polyurethane binder to further increase the electrical conductivity. After determining the most conductive configuration, the conductivity was measured after it is adhered to fabric, and during mechanical stretching.

**Poster Number: 33**

**Thermoelectric Properties of Cubixsb1-xte2 Bulk Alloys**

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Semiconducting compounds of CuBi\(_x\)Sb\(_{1-x}\)Te\(_2\) with \(x=0, 0.25, 0.5, 0.75, \text{ and } 1\) were prepared through powder metallurgy and spark plasma sintering. The samples were characterized by x-ray diffraction, scanning electron microscopy, energy-dispersive x-ray spectroscopy, and differential scanning calorimeter. Their thermoelectric properties were measured between room temperature and 700 K. All
samples with $x^{-1} K^{-1}$. The thermal conductivity values in some cases were smaller than the electronic thermal conductivity estimated by Weizmann-Frantz law, which evidences deviation from this law as well as the ultra-low lattice thermal conductivity of these compounds. The compound with $x=0.5$ showed the smallest thermal conductivity of $\sim 0.9 \text{ Wm}^{-1}\text{K}^{-1}$, with an electrical conductivity of $\sim 2200 \text{ S/cm}$, a Seebeck coefficient of $\sim 90 \mu\text{V/K}$, and a dimensionless figure-of-merit of $\sim 0.65$ at 45 C with an increasing trend towards lower temperature. The reproducibility of the compounds was investigated by synthesizing several samples and their measurement through heating and cooling cycles. This relatively inexpensive material could be further optimized versus growth and post-growth process parameters for applications in more efficient thermoelectric generators for waste heat recovery in automobile industry applications, for example.

Poster Number: 40
**Practical Application of Meta-materials for Teg Performance Optimization**

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Wearable health sensing technologies utilize low powered sensors embedded in clothing for the tracking and monitoring of patient health data. One major design goal of the wearable sensor technologies is to develop a self-powered system utilizing the energy from the body to provide a vigilant device operation. Of particular interest to this work is the use of thermoelectric generators that produce power when placed between the thermal gradient of the body and the surrounding atmosphere. Previous studies implementing these devices in a garment have shown promise to their application. This study aims to optimize the thermal gradient across these TEGs by implementing a meta-material heat concentrator design that increases the thermal heat flux from the body to the TEG. This work reviews the modeling effort and practical application of these structures toward improved energy harvesting.

Poster Number: 170
**Design and Fabrication of a Soft, Flexible Antenna System for Wearable Biomedical Devices**

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In this work, a soft, flexible antenna system using Styrene Ethylene Butylene Styrene (SEBS), Eutectic Gallium Indium (EGaIn) liquid metal, and copper sheets was developed. This antenna was designed to be used within a biomedical wearable device to efficiently transmit and receive electrical signals to another receiver. The unique stacked design of the antenna exhibited the potential to reduce the size of the device by a factor of four, thus creating a concise system that is vital in the field of wearables where size is limited. The SEBS polymer, with a liquid metal (EGaIn) channel inscribed within it, was chemically bonded to copper sheets in multiple alternating stacks of various parameters. A bonding strategy using the epoxy and amine functionalities through oxygen plasma treatment and the utilization of (3-Aminopropyl) triethoxysilane (APTES) and (3-Glycidyloxypropyl) trimethoxysilane (GPTMS) was employed to create a strong chemical bond between the SEBS polymer and the copper sheets throughout the antenna. These bonds hold up to 35 newtons of force at a contact area of 625 mm$^2$. Stacking multiple EGaIn infused SEBS layers with copper sheets maintains a durable system with a more efficient and reliable flow of electricity within the entire antenna. This new method creates a soft to the touch antenna system that is both flexible and concise, both of which is vital within the areas of wearable devices and consumer preference.

Poster Number: 184

Application of Phase Change Materials to Increase Efficiency of Body Heat Harvesting with Thermoelectric Generators.

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Thermoelectric generators (TEGs) operate on temperature differentials and the subsequent transfer of electrons through p- and n-type alloys transducing thermal energy to power certain electronics reliably and uninterrupted. Conventional TEG systems in body heat harvesting applications generate only about 20 $\mu$W/cm$^2$, and hence will not suffice for powering more energy-intensive electronics. Phase change materials (PCMs) absorb and release energy during their phase transition. By placing such materials on the top of a TEG, one can increase the temperature differential between the top and the bottom surface resulting in an augmented power output when the phase transition is underway. This research aims to investigate the effect of an organic PCM atop a conventional rigid TEG on the power output during fusion. n Nonadecane was chosen as a promising PCM due to its high enthalpy of fusion (~45 kJ/mol) and a melting point (~31°C) in the vicinity of the human body skin temperature (~36°C). IV and power measurements were carried out for a TEG with different amounts of PCM (nil, 1g, and 2g) under different airflows ranging from 0.0m/s to 5.0m/s. The power output achieved by the empty TEG under 0m/s airflow was 1.17$\mu$W/cm$^2$ while the maximum power generated by the TEG with 2g of PCM under the same airflow was 26.72$\mu$W/cm$^2$ and 6.12$\mu$W/cm$^2$ during and after the fusion, respectively. This improvement in the generated power is reported for the first time and has no precedence in the previous research.

Poster Number: 236

Powerless Microfluidic Pumping and Fluid Management for Sweat Sensing Devices
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Continual monitoring of certain health factors can be accomplished by using wearable devices. Here, a paper microfluidics device prototype is presented which is relatively inexpensive, non-invasive and operates without external power under passive sweating conditions. These powerless devices can be implemented as wearables which utilize the mechanisms of chemical potential difference and evaporation to extract and analyze sweat from the human body. The device operates by osmotic extraction using poly-acrylamide hydrogel, equilibrated with either Glycerin/Glucose/NaCl to generate a concentration greater than 0.15 M. This allows for extraction of dye (model analyte) from the model skin that we constructed, using gelatin infused with dye. Whatman filter paper is placed in between these two components, which served as the primary collection and transport medium for the dye. The movement of the dye as it wicked up the paper can be observed and modeled. Results show that our device consistently extracts dye for hours on end, regardless of its anionic or cationic nature. Furthermore, we have evidence that the device could successfully operate on human skin. Future implementations of such devices present a promising method to sense biomarkers in the human body and thus provide many opportunities for improved health diagnostics.

Poster Number: 275
Flexible Textile Electrodes for Ecg Heart-monitoring System
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Current 3M Red Dot electrodes are not ideal for long-term electrocardiogram (ECG) monitoring due to their bulky and inflexible nature. With the use of conductive textile components, wearable electrodes can be created to mimic the function of the 3M Red Dot while disguised as simple fabric patches. Conductive materials like silver thread, silver fabric, and copper fabric were all used to prototype the 5 cm by 5 cm electrode patches. Outsourced embroidered electrodes made with silver thread had inconsistent resistances between frequencies. With the use of a Brother PE-770 embroidery machine, the coefficient of friction between the thread and the plastic machine was too high, causing the thread to snap during machine operation. In response to the inconsistency produced by the use of the silver conductive thread, silver and copper fabrics were used to create patch-like electrodes. They produced resistances comparable to those of the 3M Red Dot electrodes, but lacked the stability of an embroidered patch. In order to create the perfect replacement for the 3M Red Dot electrode, further exploration is required. The next steps will include measuring the resistances of more tightly embroidered electrodes,
to see if extra thread layering and cohesiveness presents more consistency; finding a hefty interfacing backing for the patch electrodes to create stability while maintaining flexibility; and integrating the prototype electrodes with a wearable armband for testing.

Poster Number: 283

**Collecting Human Activity Data for Biometric Analysis**

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In an increasingly connected world, personal devices are allowing users to collect data from their environment and themselves. One such implementation is to detect underlying medical problems by analyzing user activity from patterns in accelerometer and gyroscope measurements. We developed an easy to use system to allow users to collect and stream data to a cloud service. The system is characterized by a wireless IMU (inertial measurement unit) sensor connected to a portable data aggregator. An MbientLab MetaMotion Bluetooth IMU was chosen due to its small form factor, sensor variety, actuators, and Bluetooth connectivity. The API was written in Python, therefore it was the language of choice for writing a script to stream data from the IMU to the microcomputer. A Raspberry Pi 3 single board computer was chosen as the aggregator platform for its Bluetooth and internet connectivity, and ability to run Python scripts. The captured data would then be sent to a cloud server for data processing and analysis to recognize patterns in activity and movement.

Poster Number: 284

**Processing Biometric Data and Extrapolating Periodic Waveforms Using Periodic Signal Processing Cleaning**

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The collection and analysis of biometric data during high levels of activity is limited by local recording on devices and variations in the recorded data. To make the data more easily accessible and more accurate to researchers, any way the data can be remotely accessed and cleaned is an aid in the research process. Using the Zephyr BioModule and BioHarness setup, biometric data (i.e. electrocardiogram, breathing waveforms, skin temperature, and accelerometer data) can be collected both locally and remotely via Bluetooth. In the greater design of the project, a Raspberry Pi is modified to actively record data from four separate sensors, with the BioModule being the primary recorder of ECG and breathing waveform data. The breathing waveform is recorded by pressure sensors attached via a harness around the torso or electrodes on the chest; however greater intensity exercise makes the periodic breathing rate less clear. Signal analysis and cleaning can be applied to attempt to determine the periodic waveform of the breathing rates from the higher activity data.
**Basic and Environmental Soil Science Training (BESST)**

**Poster Number: 42**

**Compost: How Type and Rate Affect Soil Benefits**

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Construction site activities can compact soil, resulting in increased water runoff and poor vegetation establishment. Tillage with compost amendments may offset these effects, but the amount of compost that is optimal has not been well established. This experiment was conducted to determine the effects of types and rates of compost on soil properties and vegetation establishment. Three different types of compost (food waste, yard waste, chicken litter) were mixed with a Piedmont soil (sandy loam subsoil) at rates of 2:1, 3:1, and 5:1, soil:compost, in pots. Pots planted with bahiagrass (*Paspalum notatum*) seeds were placed in a greenhouse and the grass was grown for 40 days, with periodic measurement of stem height and number of plants, and biomass at the end of the study. Water content and saturated hydraulic conductivity (HC) were determined for the soil in the pots at the end of the study. As the rate of all types of compost increased, so did volumetric water content. Soil amended with food waste compost had the highest increase in HC at rates of 3:1 and 2:1, with increases of 118% and 120%, respectively. Yard waste compost was less effective as there was no effect on HC at the rate of 5:1, and rates of 3:1 and 2:1 increased it by 35% and 55%, respectively. The chicken litter prevented grass growth and reduced HC at the rates tested. Only the effects of yard waste on grass growth appeared to be significant at rates of 2:1 and 3:1.

**Poster Number: 69**

**Comparison of NRCS Infiltration Test Method for Soil Quality with Other Procedures**

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To improve accuracy of infiltration rate measurements, methods typically involve large infiltrometers, which require a substantial quantity of water and more time and effort than small diameter infiltrometers. Intended as a simple, practical approach, the USDA NRCS Soil Quality Test Kit infiltration measurement uses a 15-cm diameter cylinder for application of 444 cm³ (equivalent to one-inch or 2.54 cm) of water. The objective of our study was to compare the NRCS method with other commonly used procedures for assessing soil infiltration. Infiltration rate was measured at three locations along a short transect at two sites by the double-ring (cylinder) infiltrometer, single-ring infiltrometer, Cornell Sprinkle Infiltrometer, and two NRCS methods using a 15-cm and a 24-cm diameter cylinder. The NRCS method is easier to perform and requires far less water than the double-ring infiltrometer method, however the 15-cm NRCS method tends to overestimate the infiltration rate in sandy soils and is less precise.

Poster Number: 85

**What the Floc? Saltwater Intrusion Induces Flocculation of Dissolved Organic Matter from Coastal Freshwater Wetlands.**

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- Julia Harrison, Matthew Stillwagon, and Marcelo Ardón

Coastal freshwater wetlands provide many important ecosystem services. It is evident that saltwater intrusion is occurring in coastal wetlands due to rising sea level and changing climate. Therefore, it is important to study how increased salinization may affect these coastal freshwater ecosystems. Coastal freshwater wetlands are important sources of carbon to estuaries and near-shore ecosystems. With this study, we examined how changes in salinity affect the process of flocculation, the removal of dissolved organic matter from the water column by coming out of solution and settling to the bottom. Water samples from multiple freshwater wetland sites around the Albemarle-Pamlico Peninsula in eastern North Carolina were exposed to a range of salinities (control, 4, 8, and 12 ppt salt), and flocculation was measured as the amount of organic matter captured with a 0.45 μm filter. Higher concentrations of salt induced XX more flocculation in all samples, resulting in higher particulates, lower turbidity, and less dissolved organic carbon remaining in the water. Salt-induced flocculation of organic matter could have important impacts on water quality and aquatic ecology of coastal regions as saltwater continues to intrude on formerly freshwater habitats.

Poster Number: 122

**An Evaluation of Intensive Management Effects on Soil Microbial Biomass and Functional Diversity**

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The effects of forest plantation management on soil microbial biomass and functional diversity can often be significant, but little is known about changes over time. We conducted a study to observe the long-term effects of management strategies used in the Southeastern Tree Research and Education Site (SETRES). This well-characterized site is a loblolly pine (Pinus taeda) stand composed of 4 treatments: control, irrigated, fertilized, and both irrigated and fertilized. Microbial biomass and functional diversity were first measured at this site throughout the early-mid 1990’s where a significant increase in microbial biomass C and N was observed in the fertilized plots while irrigation had no effect. The use of irrigation in this study was subsequently terminated in 2010. Microbial biomass was quantified with the chloroform fumigation extraction technique for total C and N. We used Biolog EcoPlates™ and FF microplates™ to quantify both bacterial and fungal microbial functional diversity, respectively. By reevaluating the effects of these management strategies exactly 20 years later we can assess the long-term effects of fertilization and irrigation in a predominately sandy soil. Understanding the soil biological impacts of intensive management in plantation forestry may help us understand long-term nutrient cycling potential. The SETRES site is scheduled for harvest, and future research projects will evaluate the changes to the microbial community.

Poster Number: 132

A High-resolution Assessment of The Impact of Floating Treatment Wetlands on Nutrient Removal
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Floating treatment wetlands (FTW) are a Best Management Practice used to retrofit existing storm water ponds for increased nutrient removal. The long-term efficacy of FTW has been reported from low resolution data (e.g., weekly), but because some removal might be associated with uptake varying with photosynthesis, it is important to capture diel concentration changes to better quantify removal kinetics. This greenhouse experiment consisted of 8 mesocosms treated with planted mats (4), unplanted mats (2), or pondwater controls (2). High resolution absorbance, temperature, and dissolved oxygen (DO) data were collected over 5 weeklong trials. Additionally, we evaluated the impact of water column mixing by turning pumps on halfway through each trial, resulting in significantly increased DO. First order nitrate removal rates were higher with FTW than unplanted mats or controls, but DO, turbidity, and Total Organic Carbon (TOC) were lower.

Poster Number: 202

Relating Physical and Chemical Characteristics to Reactivity of Biogenic Fe(oxyhydr)oxides
Author:
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Iron(Fe) transformations partially control the biogeochemical cycling of many elements, such as carbon(C), nitrogen(N), phosphorus(P), and heavy metals. In marine and freshwater environments, iron oxidizing bacteria commonly promote the oxidation of ferrous iron (Fe(II)) at circumneutral oxic-anoxic interfaces, forming mineral-organic composites known as biogenic Fe (oxyhydr)oxides (BIOS). Previous studies have examined the unique composition, morphology, and sorption reactivity of BIOS. Based on the structural consistency of the mineral phase, it has been suggested that specific surface area (SSA) and composition (Fe, C) may explain the variable reactivity of different BIOS samples. To further explore these relationships, this study utilized X-ray absorption spectroscopy (XAS) to characterize structure of samples, acid digestions and elemental analysis to determine composition, Brunauer–Emmett–Teller (BET) analysis to measure SSA, and copper(Cu) and phosphorus(P) adsorption point experiments to evaluate reactivity of BIOS samples collected in lakes and streams of the NC Piedmont. Sample composition varied widely, with %Fe and %C ranging from 13.26 – 33.70% and 3.74 -12.79%, respectively. Similarly, the sorption of Cu (initial concentration = 762.3 mmol/L) at pH = 6.0 ± 0.2 at 48 hours ranged from 399.86 - 950.89 µmol g⁻¹. Preliminary results suggest that the %Fe of BIOS has a significant positive relationship with its sorption reactivity, whereas %C does not appear to have a notable effect. Understanding the relationship between physical and chemical characteristics and reactivity of BIOS will improve our understanding of how BIOS may influence nutrient and contaminant cycling, and may lead to novel approaches for environmental remediation.

Poster Number: 207

**Determining Thermal Properties of Soil Using Fiber Optic Distributed Temperature Sensing Models in Comsol Multiphysics**

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Understanding soil water dynamics in agricultural fields is crucial for efficient irrigation management practices. The Dual-Probe Heat Pulse (DPHP) method is commonly used to measure soil thermal heat capacity and soil water content at the point scale. Typically, the heat source and the sensing probe are two short stainless-steel needles 30mm in length and 6mm apart. The thermal properties of soils are informed by the thermal response at the sensing probe. Additionally, advances in Fiber-Optics distributed temperature sensing (FO-DTS) technology provide high-resolution measurements of soil water content and thermal properties of soils at scales ranging from 0.1 to 10,000m in spatial extent using the DPHP approach in fiber optic cables. The heat pulse is applied along the metallic sheath of a fiber optic cable and the thermal response is monitored at a known distance away from the heated cable using a passive FO cable. To account for the influence of the thermal dimensions of the FO cable and non-constant spacing between cables on results are challenges to this new technology. COMSOL Multiphysics is a computational modeling software that can be used to investigate the newest FO-DTS technology in a time- and cost- efficient way. First, we investigated the feasibility of using COMSOL to model FO-DTS DPHP. Then, we used the model to investigate the effect of cable divergence on the results. We found that COMSOL’s results and the lab experiments agreed, but there is work left to be done to refine the existing models to further optimize physical experiments.
Colonization of Tomato Roots by The Soil Fungus Mortierella Elongata

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Endophytes are microbes that inhabit any part of plant tissue for part of their life cycle without causing disease. Plants may receive benefits from endophytes such as mobilization of nutrients and protection from pathogens. Mortierella elongata is a soil inhabiting saprobic fungus which decays organic matter. M. elongata sourced from eastern cottonwood (Populus deltoides) roots as a putative endophyte can increase flowering of Calibrachoa, a plant in the same family (Solanaceae) as tomato (Solanum lycopersicum). The nature of root colonization by M. elongata is unknown. The objective of this study is to determine the association of M. elongata with roots of tomato and whether the fungus forms specialized structures in or on root cells. Tomato seeds, cv. ‘Micro-Tom’, were germinated and grown for 15 days. Seedlings were inoculated with a spore suspension (10^6 spores per mL) of M. elongata isolate 624+, which harbors an endosymbiotic bacterium, or isolate 624-, which does not harbor detectable amounts of bacteria. Seedlings not inoculated with M. elongata served as the control. Tomato seedlings were harvested and subjected to microscopic examination for the first five days after inoculation and every third day thereafter. Roots of each seedling were cleared with 500 uL of 10% KOH, stained with an ink solution, and stored in acetoglycerol until examination. Confirmation of an association between M. elongata and tomato seedlings will establish that M. elongata may play a direct role in flower promotion of tomato, and further research will need to be conducted to establish a mechanism.

Relationships Between Nutrient Content, Microbial Communities, And Presence of Siderophores In North Carolina Soils

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The production of siderophores, iron chelating secondary metabolites, is thought to be an essential strategy for iron acquisition among many taxa of bacteria, fungi, and plants. However, little work has been done to isolate and characterize siderophores in situ, especially from soils. Given the importance of iron to soil organisms and soil processes, we expected to find high concentrations and diversities of siderophores in soils that are oxic and moderately basic, conditions that limit iron bioavailability. Methods for siderophore extractions were tested using 4 different extractants (H2O, MeOH, EDTA, & ethyl acetate) and 3 different soils. Spike recovery extractions were conducted in order to validate methods by adding known concentrations of siderophores to soils and then performing extractions. Metabolomic analyses of complex cultures isolated from the soils grown in iron-limiting conditions were also used to guide analysis of soil siderophore extracts. Moisture, pH, iron content, and macronutrient content were analyzed for each soil and FAME analysis was performed to characterize microbial diversity. This research presents new methods of siderophore extraction and characterization.
from soils. Our results will also illuminate connections between microbial community structure and the abundance and diversity of siderophores in different soil environments.

Poster Number: 282
**The Addition of Humic Acid to Soil Samples**
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Humic acid can act as an electron acceptor in anaerobic respiration and has been shown to reduce methane emissions from soil, however this process is not well understood. This experiment looks into the effects of the addition of humic acid at different concentrations (0.5mM, 1.0mM, and 5mM) on soil samples that have been submerged in water to induce anaerobic respiration. The experiment took place over the course of 34 days, and the gas fluxes of methane, along with carbon dioxide and nitrous oxide, were recorded. There was not a clear pattern from this data, as sometimes the methane showed an increase and sometimes a decrease in both the experimental and control groups. This may indicate that there is not a distinct correlation between the addition of humic acid and a decrease in methane emissions, but more research should be conducted in this area to gain a better understanding of these patterns.

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**BeeMORE: Bees and Microbes in Organized Research Experiences**
Poster Number: 7
**Beetles, Bees, And Systemic RNAi, Oh My!**
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The small hive beetle, (SHB), Aethina tumida, is a parasitic scavenger of honey bees and can cause significant harm to colonies. Given the importance of honey bees, we wanted to find an eco-friendly way to control their pests. RNA interference (RNAi) is the most promising new control method and is just now starting to be used in integrated pest management practices. RNAi is triggered by double-stranded RNA (dsRNA) that after processing into siRNAs can interfere with a target gene’s normal function by reducing the amount of available transcript. I use microinjection of dsRNAs targeting two SHB genes to determine the effectiveness of RNAi in SHB. Specifically, I am microinjecting dsRNAs targeting white and laccase-2 to determine baseline phenotypes using this approach. White encodes an ABC transporter known to be involved in eye pigmentation, therefore white-specific knockdown is expected to result in a white-eyed phenotype. Laccase-2 is linked to cuticle pigmentation, so knockdown of laccase-2 produces lighter-colored individuals. I am also testing for changes in transcript levels following injection of dsRNAs by extracting RNA and performing RT-PCR. We will determine if SHB is compatible with RNAi and the possibility for eventual creation of a biopesticide; this would aid the honey bee by controlling pests without the harsh use of general insecticides that are often detrimental to colony health. Once we establish baseline phenotypes and transcription levels for these two genes we will test oral
administration of the same dsRNAs since injection-based RNAi is not a practical control method in the field.

Poster Number: 43

**Growth Kinetics of Parasaccharibacter Apium Cultured in MRS Medium Containing Different Sources of Carbon and Energy**

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- Addison Collins  *Food Science* NC State University
- Leah Isenhour  *Food Science* NC State University
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Pollinators play a key role in cycling many of the world’s resources. Honey bees are among the most delicate and important of those contributors. One of the main reasons they are able to accomplish the tasks that they perform is thanks to the microbiota within their gut. *Parasaccharibacter apium* is a bacterium isolated from the gut of honey bee larvae that has recently come to the attention of bee researchers for its potential benefits to hives. When seeded to the hive, it is responsible for maintaining health and developing stronger adult colonies that can successfully carry out the tasks that make honey bees so important to the world. In order to learn more about the capabilities of *P. apium*, the bacterium growth rate was calculated when cultured in the presence of different carbon sources in De Man, Rogosa, and Sharpe (MRS) media. Since honey bee products contain a large amount of sugar, the bacterium was cultured with lactose, galactose, sucrose, fructose, and glucose as sources of carbon and energy. We evaluated which sugar would produce the highest biomass yields of the *P. apium* bacterium for future experiments. It was determined that *P. apium* grew best in MRS media with glucose as a carbon source relative to the other sugars, with the growth rate measuring 0.48 h⁻¹ and the doubling time being 1.44 h.

Poster Number: 67

**Evaluating Lignin Degradation Potential of Streptomyces Sp. Isolates From Carpenter Bees**

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Lignocellulose, which makes up plant matter and is composed of cellulose, hemicellulose, and lignin, is an important feedstock for second generation biofuels. However, the lignin fraction of lignocellulose is difficult to degrade due to its complex nature. Lignin is also a main component of black liquor, a waste stream from paper making facilities. Black liquor is estimated to contain roughly half of the energy that
is present in wood chips that are processed in paper pulping mills, and it is currently burned as a way of disposal. If this energy could be harvested into biofuels, this would represent a success in sustainability. To achieve this, three *Streptomyces* spp. isolates (1-10, 2-6, 2-10) from Carpenter bees are being investigated as potential lignin degraders. Growth rates when cultured on black liquor as the sole carbon source were determined using dry weight-based growth curves. Strain 2-6, increased by 31.8 milligrams of dry weight over a 9 day period when grown in media with black liquor. Lignin and cellulose degradation have been assessed by growing the strains with 0.2% of Biochoice lignin and ~0.07g of cellulose filter paper, respectively and determining the amount of lignin or cellulose that has been depolymerized by the isolates. 16S rDNA sequence analysis will be used to establish the mostly closely related *Streptomyces* sp. for each isolate. Further genomic testing of these strains will also reveal what enzymes are used by these organisms for lignocellulose deconstruction.

Poster Number: 97

**Patterns of Pathogen Transfer Between Honey Bees and Bumble Bees Across North Carolina**

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Bee populations play a critical role in the agricultural economy. They contribute to more than $18 billion dollars worth of crop production worldwide. However, honey bee populations are experiencing a higher-than-acceptable mortality rate, and native bees are also declining, due in large part to RNA viruses and other pathogens. Since honey bees live in a large social structure, the rate of pathogen transmission is very high. The heavy social interaction among honey bees is believed to increase the spread of pathogens to native bees when they come into contact with one another while foraging for food; this poses a sizable threat to the wider pollinator communities. Therefore, it is vital to study pathogens in bee populations. The objective of this study is to sample bumble bees (*Bombus impatiens*) and analyze potential pathogens at North Carolina Department of Agricultural research station, where habitat has been planted to support pollinators. The purpose of this project is to determine the prevalence and intensity of pathogens observed in bumble bees, in order to determine the association between the pathogens found in honey bees and those found in bumble bees. Pathogens were detected using quantitative-PCR protocol. Results of this project will be discussed in the results section. This research may explain the patterns of pathogen transfer between different bee populations. As a result of this research, we can suggest ways to prevent the spread of pathogens in bee populations in order to protect agriculture and ensure the survival of one-third of the food humans consume.

Poster Number: 131

**Forging A Connection Between Bees and Yeasts: Characterizing Candida Cellae**

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Yeasts have an important but unclear role in bee bread production, which provides essential nutrients to bees. Our experimental goal was to characterize *Candida cellae*, a new yeast species known to be associated with solitary bees in the Amazon. *Candida cellae* was studied in comparison with a similar yeast species, *Candida magnoliae*, which is also associated with honeybees. By comparing these yeasts, more information about *C. cellae* may be deduced. Biolog phenotypic characterization plates were used to assess differences in metabolic patterns between these yeast. The Biolog data thus far does not show a difference in the way these yeasts grow on different carbon and sugar sources. Fructose was not included as a sugar that the Biolog plates test; therefore, fructose spot plate assays were conducted. These assays illustrate that *Candida magnoliae* grows faster on fructose than *Candida cellae*. Color differences were observed between the yeasts: *C. magnoliae* produced white colonies, while *C. cellae* colonies were distinctly pink. Growth curves were conducted by diluting cultures and measuring their OD600 readings over time, revealing that both yeasts had an average doubling time of 134 minutes. Genetic differences between these yeasts were assessed by PCR to determine if there are differences for genes of interest, such as the GPD1 (glycerol) gene and the ER1 (erythritol) gene. The ER1 gene was amplified from *Candida magnoliae* for cloning and sequencing. Results indicate that these yeasts are metabolically similar but also have distinct genotypic differences. Future studies aim to characterize selected genes from these organisms.

Poster Number: 214

**Viral Loads in Honey Bee Larvae and Adult Honey Bees**

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Honey bees are responsible for many of the crops we enjoy in everyday life and they contribute significantly to the agricultural economy. The honey bee population is currently threatened by various environmental stressors. This project aims to pinpoint specific factors impacting honey bee health and influencing the decline of honey bee populations. During this project, I compared the viral counts of honey bee larvae and adult honey bees. The larval samples groups had been treated with a pesticide mixture at various treatment levels. I compared the larvae sample treatment groups to the control samples. No differences were observed in the pathogen loads between the larvae exposed to different levels of the pesticide mixture. The adults and larvae being used in this investigation all come from various stocks. The variation in the stocks of the groups allow for an analysis of how the exposure of different physical and chemical environments impact their viral counts. The project uses several methods during this experiment to analyze the viral counts of the groups. These methods include RNA extraction, CDNA formation, and PCR testing. This project is extremely important to the future of honey bee research because it can provide knowledge into the factors impacting the health of honey bees.

Poster Number: 220

**Investigating North Carolina Paenibacillus Larvae, The Cause of American Foulbrood in Honey Bees, And Its Bacteriophages.**
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American foulbrood (AFB) is a widespread and destructive bee brood disease caused by the spore-forming bacterium *Paenibacillus larvae*. *P. larvae* is a rod-shaped Gram-positive bacterium that infects honey bee larvae. AFB causes destruction of the hive and there are only two known treatments - prophylactic tetracycline treatment and burning of infected hives. My work involved *P. larvae* strains ATCC 9545 (the Type strain), NW6 (previously isolated from an AFB hive near North Wilkesboro, NC) and Wake2. In this project, I worked on the isolation of strain Wake2 obtained from an AFB hive in Wake County, NC. The Wake2 isolate is being characterized by 16S rRNA sequencing, with the potential for full genome sequence analysis. Bacteriophages are viruses that infect bacteria. Several bacteriophages have been previously isolated that infect *P. larvae*. Another aspect of this research was to induce phages (termed prophages) that had been identified in the genome sequence of strain NW6. Various growth conditions (temperature shifts, lighting, etc.) were used to provoke phage induction, and then measure, by plaque assays, the presence of phages in the growth medium. The ability of the induced phages to infect different *P. larvae* strains (host range) is being evaluated. These results contribute to understanding the diversity of *P. larvae* strains and their genomes, the role of phages in genome evolution and strain ecology and can potentially contribute to controlling AFB disease in honey bee hives.

Poster Number: 226

**Do Floral Traits Affect Survival of Bumble Bee Pathogens?**

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Pathogens are associated with the decline of wild and managed bee populations. Many of these pathogens are transmitted at flowers. The protozoa *Crithidia bombi* is an intestinal parasite of bumble bees (Bombus spp) that can reduce worker survival and colony development, commonly affecting commercial and wild bumble bee colonies. *C. bombi* spreads when bees defecate on flowers and a new individual makes contact with the infected faeces; however, *C. bombi* can only survive outside of its host for a limited period of time. Therefore, studying the impact of floral traits on the duration of survival is essential to understand transmission dynamics. To test the influence of floral traits and deposition location on *C. bombi* mortality, we tested four species of flowering plants that differ in floral traits in semi-field conditions. We inoculated flowers on two different floral parts (parts varied depending on the flower morphology) and monitored the number of surviving *C. bombi* cells over time. We observed that *C. bombi* degrades over time on all tested species. We also observed a relationship between *C. bombi* survival and floral traits including corolla width, petal width, and number of flowers per inflorescence. Additionally, we observed that floral traits influence the speed and magnitude of *C. bombi* degradation not only between different flowers, but also between different areas of deposition on the same flower. These results contribute to the advancement of knowledge about bee pathogen transmission dynamics and encourage the selection of plant species in pollinator gardens that decrease *C. bombi* survival.
Doomed to Die: Medea’s Impact on Embryonic Transcriptomes

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Selfish genes, or selfish genetic elements, are genes that counteract the forces of natural selection, using non-Mendelian methods of inheritance to spread through a population despite providing no advantage. The selfish element, Medea (Maternal-Effect Dominant Embryonic Arrest), in Tribolium castaneum, the red flour beetle, is widespread in natural populations, but remains poorly understood. If the mother is heterozygous for Medea, then the offspring must receive a copy of Medea (from either parent) in order to survive. Thus, Medea demonstrates its selfish behavior and perpetuates in the population. The current hypothesis for the mechanism is that Medea is a bifunctional gene, with the maternally expressed Medea acting as a toxin, and the zygotically expressed Medea acting as an antidote. In order to investigate this mechanism, RNA-sequencing was performed on late-stage embryos and newly-hatched larvae from a heterozygous Medea mother and the transcriptomes were surveyed for differences between offspring that inherit Medea and survive and their siblings that fail to inherit Medea and are doomed to die. Both Medea-positive and Medea-negative offspring were analyzed, as well as controls from homozygous lines. We found that there were several notable differences in gene expression levels. Genes that were affected include those in developmental pathways. Overall, the transcriptome of Medea-negative larvae is more similar to Medea-positive embryos than Medea-positive larvae, suggesting the maternal “toxin” may cause a delay in development that can only be rescued by zygotic expression of Medea.

Determining the Interactions and Time-resolved Occupancy of DNA Repair Proteins in Escherichia Coli

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DNA is present in all living organisms and is necessary for proper cell function. While prone to many factors that cause damage, DNA has repair pathways to fix these breaks and continue cell survival. As Escherichia coli is a widely employed model for DNA repair because of its similarity to Eukaryotic systems, E.coli repair proteins RadD and SSB were studied through various experiments in this project. SSB and RadD have been implicated to interact at the site of DNA damage and assist in the repair process. As a part of this project, RadD is being purified from E.coli bacteria and a cDNA library for use in a yeast two-hybrid screen is being created to learn about other protein interactors with SSB and RadD. The ATPase activity of RadD was also studied. The time resolved occupancy of SSB on the genome was specifically looked at to gain a better understanding of the time-scale of DNA repair. Chromatin immunoprecipitation (ChIP) followed by qPCR was conducted on SSB-FLAG samples of E.coli before inducing a double strand
break using SbcCD complex (0 min), 30 minutes after, and 60 minutes after. Although the qPCR confirmed
the presence of SSB at a damage site, to fully understand the time scale of repair, the full population of
SSB-bound DNA would have to be sequenced (ChiP-seq) and mapped to the genome. In addition to
completing the yeast-hybrid screen, future aims of this project are to conduct a ChiP-seq for SSB and
RadD.

Poster Number: 47

Differences in the Microbiome of Wild-type Flies and Files with Silenced Single-minded Neurons

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The microbiome has become an increasingly popular area of study and has been shown to have
significant effects on organismal health, metabolism, disease susceptibility, drug efficacy, and the ability
to fight off infection. Ours experiments look at the role of pathways involving the transcription factor single-minded in regulating the Drosophila microbiome, and how that may contribute to behavioral, immune, and metabolic changes. Past studies in mice have indicated that single-minded, expressed in certain neurons within the hypothalamus, plays a role in metabolic regulation and maintaining homeostasis. In mice, homozygous single-minded mutants die perinatally, while heterozygous mutants exhibit a shorter lifespan, hyperphagic behavior, and obesity. The human homologs Single-minded1 and Single-minded2 have been implicated in Prader-Willi-like phenotypes, as well as impaired brain development, possible contributions to mental retardation in Down syndrome, and craniofacial deformities, respectively. The Estes lab has studied flies with silenced single-minded neurons and found similar results. These flies are hyperphagic as larvae and live for only around 10 days, opposed to the 30-60-day lifespan typical in wild-type flies. We focused on using next-generation Illumina sequencing, plating and culturing, and common garden experiments to explore differences in the microbiome of wild-type and single-minded-silenced flies and their food, in order to determine if host-microbe interactions are affected by single-minded activity.

Poster Number: 46

The Relationship Between Health, Longevity and The Microbiome

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Single-minded plays a role in energy balance in both mammals and flies. Reduction in single-minded activity in Drosophila melanogaster results in efficient energy storage, but adult flies become inactive after 8 days. In addition, the flies are hyperphagic, obese and, ultimately, die much earlier than wild type flies. A change in the consistency of the fly food led us to investigate the flies’ microbiome. For this, we performed 16S metagenomic analysis of homogenized flies and the surface of the food. To compare the
amount of bacteria associated with wild type flies to flies with reductions in single-minded activity, we cultured bacteria derived from flies and their food. Utilizing databases of identified sequences, we compared the results to known strains associated with Drosophila melanogaster, including Lactobacillus and Acetobacter. Ultimately, the goal of the experiment was to determine the relationship between microbiome content and its involvement with energy balance and overall health.

Poster Number: 115
**Using Directed Evolution to Engineer Improved Cytokines**
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Engineering proteins is a powerful tool to address basic, translational, and commercial research needs. One powerful strategy for engineering proteins is to harness the power of directed evolution. Directed evolution relies upon stringent strategies that are able to select of a desired phenotype. Cytokines are small, soluble proteins of the immune system that bind to cellular receptors and initiate changes in cell behavior. We sought to design strategies that would select from a library of random cytokine mutations that would modulate cytokine-receptor affinity, increased cytokine expression and stability, and alter cell signaling through their cellular receptors. Each selection strategy is designed to make use in changes in fluorescent intensity of cells that allow for fluorescent activated cell sorting (FACS) of cells with the desired phenotype. Individual cell sorting then allows for recovery and identification of the genotype of the desired cytokine mutation. Interleukin 10 and interferon lambda were chosen as initial cytokines to test these strategies. However, these selection strategies are designed to be generalizable to other cytokines.

Poster Number: 120
**Identifying Conditions of Radd Expression in Escherichia Coli During DNA Repair**
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Down to the single cell level, DNA is responsible for maintaining the health and reproduction of a cell. However, when normal environmental stresses such as light, radiation, chemical exposure, or replication errors, damage the cell’s DNA, repair mechanisms must be initiated. Otherwise, the cell will die. RadD, has recently been shown to interact with SSB in the repair of DSBs, a particularly lethal form of DNA damage. Unlike most genes in the E. coli genome, transcription of the radD gene is initiated by the association of σ54 with RNA polymerase, indicating that radD is inducible under environmental stresses. It has been shown experimentally that strains lacking radD have increased sensitivity to certain conditions such as UV irradiation, ionizing radiation, or chemical agents (ciprofloxacin), which cause DSBs. Therefore, we would expect that these stressors would drive an increase in expression of radD. After applying environmental stressors that cause DNA damage and oxidative stress, reverse transcription of mRNA can be quantified using qPCR to measure radD gene expression. An alternative GFP reporter system will be designed to preliminarily screen for increased radD expression under
environmental conditions, as well as provide redundancy to strengthen results. This system will be less time intensive and less costly than the RT-qPCR experiment, permitting an effective means of screening a wide variety of environmental stressors that can then be confirmed by the more quantitative RT-qPCR system.

Poster Number: 145
Skin Microbiota Dynamics of Anadromous Striped Bass
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Knowledge of shifts in skin microbiota of diadromous fishes is important to elucidate changes in the function of the mucosal barrier during the transition between freshwater and saltwater. Striped bass (\textit{Morone saxitilis}) are anadromous fish which spawn in freshwater and migrate to saltwater and are native to eastern United States and the Gulf of Mexico. The changing dynamics of the microbiota of striped bass following the shift between freshwater and saltwater is unknown. In this project, a 16S rRNA marker gene sequencing study was performed to investigate microbial community changes on the skin of the fish during this transition. DNA was extracted from skin and subopercular swabs taken from wild fish captured off coastal Virginia, in the Roanoke and Neuse Rivers of NC, and from cultured fish in either flow-through or recirculating systems and prepared for sequencing. The resulting sequences were analyzed using the microbiome analysis package QIIME2. There was no difference in microbial community diversity between swabs taken from the skin or under the operculum of the fish (p

Poster Number: 197
Evaluating the Use of RAD-seq Data to Characterize Metagenomic Communities
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RAD Sequencing produces large quantities of genomic data which provide the opportunity to identify symbionts. We attempted this approach using double digest RAD-seq data for over 600 \textit{Pieris rapae} individuals from across the world. \textit{Pieris rapae}, commonly called the cabbage white butterfly, originated in Europe and Asia and has spread invasively throughout the globe, resulting in many pockets of genetically different populations. We evaluated what patterns could be observed from the metagenomic RAD-seq data of these distinct populations. We used sequences that did not map to \textit{Pieris rapae} as the data for its metagenomic communities and blasted these sequences to the NCBI database, keeping only the resulting hits with at least 97% identity. We used the identified genera to create OUT tables and NMDS ordination plots to assess how the data clustered according to factors including sex, population, and preservation method. We found that preservation method appears to have a strong effect on metagenomic community. We observed slight differences in the metagenomic communities of different populations but saw no clear difference in the metagenomic communities of males and females. We
concluded that using metagenomic analyses of RAD-seq data to answer community ecology questions should be exploratory as only large differences are detectable. Our results further suggest that specimens not stored in preservative may be highly problematic because their metagenomic communities are altered. It is critical to identify the biases that are clearly present in RAD-seq data before it is used to answer metagenomic questions.

Poster Number: 198

Evaluating the Use of Radseq To Screen for Endosymbionts

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RADseq is widely used in experiments often for generating genomic data for focal taxon. Given that RADseq data also contains metagenomic data, there is an opportunity to screen for endosymbionts. We focused on Wolbachia, one of the most widespread bacterial endosymbionts, which is estimated to infect over half of Arthropoda. We used an existing RADseq data set that was generated for Pieris rapae to distinguish between known P. rapae sequences and possible endosymbionts. We used ddRAD sequence data from 649 individuals; the sequences that didn’t map to the P. rapae genome were blasted to the NCBI database. The genera of sequences with a pident of 97 were then identified using R taxize. We identified 9.24% of individuals as infected with Wolbachia, which is significantly lower than expected; these results can be confirmed through future Sanger sequencing. We concluded that a lack of sequences may have led to false negatives. A better estimate of the rate of false negatives may be determined through more targeted sequencing.

Poster Number: 211

Use of Activity-based Protein Labeling to Detect Monooxygenases in Pure and Mixed Bacterial Cultures

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Bacterial monooxygenases catalyze many environmentally important reactions that range from initiating catabolism of volatile organics through to fortuitous biotransformation of environmental pollutants. In this study we have used a novel activity-based labeling technique to detect the diversity of monooxygenases expressed by bacteria that can grow on gaseous hydrocarbons. Our initial studies focused on the detection of bacterial monooxygenases in undefined mixed cultures. A series of soil samples were obtained from local sources. The soils were incubated with C1-C4 alkanes and the consumption of each gas was monitored by gas chromatography. Once active gas consumption had been established compared to abiotic controls, a probe (1,7-octadiyne [17OD]) was added to inactivate the monooxygenase enzymes expressed by the native bacteria. Intact cells were then obtained using Nycodenz density gradient centrifugation. The extracted cells were then conjugated with AlexaFluor 647
azide using a copper-catalyzed alkyne/azide cycloaddition (CuAAC) reaction. The resulting labeling patterns were then determined by analyzing total cell proteins using SDS-PAGE and NIR scanning. Our studies of pure bacterial cultures used a similar approach and focused on the versatile gaseous hydrocarbon-metabolizing bacterium Mycobacterium chubuense NBB4 which grows on C2-C4 gaseous alkanes and alkenes. Overall our results demonstrate that activity-based labeling is a powerful approach for detecting monooxygenase enzymes in both well-defined and mixed microbial cultures. While our experiments involving soils have highlighted issues associated with gas sampling and cell recovery, our studies with pure cultures of strain NBB4 have demonstrated this strain expresses several different monooxygenases during growth on gaseous alkanes and alkenes.

Poster Number: 233
Expression of Carbon Fixation Pathway from Metallosphera Sedula in Extremely Thermophilic Caldicellulosiruptor Bescii to Produce 3-hydroxypropionate

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Extremely thermophilic microorganisms have potential applications in industrial processes because of their ability to thrive at high temperatures (>70°C). Most interestingly, extreme thermophiles can perform as biocatalysts in the degradation and utilization of complex substrates and be metabolically engineered to heterologously produce chemicals and proteins of interest. The goal of this study is to produce 3-hydroxypropionate (3-HP), a molecule with potential applications in polymers and chemical synthesis intermediates, in Caldicellulosiruptor bescii (T_{opt} = 78°C) based upon the 3-HP/4-HB carbon fixation cycle genes natively found in Metallosphera sedula and related thermoacidophilic archaea. Due to the number of segments required, a Gibson assembly was performed in two separate vectors for later assembly. The first vector contained the genes for expressing acetyl-CoA carboxylase (ACC) that converts acetyl-CoA to malonyl-CoA via the addition of CO₂. The second vector contained genes for malonic semialdehyde reductase (MSR), malonyl-CoA reductase (MCR), and biotin protein ligase (BPL). The genes were then assembled into a C. bescii kanamycin resistant replicating vector with a strong constitutive promoter in front of the ACC operon for high level expression. A second constitutive high strength promoter was placed after the ACC in front of the second set of genes to ensure further high-level expression of MSR, MCR, and BPL. The current direction of this study is to transfer the genes into a C. bescii vector and then transform it into C. bescii before assessing the production of 3-HP.

Poster Number: 234
Using Directed Evolution to Understand HSV Fusion Proteins

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In order for viruses to infect a new host, they must first penetrate the cell membrane of a host cell. Alphaherpesviruses, including Herpes simplex virus (HSV-1), use four entry proteins to fuse the viral and cellular membranes to invade a cell. Binding of glycoprotein D (gD) to either of its cellular receptors, nectin-1 and HVEM, initiates membrane fusion by triggering glycoproteins B, H, and L (gB, gH, gL). The mechanism of how gD-receptor binding triggers the other fusion proteins is not completely understood. The closely related porcine alphaherpesvirus, Pseudorabies (PrV), encodes homologs of the four HSV-1 entry proteins. PrV gD, like HSV-1 gD, binds to nectin-1. Despite this, HSV-1 gD cannot functionally substitute PrV gD. We hypothesize that the region of gD that interacts with the other entry glycoproteins is not conserved between HSV-1 gD and PrV gD, which have only 30% amino acid identity. In order to identify the region of gD that interacts with the other entry glycoproteins, we created a library of mutant HSV-1 gDs on the background of a gD-null PrV. In the absence of gD, PrV does not produce extracellular virions. By monitoring for the recovery of extracellular virions, we hope to identify HSV gD mutants that have gained the ability to interact with PrV fusion proteins, and ultimately identify regions of gD that interact with the other entry glycoproteins.

Poster Number: 248

**Elucidating the Genetic Determinants and Pathway of Metal Biooxidation in Extremely Thermoacidophilic Archaeal Species**

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The order Sulfolobales is composed of extreme thermoacidophilic archaea that subsist at high temperatures (>70 °C) and acidic pHs (*Metallosphaera prunae* and *Metallosphaera hakonensis*), that possess the known and hypothetical biooxidizing determinants, have a reported history of biooxidation, and yet fail to reproducibly oxidize metal species in laboratory cultures. In both cases, we are utilizing transcriptomics of these “fox” genes in order to establish which genetic determinants are essential to the iron biooxidation process. In light of the proteomic data available, we are also expressing proteins in order to characterize their activities and potentially reconstruct the biooxidative process *in vitro*.

Poster Number: 249

**Developmental Disruption of Norepinephrine Neuron Firing Impacts Embryonic Brain Development and Subsequent Behavior** Casey Baird¹*, Erin Dancy¹*, Clai

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Norepinephrine is a neurotransmitter that is synthesized by a group of specialized neurons in the brain. Norepinephrine neurons play a vital role in behaviors such as attention, learning, and memory in adult animals. Disruption of this system has been implicated in developmental disorders, including autism. However, the contribution of this system to the development of the embryonic brain is poorly
understood; mostly due to a lack of tools for disruption of norepinephrine neurons embryonically. Our research uses a chemogenetic mouse model to express DREADDs (Designer Receptors Exclusively Activated by Designer Drugs) in a subset of norepinephrine neurons and manipulate their activity during critical periods of brain development. Previous work revealed that this aberrant activation of norepinephrine neurons from embryonic day 12 (E12) to postnatal day 10 resulted in behavioral deficits in adulthood and a significant decrease in whole brain volume in female mice. To understand how overactivation of the norepinephrine system impacts embryonic brain development, mice were treated from E12 to E15, before being measured for cortical area, thickness and length at E15. E15 is a critical period of brain development when neuronal differentiation and migration is occurring. We hypothesize that cortical thickness and area will be reduced in female DREADD mice, due to increased apoptosis during embryonic development. Our results show that there is a decrease in the cortical area of DREADD mice. In the future, we will genotype our embryos, analyze our data by gender, and perform a TUNEL stain to assess apoptotic cells.

Poster Number: 254

Delftia Spp. As A New Genetic Source for Bioproduction Of Polyhydroxyalkanoates

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Polyhydroxyalkanoates, or PHAs, are a diverse class of polyesters used in the production of bioplastics. These plastics are biodegradable and can be sustainably produced from waste streams from other industries, such as paper mills. Bacteria widely produce PHAs under nutrient-limiting conditions. This project focuses on the poorly characterized strains Delftia acidovorans ATCC 13751 and Delftia tsuruhatensis BAA 554. The aim was to determine if the two strains are capable of synthesizing PHAs and whether their genomes encode genes associated with PHA production found in other strains or species of bacteria. Biolog phenotypic characterization plates were used for screening what conditions and carbon sources yield growth of these D. tsuruhatensis and D. acidovorans strains. Compounds and conditions commonly found in paper mill effluent were especially noted. Genomic DNA was isolated and purified from D. acidovorans and D. tsuruhatensis, and BLAST was used to design primers to amplify the phaA, phaB, phaC genes involved in PHA production. Current experiments seek to determine the presence of phaA, phaB, and phaC genes in these strains through PCR and gel electrophoresis, as well as high-throughput screening of numerous conditions for PHA production using staining and ultraviolet fluorescence detection of PHAs. These D. tsuruhatensis and D. acidovorans strains may be used to produce PHAs in an industrial or ecological/waste remediation setting in the future.

CASL REU (Nuclear Engineering)

Poster Number: 9

Constant Peak Power During A Neutron Cycle

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To improve the efficiency in nuclear power production, there were many different simulation of codes running to see which position would work best during a neutron completion cycle in a reactor that would have a greater chance for the peak power to stay constant for a period of time without having an interference within it. The two poison that were used was Gadolina and IFBA. Some codes was ran with all fuel rods with either coated with Gad (gadolina) or IFBA: and the other codes had a mixture of both Gad & IFBA but on different fuel rods in different arrangements. Every cycle had a depletion of -60.00sec; which gave more points or positions to plot on a graph. The project results show that when there is an increase of IFBA and a small portion of Gad mixed together in a fuel assembly the peak power stays constant. These results will help to try to extend the life of the reactor and enable future increases in operating power.

**Comparative Medicine (CMI) Summer Interdisciplinary Research Initiative (CMI SIRI)**

Poster Number: 10

**Effects of PH Change on Extracellular Vesicle Size Distribution**

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Extracellular vesicles (EVs) are small, membrane bound carriers that play important roles in cell communication. They are categorized as exosomes, microvesicles, or apoptotic bodies based on their size, contents, and method of formation, and they are released from most known cell types. Apoptotic bodies, the largest of the three EV subtypes, contain debris from dying cells and are easily identifiable markers of cell death. It is believed that the biochemical information carried by EVs may be good a indicator of cell health, and that the size and type of EVs from stressed cells would differ from those of healthy cells. To test this, porcine fetal fibroblast cells were stressed by altering the pH of the growth media, and the media containing the resulting EVs was collected at 12 and 24 hours. Cells were grown in DMEM (Corning) with 1% penicillin and streptomycin with or without 15% FBS at 37°C and 5% CO2. pH was altered by adding NaOH or HCl dropwise to reach final readings of 6.35 and 8.35, with a control pH of 7.35. Media was collected from each sample and Malvern Panalytical NanoSight NS300 was used to analyze the size and concentration of EVs. Continuing to characterize the distribution of size and subtypes of EVs released from cells under stress will allow for better assessment of cell health.

Poster Number: 14

**Developing Exosomes as a Mediator for CRISPR/Cas9 Delivery**
CRISPR/Cas systems present a powerful gene-editing tool with the potential for widespread therapeutic use, however current methods of *in vivo* delivery such as Adeno Associated Viruses (AAV), may stimulate an immune response. The reduced effectiveness of AAV based delivery creates the need for an alternative for delivery of CRISPR/Cas9. Exosomes are small vesicles that are released by cells and serve as a delivery system for RNA, proteins, and various molecules to other cells. The focus of this project was to use exosomes as a delivery system for Cas9, exploiting their ability to avoid the immune system *in vivo* and their high uptake by target cells. Exosomes were isolated from porcine fetal fibroblasts using centrifugal filtration and characterized using transmission electron microscopy, NanoSight, Western blot and a dye uptake assay. Exosomes were loaded with Cas9 using sonication, incubation with Saponin, or extrusion, and efficiency was analyzed by Western blot. Sonication yielded a 16.7% loading efficiency, incubation with 0.6% Saponin yielded a 19.2% loading efficiency, while loading with extrusion was undetectable. The loaded exosomes were then delivered to H2B-GFP cells, with the Cas9 targeting GFP. Cells were evaluated for loss of fluorescence by flow cytometry and DNA sequences were evaluated for indels using TIDE software. Overall, the clinical impact of *in vivo* delivery of CRISPR/Cas9 via exosomes is significant as Cas9 could be targeted to destroy critical genes in tumor cells and used to treat many congenital genetic diseases including Sickle Cell Anemia and Duchenne Muscular Dystrophy.

Poster Number: 20

**The Development of a Three-dimensional In vitro Model of Mast Cell Neoplasia**

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Preclinical drug development for canine mast cell tumors (MCTs) is difficult due to the biological and clinical diversity of these diseases. Mutations in the proto-oncogene *c-KIT* cause activation of the receptor tyrosine kinase KIT, leading to neoplastic mast cell growth in the skin, gastrointestinal tract, and bone marrow. Currently, *in vitro* models and mouse models do not accurately represent the highly variable tumor cell growth that naturally occurs in canine disease, making it difficult to develop new therapeutic strategies. We have developed a three-dimensional (3D) *in vitro* model to study mast cell neoplasia, using extracellular matrix (ECM) hydrogels from decellularized porcine dermis and the canine...
mast cell line HRMC, derived from a dog with MCTs. We hypothesize that culturing HRMCs within a tissue-specific 3D structure will influence cell behavior, leading to more accurate representation of tumor cell growth in vivo. We confirmed expression of the KIT gene and protein using PCR and flow cytometry, respectively. Histochemical staining, alamarBlue, PicoGreen, and LIVE/DEAD viability assays were used to analyze cell survival and proliferation. In comparison to control gels made from collagen, cells in ECM hydrogels had elevated rates of proliferation and indices of malignancy. We found good cell viability in hydrogels between 24 and 72 hours, indicating that these time points would be optimal for future mast cell phenotype experiments. Our results suggest that this model mimics MCTs in vivo, and is therefore a useful tool for the development of new therapeutics for mast cell neoplasia.

Poster Number: 22

**Engineering Fibrin Nanoparticles That Combat Bacteria Within Wound Associated Biofilms**

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Chronic non-healing wounds affect on average 6.5 million Americans and cost over $25 billion in treatments and wound management. In certain patients the inability of blood to clot and barriers to tissue regeneration delay the rate of healing/dermal wound closure. Infections in a wound bed further complicate the healing process requiring painful treatment options. Current treatment methods include the use of fibrin sealants that separately provide fibrinogen and thrombin that clogs the wound zone and provide a protective cover. My research aims to create fibrin nanoparticles that preserves fibrin functionality at wound zones, supplemented with bacterial biofilms to enhance dermal wound healing and simultaneously prevent bacterial contamination. My work offers an optimized protocol on the synthesis of fibrin nanoparticles. DLS, CryoSEM and AFM studies suggest that an increase in working concentration of fibrinogen resulted in an increase in fibrin size. Concentrations of 1mg/ml, 2mg/ml, 5mg/ml, and 10mg/ml were tested and resulted in sizes of 656.1±699.68nm, 836.18±1219.76nm, 857±1064.79nm, and 901±418.1nm respectively. My research also investigated the drug loading and release capability of fibrin nanoparticles with antibiotics and dextran labeled proteins. The functional validity of fibrin nanoparticles loaded with ampicillin was tested by measuring the growth curve of E.Coli in the presence of these particles. 10mg/ml lyophilized FBN was separately soaked with 1X, 2X, and 20X ampicillin and showed a dosage dependent effect on the growth of E.Coli. I conclude that FBN works as a carrier for antibiotics and has the potential for controlled/sustained release of biotherapeutics into a wound zone.

Poster Number: 37

**Comparing Pain and Severity Outcomes in Two Induced Models of Osteoarthritis in Young and Aged Rats**

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Recent rises in pediatric anterior cruciate ligament tears have resulted in more young patients with chronic knee pain associated with osteoarthritis (OA). We investigated the age-dependent progression of OA *in vivo* using young (*n* = 6 48 days old) and mature (*n* = 6 107 days old) Sprague-Dawley rats. OA was induced via intra-articular injection of monoiodoacetate, or surgical induction involving transection of the cranial cruciate ligament and destabilization of the medial meniscus. We hypothesized that OA would progress more severely in the younger population following mechanical injury. Catwalk Gait analysis, hind limb loading, quantitative sensory tests (QST), Open Field Analysis (OFA), and lameness score were used to assess pain and changes in mobility. After 6 weeks the animals were euthanized and stifles were collected for MRI and histopathological staining. We incorporated magnetic resonance imaging as a novel tool for morphological characterization of cartilage lesions in both models. Images were masked and quantitatively assessed for damage using 3-D models. In the aged population, both the surgical and chemical models had decreased sensitivity to the cold thermal test. Considering the young population, in comparison of D9 and D16, there is a statistically significant decrease in response latency to thermal tests, suggesting the onset of hyperalgesia. During OFA, a significantly larger distance was traveled at the end of the study compared to baseline, suggesting habituation to the injured limb and anxious behaviors. Through comparison of imaging and clinical metrics, we hope to help devise a quantitative method of non-invasive diagnosis of OA severity.

**Poster Number: 60**

**A Translational Model for Canine Hereditary Ataxia in Drosophila**

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Hereditary ataxia is a category of diseases that primarily affect the movement ability of organisms due to the cerebellar or spinocerebellar dysfunction, and includes an autosomal recessive cerebellar degenerative disorder found in purebred canine breeds. The movement impairment is usually exhibited as the organism ages. A glutamine to proline amino acid substitution (Q38P) in the Rab24 protein, was identified in Old English Sheepdogs and Gordon Setters with canine hereditary ataxia. Rab24 is a small GTPase that regulates intracellular protein trafficking. Transgenic fly models that expressed this mutation were established using the UAS-Gal4 system with elav-Gal4 as the neuronal-specific driver line. We drove expression of both the wild-type Rab24 gene and the mutant [Q38P] Rab24 gene specifically in the neurons of the fly using this system. Phenotyping was performed on the Drosophila model by subjecting the flies to a climbing assay at different ages to quantify the ataxia. The normalized values were compared to the background control strain. RNA sequencing will be performed to identify genes that are perturbed due to expression of canine-Q38P-Rab24. The candidate genes and pathways that we identify could potentially be used as novel therapeutic targets for disease treatment or prevention.
Environmental Factors Affect Transcription Levels of Various Genes in Rifampicin Resistant Escherichia Coli

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For pathogens, antibiotic resistance can cause trade-offs in fitness; specifically, resistance to rifampicin, a drug which targets bacterial RNA polymerase, leads to reduced fitness. Using RNAseq data of E. coli isolates collected during inoculation trials of a currently running study of transmission in feedlot cattle, we investigated the changes in gene expression which may suggest potential mechanisms and tradeoffs involved in acquired rifampicin resistance, as well as the effect of environmental conditions on. We compared gene expression of isolates collected before and after acquisition of rifampicin resistance to determine genes correlated with rifampicin resistance. Then, to investigate compensatory adaptations and stability of the resistance, we compared these samples to isolates collected from the pen surface later in the study, as well as an isolate grown in the lab. We found a number of genes that were consistently differentially expressed between single and dual resistant strains involved in purine synthesis. Furthermore, we found expression changes in various pathways, including the iron acquisition pathway, that persisted in the pen surface samples, but not in the lab-grown end-of-season sample. More changes in expression were retained in the pen surface samples in contrast to the end of season strain, potentially indicating that environmental conditions exert more influence on bacterial evolution than the costs of antibiotic resistance.

A Translational Model for Feline Hypertrophic Cardiomyopathy Using Drosophila

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Hypertrophic Cardiomyopathy (HCM) is the leading primary myocardial disease that is affiliated with thickening of the left ventricular myocardium, arrhythmias, and dyspnea. Symptoms of HCM are usually unapparent, causing unexpected death, especially in athletes. HCM arises from mutations in genes that encode for sarcomeric proteins in cardiac muscle. HCM has been traced to mutations in the MyBPC3 gene in felines and humans. In felines, it commonly affects the Maine Coon and Ragdoll breeds, being the most frequent heart disease in cats. The two MyBPC3 gene mutations that occur are A31P and R820W, respectively. Understanding the disease etiology would help prevent or treat HCM in felines and athletes. To map the disease etiology, we used the UAS-Gal4 system in Drosophila as a cardiovascular model. We generated Drosophila UAS-MyBPC3 transgenic lines that were crossed to a heart-specific driver line (TinC-Gal4) to drive expression of MyBPC3 (wild-type and variants) in the progeny. We assayed the progeny to assess their cardiac stress responses using larval heart-rate assays and an intense exercise regime in adult flies. We observed significantly increased heart-rates in larvae that express A31P and
R820W variants compared to the wild-type MyBPC3. MyBPC3 lines post-exercise were most exhausted and did not perform well, indicating that cardiac stress affects motor functions and may dysregulate various genetic networks. This data provides evidence of the effect of the A31P and R820W MyBPC3 variants on cardiovascular health. Transcription profiling experiments may reveal novel genetic therapeutic targets for the prevention or treatment of HCM in cats and humans.

Poster Number: 180

**Exploration of The Immunomodulatory and Anti-inflammatory Properties of Bio-ply in an Infectious Arthritis Model**

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Infectious arthritis is an emergency situation that affects many horses and frequently ends in lameness or euthanasia. The key effector cells in joint infections are chondrocytes, synoviocytes, and neutrophils. Synoviocytes and chondrocytes will be cultured together to study communication between these cells during bacterial challenge. Additionally, we will measure their change in response after treatment with a novel biologic derived from platelets (BIO-PLY, patent pending). The conditioned media from these co-cultures will be incubated with neutrophils to study the host cell interactions during infectious arthritis. Our lab has shown that several bacterial species, including *Staphylococcus aureus*, form free-floating aggregates, termed biofloats, within joint fluid which possess significant antimicrobial recalcitrance and immune tolerance. BIO-PLY has been shown to dispel biofloats, restore antimicrobial efficacy, and reestablish immune cell function. After co-cultures are infected with *S. aureus* and treated with BIO-PLY, qPCR will be used to determine each cell type’s transcriptomic change, respiratory burst and phagocytosis assays will be performed to analyze neutrophil function, and the co-culture supernatant will be analyzed for cytokine composition. We hypothesize that the *S. aureus* biofloat infection will decrease the NLRP3 inflammasome, decrease neutrophil functionality, and increase synoviocyte inflammation resulting in toxicity to chondrocytes compared to a planktonic infection. Additionally, we speculate that BIO-PLY will restore immune cell efficacy while imparting chondroprotection. The objective is to characterize the communication between the host and microbe during a biofloat infection and validate the use of BIO-PLY as a treatment for infectious arthritis.

Poster Number: 185

**Investigating Endothelial Cell and Intestinal Stem Cell Interaction and Expression During Hypoxia**

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The role of hypoxia, or low oxygen, on endothelial and epithelial cells is relatively well understood when in separate environments, as endothelial cells are known to undergo the process of angiogenesis to seek new sources of oxygen, while intestinal epithelial cells differentiate to specialized roles. However, cellular interactions and genetic expression are not well understood in co-culture environments. Identifying
endothelial and epithelial cell responses to hypoxia in co-culture can provide better insight into how oxygen levels influence cell to cell communication during intestinal ischemic injuries. Information on genetic expression and cellular interactions can then be applied to treatment and recovery methods for intestinal injury and diseases. Using human umbilical vein endothelial cells (HUVECs) and primary murine intestinal epithelial cells, monocultures and co-cultures have been grown in normoxic and hypoxic induced environments. Sensors embedded within HUVEC seeded collagen hydrogels provided information on oxygen levels over 24-hour experimental periods. Following the 24-hour normoxic or hypoxic period, cell seeded hydrogels were removed for RNA lysis and RT-qPCR to measure relative genetic expression. Target genes of interest within this experiment were Hypoxia Inducible Factor 1-Alpha (HIF1A) a cellular response regulator, Vascular Endothelial Growth Factor Alpha (VEGFA) a signal protein for blood vessel formation, and BNIP3, a programmed cellular death protein. Thus far, expression of HIF1A, VEGFA, and BNIP3 have been higher in hypoxic HUVECs.

### Food Science Summer Scholars

**Poster Number: 18**

**Enhancing Learning Through Virtual Reality Microlessons**

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We designed a mini lesson to teach food science students about the risks of cross contamination and how to prevent it. The lesson includes a pre-quiz and post-quiz, one infographic, two instructional videos, and is based in a 360° virtual reality setting. From our research, we predicted that by teaching three small concepts through different media, our students would increase their knowledge and understanding of cross contamination by a statistically significant amount. Many studies done by Ian Young have determined that learning is retained in simulations (2016). We determined if our lesson was effective by administering a pretest and post test and comparing the results. We conducted a paired t-test to determine if there is a difference. Our null hypothesis is there is no difference between pre- and post-test results. Our alternative hypothesis states there is a difference between pre- and post-test results.

**Poster Number: 99**

**Assessing the Impacts of Simulated Organic Versus Conventional Farming Treatments on Peanut Composition in High Oleic Cultivar**

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Organically produced foods - including peanuts which are noted for their high nutritional impact, low price, and pleasing roasted flavor - are increasing in popularity in the U.S. Production of organic peanuts has been limited by on-farm challenges of tackling pests, weeds, and disease, as there are USDA restrictions on the use of the conventional, synthetic treatments. There are also questions as to quality differences among organic versus conventionally grown crops. This study evaluated the impact of various
farming treatments on peanut composition. Peanuts of a high oleic, Virginia-type cultivar ('Sullivan') were grown under twelve modified treatment conditions, including conventional and simulated organic, at two research stations in Eastern North Carolina. After harvesting, samples were sorted by size, and sound mature kernels were analyzed for oil content, fatty acids, tocopherols, and sugars. Compositional differences across treatments were found to vary by location, but for both locations, conventional and simulated organic peanuts were not found to be significantly different from one another (p > 0.05 for all measured values). These results suggest that organic production methods have minimal impact on peanut composition.

Poster Number: 133
**Dairy Food and Microbiology Micro-lessons**
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The field of education is always evolving, with instructional designers and teachers continually finding new ways to convey information. A novel concept in the field of education is the “micro lesson,” an informal tool with created, curated, or crowdsourced information compiled to teach a topic in less than five minutes. Things like videos, infographics, or newsletters are common examples of micro lessons that are most often utilized in corporate settings to train employees or maintain office culture. Subjects such as biology and chemistry are commonly taught at introductory levels in a university setting, and thus there is a breadth of material for reuse on these topics. Food science is a small field, so classroom resources are lacking. There is a need for food science educational materials for professors to utilize in classrooms across the country. We hypothesized that the micro lesson format would allow introductory food science students to identify and recall simple concepts. If our hypothesis proves true, micro lessons would be an efficient and easily adapted tool for food science professors across America. For this study, we designed three micro lessons, combined with a pre- and post-test to gauge efficacy. The micro lessons were distributed to food science undergraduates to demonstrate how they might impact learning and engagement of the target audience.

Poster Number: 136
**Using Virtual Reality as a Training Tool for Effective Sanitation in Commercial Breweries**
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The objective of this project was to create a game-based virtual reality (VR) simulation to teach effective sanitation and hygienic equipment design in commercial breweries. This endeavor was supported by the USDA and Alpha Chemical Company. The number of craft breweries in the United States is increasing at a fantastic rate, with nearly 1,000 opening in 2017 alone. Along with this growth arises the issue of whether or not these incoming brewers have the proper knowledge of cleaning and sanitation of their facilities, and familiarity with the new demands of the Food Safety Modernization Act (FSMA). Craft brewers come from a variety of scientific and non-scientific backgrounds and their preconceived notions
of sanitation are not always the best practice. Most of the misconceptions derive from the false analogies that some craft brewers create between homebrewing and commercial brewing. Our project was designed to instill attitude changes towards sanitation by incorporating virtual reality simulations of a brewery, and several education mediums that address the most common common knowledge gaps on cleaning and sanitation in the workplace. The primary focus of the material is on the proper use of chemicals. We also incorporated a point system within the instructional quizzes that keeps users engaged. By using a Likert Scale prior and after their walkthrough of the module, we identified their changes in attitude towards several topics. Our educational program will be accessible through a computer or tablet. All of the resources and lessons will remain available to the user after completion.

Poster Number: 221

**The Use of Hemp Roots as Possible Means of Reducing Inflammation.**

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The activation of glial cells and neuroinflammation play a major role in the central nervous system response to centralized pain. Attenuating neuroinflammation may also help to determine possible therapeutics for neurodegenerative diseases such as schizophrenia or multiple sclerosis. This study investigates the anti-inflammatory properties of hemp roots, a historically documented therapeutic to inflammation that is widely ignored in modern medicine. Two hemp (*Cannabis sativa*) varieties selected either for their high cannabidiol (CBD) or fiber content, were subjected to bioactivity-guided fractionation to determine bioactive hemp constituents responsible for its anti-inflammatory effects. Inflammation was induced in HAPI microglial cells by exposing them to lipopolysaccharide (LPS) and subsequently treating the cells with different doses of crude extracts, fractions, and pure compounds isolated from hemp roots. Griess reaction test (nitric oxide production) and a qPCR analysis were performed to quantify the anti-inflammatory effects of hemp bioactives and identify the molecular signaling pathways that modulate anti-inflammatory responses. High and mid-range hydrophobic fractions of hemp roots showed strong suppression of inflammation by reduction of nitric oxide production and down regulation of three key pro-inflammatory genes (Cox 2, IL-6 and IL-1b). While some of this activity could be attributed to CBD, a bulk of the activity associated with yet unknown constituents of these fractions. As little is still known about the chemical composition of hemp roots, the specific compounds attributed to their anti-inflammatory responses should be further investigated. The successful suppression of inflammation indicates a potential for future medicinal and therapeutic applications of the hemp root.

Poster Number: 224

**Establishing A Physical and Chemical Profile for Colombia Coffee Beans at Multiple Roast Levels**

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This research sought to take an in-depth look at the chemical and physical changes that Colombia coffee beans undergo as roast level progresses from unroasted to dark roasted coffee. Green Colombia coffee beans were light, medium, and dark roasted. Roast levels were correlated to Agtron values of 80, 60, and 40, respectively. Time/temperature profiles, densities, moisture contents, and L*a*b* and Agtron values were obtained for each roast level, whole bean and ground. Unroasted, light, medium, and dark roasted bean extracts were then analyzed for caffeine and chlorogenic acid (CQA) content, total phenolic content, and total antioxidant content. Bean density and Agtron value decreased as roast level increased. The moisture content of the beans generally decreased as roast level increased. However, the medium roast beans had a lower moisture content lower than the dark roast beans, 0.68% and 1.25%, respectively. Antioxidant and total phenolic content was highest in green coffee beans and decreased as roast level increased. Of the roasted coffee, the light roast had the highest total antioxidant and phenol content, as well as the highest concentrations of caffeine and chlorogenic acid. This study successfully developed a detailed report on the physical and chemical characteristics of roasted and unroasted Colombian coffee beans. Future studies would compare the data obtained during this study to data obtained from analyzing faded Colombia beans. This would work to develop a deeper understanding of the chemical (specifically non-volatile chemical) and physical changes that contribute to quality degradation in green coffee beans over time.

Poster Number: 237

**Mountain Spinach: A Superior Plant-based Protein Source**

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Increased protein intakes and supplementation have exceedingly been focused on promoting muscle strength and enhancing weight reduction in the general population regardless of their age or athletic status. While dietary protein is available from many animal and plant sources, its quality varies significantly based on the origin and industrial processing. Mountain spinach, also known as orach (*Atriplex hortensis*), is a traditional green leafy vegetable native of Europe and Siberia that produces high levels of leaf proteins with a well-balanced amino acid composition. In this study, we developed an efficient, inexpensive method for isolating mountain spinach leaf protein, which is superior to other vegetable proteins in its quality (PDCAAS of 0.88-0.92) and in vitro digestibility (0.90-0.92). The amino acid analysis revealed that its protein has a balance similar to that of animal origin, with a combined lysine and methionine content of 29.54-30.72 mg/g protein. Overall, leaves from this plant contained 9.77 g protein/100 g fresh weight, and produced both green and beige protein concentrates that contained 1.58 g protein/100g centrifuged pellets and 22.06 g protein/100g beige protein concentrate, respectively. The results have proven that mountain spinach can be used as a nutritious, alternative source of plant-based protein. Future research should aim to determine its biological, functional, and gustatory properties for effective incorporation into advanced nutrition protein products.

Poster Number: 268

**Fluorescent Protein Tagging Listeria Strains to Allow Ease of Survivability Testing**
Author: Duncan Matthews Microbiology NC State University

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Listeria monocytogenes is one of the only species of Listeria to effect humans. The purpose of this experiment is to barcode various sequences of Listeria monocytogenes, and to add a fluorescent protein tag to each barcoded strain so that the strains can be easily identified by which color they fluoresce under UV light. Each barcoded strain will have a different color fluorescent tag, so that there are no repeating colors. Each strain can be sequenced to see the specific barcode, which will allow researchers to know exactly which strain of monocytogenes has the highest survivability on specific food and media types, compared to other strains. The strains used in this experiment are F2365, 2014L-6695, 2014L-6680, and 2014L-6268. F2365 is an isolate that caused the Jalisco cheese outbreak in 1985, 2014L-6695 and 2014L-6680 were part of the 2014 caramel apple outbreak, and 2014L-6268 was from the 2014 stone fruit outbreak. So far, we have successfully barcoded 2014L-6695 and 2014L-6680 through electroporation with PTZ-200. The barcodes were confirmed using PCR and Genewiz sequencing. We tested multiple colonies from both 2014L-6695 and 2014L-6680. The sequences showed that the barcodes in the colonies were the same for each strain but varied between strains. This experiment will allow researchers to immediately narrow down which strains of monocytogenes could be the cause of future outbreaks, simply due to what food is the cause of the outbreak.

FREEDM Center

Poster Number: 66

Silicon Carbide Semiconductors

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This poster introduces SiC semiconductors, highlighting their importance within power electronic devices. The need for better and more reliable electronic devices is greater than ever making SiC semiconductors vital to the improvement of power electronic devices. Despite the advantages in power efficiency, power density, and overall application, SiC semiconductors have some drawbacks. The fabrication methods are expensive, therefore making Silicon a viable alternative despite the superiorities of SiC. Research and developmental processes are constantly being improved with the hope that one day SiC semiconductors will become the successor of Si semiconductors. Here at NCSU, we are focusing on driving down the costs of manufacturing Silicon Carbide devices. With the help of PowerAmerica, NCSU has developed a process called PRESICE, or PRocess Eengineered for manufacturing SiC Electronic-devices, that has the ability to drive down manufacturing costs of SiC semiconductors. Partnering with Texas-based foundry called X-Fab, we have been able to implement a manufacturing process that has high yield SiC electrical properties while keeping manufacturing costs affordable.

Poster Number: 141

High Power Medium Frequency Filter Inductor Design For The Solid-state Transformer
The Solid-State Transformer (SST) provides a reduction in size and weight from the conventional powerline transformer and introduces control over the power flow through it. Currently, the SST requires its output frequency to be filtered from 20kHz to the United States utility frequency, 60Hz, for its future implementation into the grid to be possible. This project focuses on the design of a high power, medium frequency filter inductor to meet the requirements of the SST. The general design being explored involves windings of copper wire passing through the core windows of multiple cores to achieve the required inductance of 15mH. The inductor being used as a reference is a Kool Mu powder core inductor with 10 windings and 1000 cores. The core designs being explored are made of an amorphous alloy, 2605SA1, with varying dimensions. The categories considered for comparison include, volume of material required, design volume, design weight, wire length required, cost, inductance accuracy, and capacitance between the windings and the core. Each amorphous design exhibits enhancement in at least one category over the Kool Mu inductor. This project shows that the use of the amorphous alloy with appropriate air gaps may be preferable to the Kool Mu core for use in the SST.

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Marine Shipboard Power Systems frequently require steady Medium-Voltage DC power distribution. To accomplish this, several DC active filter circuit designs exist to improve system reliability by reducing voltage ripple. However, implementing these topologies is difficult when system response cannot be analyzed in real-time. To resolve this, a Hardware-in-the-Loop simulator called “Typhoon-HIL” is used to translate an existing model in PLECS. Core couplings are placed and tested to divide separate subsections of the circuit on a single HIL device. Next, filter designs are implemented in increments in order of increasing complexity. Passive filter Inductance and Capacitance values are tuned to a 720 Hz resonating frequency and modified according to PLECS model specifications. Finally, a Hybrid Passive-Active Filter design is implemented based on Typhoon-HIL’s Thyristor Rectifier Library Model schematic. The finalized design is evaluated for its response to a range of firing angles and harmonic frequencies.

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Poster Number: 179
Comparison of Passive and Active Battery Balancing Topologies for the Ecoprt
The advent of electric vehicles created a larger dependency on batteries and the smart technology utilized in battery management systems (BMS). To achieve the necessary power output to run these vehicles, multiple battery cells must be connected in series. A series string of batteries will charge and discharge at different rates due to variations in both internal properties of the batteries (i.e. differences in internal resistance) and external conditions (i.e. temperature variances). This difference can cause problems regarding the health and longevity of batteries. To mitigate these problems BMS will sense differences in voltage or states of charge in the cells and bring their energy states within an acceptable threshold. This study compared three models of balancing circuits that could be implemented into NCSU’s planned ecoPRT. Two models, the shunt resistor and a modified shunt resistor, employ a passive design approach. These models balance a battery pack by dissipating excess energy through resistors as thermal waste. The last model, the switched capacitor topology is an active design. The switched capacitor focuses on energy efficiency by transferring excess energy into lower cells through capacitors instead of converting it into thermal waste. These three models were evaluated based on equalization time, charging time, and efficiency.

Poster Number: 191

**Passive Battery Balancing in Ecoprt Electric Vehicles**

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This poster summarizes the initial development of a passive battery balancing circuit board for use in the charging of electric vehicles. Society’s need to reduce greenhouse gas emissions is a growing concern in the push to lessen the effects of climate change. Electric vehicles present a sustainable alternative to gasoline-powered automobiles. Limitations in current battery technology present a number of challenges. Batteries in series charge at slightly different rates due to variance in internal resistance. When the first cell in a pack reaches capacity, the rest of the cells terminate charging, which decreases the potential range that an electric vehicle can achieve on a single charge. This issue can be mitigated using passive battery balancing methods. At NC State, the broader EcoPRT project envisions two-person electric vehicles to shuttle students between campuses on a raised track. The focus of this poster and specific project is the development of a circuit board for the purpose of cell equalization during charging of the EcoPRT vehicles. In its early stages, this project consisted of hand-drawing iterations of a passive balancing circuit until an acceptable and compact solution was reached. Next, we drafted a bill of materials and ordered all electronic components. Most recently, we designed the circuit using EasyEDA software and converted it to a virtual printable circuit board schematic. Future advancements include testing the printed circuit board and implementing it in the EcoPRT vehicle.
**Poster Number: 245**

**Inductance of New Toroidal Transformer Design**

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The following involves research on a new toroidal transformer design that could potentially improve transformers that currently exist. Like many things in this world that build upon each other, my work builds upon research that has accumulated throughout the decades. One of the most recent investigations done on transformer leakage inductance was conducted by researchers Iván Hernández, Francisco de León, and Pablo Gómez. They proved that tuning the leakage inductance on a toroidal transformer was possible. Furthermore, this enabled viewing toroidal transformers through a different scope full of opportunities and a road worth the while exploring. The research done on the new design presented was to analyse and demonstrate whether or not similar power density values to that of transformers currently used could be achieved by tuning the leakage inductance. The way that this was approached was by implementing a Finite Element Analysis (FEA) through a software called Finite Element Magnetics Method (FEMM). The software enables a digital replication of anything that involves magnetics, which as a result facilitates the process of deciding whether a certain design is promising or not. In addition, the following describes results and future possibilities for the new transformer design.

**Poster Number: 257**

**The Application of Microcontrollers in Wireless Power Transfer for Electric Vehicles**

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With growing concern about climate change and America’s reliance on foreign oil the need for electric vehicles is at an unprecedented high. Increasing convenience and public use of electric vehicles is a big step towards convincing the masses to make the switch and this has already seen success in some countries that use electric vehicles and busses as public transportation, many of which using wireless power transfer to charge these vehicles. The EcoPRT is an electric vehicle that rides on an elevated track on NC State’s campus allowing for fast and direct travel between centennial and main campus. It will charge using wireless power transfer to make the process of picking someone up, dropping them off and then going to get charged fully automated as nobody will have to plug the vehicle in. A battery balancing circuit is necessary to ensure that the batteries used don’t get overcharged and have a long lifetime of use. This poster describes the study of the capabilities of Texas Instruments microcontrollers for applications in the EcoPRT’s battery balancing circuit board. I first tested the microcontrollers digital output capabilities as that is how it will communicate with relays control the flow of electricity. Then I
tested its input capabilities as it needs to measure and compare the batteries voltages. Last, I am testing its abilities to communicate wirelessly with the transmitting coil. The microcontroller has proven to have all of these capabilities and the next step is testing it in a real circuit.

Poster Number: 273

**Optimization Algorithm for Co-axial Transformers in High-power Medium Frequency Converters**

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The adoption of wide-bandgap semiconductors has been disruptive to traditional power converter design. However, in high-power medium-frequency converters adoption has been much slower due to excessive losses in the system magnetics. New nanocrystalline magnetic materials with favorable material properties have been developed to remedy this problem. However, optimal performance cannot be realized by simply substituting a nanocrystalline material into existing transformer designs. New designs that leverage the unique material properties of nanocrystalline materials are required to realize improved efficiency and power density. One promising design is the co-axial transformer. To gain intuition on designing a co-axial transformer, a multivariable optimization strategy is proposed. The very broad design space is explored using a genetic optimization algorithm and solutions for maximum efficiency and power density are visualized. The implementation of lower-loss magnetics in high power converters utilizing wide-bandgap switches would increase performance in applications like solid-state transformers, multiport multi-directional power converters, and bidirectional electric vehicle chargers.

Poster Number: 274

**Enhanced Electrical Engineering Design Using Virtual Reality**

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The market of virtual reality (VR) has become significantly popular in recent years. The release of many VR headsets in 2016 onward led to an explosion of research and development to fully exploit the potential of these new platforms. These technologies also present an opportunity for applications in the realm of electrical and computer engineering. This project focuses on the applications for VR in the area of assisted electrical engineering design and fabrication. Using standard game development software along with existing technologies for design and simulation of electronic components, an environment could be designed to integrate these software into an interactive virtual electronics design platform. This platform would enhance the design and prototyping process for electrical engineers, allowing them to design and simulate circuit boards in VR with enhanced tools and visualization capabilities. This project presents a prototype of this software, and presents possibilities for the future development of such a software.
Dynamic Wireless Power Transfer for Electric Vehicles Utilizing a Concatenating Segmented Receiver Array

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Dynamic Wireless Power Transfer (D-WPT) has long been conceptualized as a method for charging electric vehicles (EVs) as they travel along roadways. D-WPT transfer comes with many obstacles to overcome. Among those obstacles is the periodic interruption of the flow of energy that is inherent with the use of a segmented transmitter array. Those Interruptions limit the power that can be efficiently transferred to a power curve that is significantly reduced by even the slightest misalignment and almost entirely absent by the time the coils are 50% misaligned. This research proposes a novel method for generating continuous and uninterrupted DC power for charging of an electric vehicle from a segmented transmitter array utilizing an offset concatenating segmented receiver array. This technique incorporates multiple receiver (Rx) coils on the vehicle that are spaced in a manner so that as the vehicle progresses down a roadway that has an imbedded transmitting (Tx) array one of the Rx coils will be in close alignment with one of the Tx coils.

Global Engagement in Academic Research (GEAR)

A Portable Epifluorescence Microscope Based on A Mobile Phone

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Fluorescence microscopy has been widely applied in biomedicine because of its high sensitivity and wide selection of dyes. In this project, we aim to develop a lightweight, portable epifluorescence microscope based on a mobile phone. Our epifluorescence microscopy includes a laser diode for excitation, external lens, a case, optical filters and a focusing stage. In the whole experiment process, we make the cell phone microscope attachment by using 3D modeling software to design and 3D printer to fabricate. We choose appropriate wavelengths of the laser diode and the band-pass filter to match them with our sample. Considering of the error of the device, we will use a focusing stage to make sure sample is in focus. We will determine the resolution by imaging fluorescent beads with different sizes. We expect to image 100nm fluorescent beads with this platform, In the future, this device can be used to read bio-assay array, and the device can eventually be applied in the field of medical detection.
Poster Number: 74

A Better Way to Learn: Retrieval-based Practice Effects Under Different Schedules

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Although there has been much research in the area of retrieval schedules, it is still unknown exactly what retrieval schedules result in the most effective learning. Generally speaking, equal intervals are considered better for long-term retention while expanding intervals are considered better for short-term retention. However, this body of research does not sufficiently explore the mechanisms by which certain schedules outperform others. The current experimental design compares 26 unique retrieval schedules, including 8 expanding, 8 contracting, 4 constant, and 6 random schedules. After each retrieval attempt participants rated the perceived difficulty of the retrieval. Participants then took a final retention test after either 1, 2, or 3 days. This design will enable us to investigate the effectiveness of different retrieval schedules for learning. In total, data from 146 participants are collected and we employ statistical analyses (including linear and logistic regressions) to determine the factors most predictive of final retention accuracy. We also investigate the correlation between the effort participants put into the retrieval process and the accuracy of each retrieval, as well as the accuracy of the final retrieval. Analysis of learning curves shows that the reaction time is not a better estimate for difficulty than the average retrieval accuracy. We hypothesize that schedules using the expanding retrieval intervals ought to produce the best retention. These findings may be of value in determining the most efficient ways to learn new information, and the factors associated with high future retention.

Poster Number: 76

A Reliable Intelligent Unmanned Vehicle Based on iSpace System

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This research aims to use MATLAB, Lego Mindstorms EV3 kit and intelligent space (iSpace) platform to build up an intelligent transportation system, which can simulate three traffic events, including warning and intercepting speeding vehicles, on/off road collision avoidance and intersection traffic handling. We find that while facing complicated situation, the existing iSpace system is vulnerable, so we decide to optimize the iSpace system to make the intelligent vehicles better adapt to the real road conditions. Initially, we will design two ultrasonic speed detectors, the first for sending slowing down message, and the second for setting out a police car when the vehicle is still overspeed. Then, utilizing Opti-Track system to locate the vehicles, we can prevent the vehicles’ collision at turning points where the following one’s ultrasonic sensor fails to percept the ahead one. Besides, we will make a FIFO (First-in-first-out) algorithm to manage the four vehicles meeting at forks to pass the crossroad one after another. Finally,
we will integrate all three additional modules with the existing system so that more realistic transportation system can be represented. If successful, unmanned vehicles can observe the traffic rules and run in the roads smoothly without encountering traffic accidents.

Poster Number: 78
Reducing Fuel Consumption to Improve Sustainability and Profitability for The U.S. Airline Industry
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The airline industry consumes billions of tons of fuel and contributes significant carbon dioxide every year that accelerates global warming. The goal of the project is to demonstrate how the U.S. aviation industry may reduce fuel consumption to lower its carbon footprint. Zou et al. (2013) identify key factors influencing fuel use. This research analyzes the impact of reducing departure numbers on fuel savings. Specifically, this research focuses on canceling the chronically delayed routes, which are routes with more than 50% delayed arrivals of more than 30 minutes. Cutting down these routes may reduce customers’ complaints and protect the industry’s sustainability and longtime profitability. A case study of Southwest route #6039 will outline the systematic approach for route cancellation. Then a regression model is used to estimate the total fuel saving for the U.S. airline industry for the coming year. The research results provide an effective fuel saving option that will support the U.S. airline companies improving their sustainability, customers’ satisfaction, and profitability simultaneously.

Poster Number: 79
Numerical Solutions and Analysis for Parabolic Partial Differential Equations and Applications
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Partial Differential Equations (PDE) can be used to describe a wide variety of applications in our daily life such as temperature distribution in physical phenomena and option pricing in financial mathematics. Our goal in this project is to obtain approximate solutions for some mathematic models using parabolic PDEs using modern computer. First, we plan to develop and validate some finite difference methods to solve parabolic PDEs such as the heat equation numerically. Then, we plan to use the developed methods to tackle the Stefan problems one dimensional (two variables). We will try to develop the PDEs with different settings such as with a free boundary; the infinite domain; and a terminal boundary conditions. The Stefan problem in two dimensions and the optimal control using distributed and the boundary control will also be studied if time allows.

Poster Number: 81
Real-time Semantic Segmentation in Construction Applications
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Autonomous robotics systems able to provide effective construction project monitoring in construction applications are in need. The final objective of this project is to make an autonomous mobile robotic platform, contextually aware of its environment. Context awareness includes object detection and semantic segmentation tasks. However, most semantic segmentation methods are based on a very large encoder-decoder model, which is computationally expensive and challenging to apply on robotic platforms with limited computational source. A computationally lighter convolutional network is needed for this project. To address this limitation, my research as a member of CARL (Construction Automation and Robotics Lab) is to apply a light segmentation algorithm on a proper deep learning framework (applicable on Jetson TX1). We train and validate the efficient neural network (ENet) on PyTorch to make it fit for construction applications (e.g. real-time obstacle recognition). By using ROC Curve and confusion matrix, the result is confirmed to be reliable and shows that the platform has advantage in performing real-time semantic segmentation and features an enormous prospect in construction applications.

Poster Number: 83
Synthesis and Characterization of Magnetically Responsive Polymers to Engineer New Textiles with Remotely-controlled Permeability
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The objective is to synthesize, characterize, and optimize magnetoresponsive polymer hydrogels. An ensemble of co-polymers of dopamine acrylate, N-isopropylacrylamide (NIPAM), and acrylic acid with different monomer composition will be synthesized by free-radical polymerization and grafted onto Fe₂O₃ nanoparticles. The chemical composition of the polymers will be validated by Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (1H NMR). The hydrogel-nanoparticles composites will be characterized by magnetic field-rheology to select a material with appropriate magnetoresponsive character. Later, this will be incorporated in non-woven fabric to form membranes with magnetically-controlled permeability for pharmaceutically-active ingredients.

Poster Number: 84
Pursuing Stronger and More Sustainable Fibers: Molecular Simulation Approach to Optimizing Interactions Between Polyvinyl Alcohol and Additives
Author:
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Polymers have already become one of the most important materials in daily life. Among various kinds of polymers, polyvinyl alcohol (PVA) is expected to play an important role in biological and medical materials, like fibers, due to its unique biodegradable and nontoxic features. However, PVA does not make strong fibers. Recent work reported that adding some organic additives as antiplasticizers, usually carboxylic acids, can increase the mechanical strength of PVA. In order to do further research on this topic, eight organic molecules: oxalic acid, fumaric acid, itaconic acid, xylonic acid, gluconic acid, ascorbic acid, galacturonic acid and glutamic acid are adopted as additives to PVA in certain proportions, and molecular simulations are used to calculate physical and chemical properties of PVA–additives systems. The results reveal molecular-level details about these interactions and their correlation with the mechanical strength and other properties. Our next step is to identify additives that can increase the performance of PVA at utmost, and predict a feasible way to synthesize the most ideal PVA–additive complex. Since all additives of focus here can be found in organisms and can recycle, employing them can not only increase the strength of the polymer, but also bring sustainable and environmental-friendly significance.

Poster Number: 86

**Investigating 3D Structure of Domains on Supported Lipid Bilayers with Single Particle Tracking**

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Domains play essential roles in cell membrane functions and are involved in various processes such as material transport and signal transduction. Due to technical challenges, the formation and function of domains are still under intensive investigation. Single particle tracking (SPT) techniques are powerful tools to probe the structure of cellular membranes and the mechanism of cell activities by tracing the motion of single particle probes attached to lipid bilayers. Unlike most of other current SPT studies which only focus on the 2D motion of the particle probes and lack the information of the particles’ movement in the z-direction, we applied three-dimensional single particle tracking technique to investigate the organization of the lipid bilayer and its interactions with gold nanoparticle probes. In this project, we studied the motion of 40 nm CTxB-modified gold nanoparticles attached to supported lipid bilayers (SLBs) containing different concentrations of GM1 ganglioside, which is one of the key components in domains on cellular membrane. This study will provide important information about the 3D domain structures and the interactions between nanoparticle probes and lipid membrane.

Poster Number: 88

**A Study About the Role of Elastomer Substrate-pdms on the Stability of Films-p3ht Undergoing Cyclic Strain.**
Polymer semiconductors can be highly deformable materials that have tremendous potential for implementation in stretchable electronics. Previous demonstrations have illustrated that these materials can maintain their electrical properties when deformed in both tension and compression. However, the failure limit of these films on exposure to cyclic strain requires further investigation. In particular, the substrate can have a large influence on the behavior of the polymer film. Our goal is to study the role of the substrate properties on the stability of the films under cyclic strain. We have picked P3HT (poly3hexylthiophene) as the material of study. The films are initially spun cast on substrates and transfer printed onto a PDMS (polydimethylsiloxane) elastomer substrate where they undergo cyclic strain. The properties of the PDMS are tuned through UV-ozone treatment for different time intervals. Statistical information on the crack and wrinkle onset of the films under different strain conditions and PDMS treatment will then be obtained. The strain process will be performed with the aid of a motorized strain stage. The obtained information will provide valuable information on the mechanical stability of polymer semiconductor films.

Poster Number: 89

Combining Multiple Models for Physiological Response Prediction Using Wearable Sensors Data

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Prediction of physiological responses is essential to the health and medical fields. For example, it is established that vital signs are likely to change before cardiac arrest. Therefore a precise prediction could help diagnose and detect physical diseases in advance. The aim of this project is to establish a model which could increase the accuracy of physiological responses prediction, and focus on the case of heart rate prediction. For this study, the NCSU-ADL dataset is used, which contains physiological, activity and environmental data on healthy subjects over a period of several days. First, a sliding window technique is used to extract activity features. Given that different kinds of activities may have different patterns of heart rate. One particular approach explored is clustering activities to identify which particular activity the subject is engaged in. Together with the history of heart rate and extracted activity feature, a long short-term memory (LSTM) neural network model is adopted for each cluster to predict the physiological response. The second approach considered uses a mixture of experts combining those different models for prediction. The root mean square error metric was used to evaluate the overall prediction performance as well as the performance per activity cluster.

Poster Number: 90
Q-carbon Seeding to Grow Adherent Diamond Films

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Diamond has many interesting mechanical and electrical properties that make it suited for a number of applications ranging from advanced cutting tools to quantum computing. Recently, a new material named Q-carbon with hardness higher than diamond, and other outstanding properties such as high-temperature superconductivity, demonstrates a great promise for these applications. Chemical Vapor Deposition (CVD) is widely used to grow diamond thin films. However, during this process an inevitable layer of graphite forms at the film-substrate interface. Graphite has poor mechanical stability as a result, the deposited diamond films are not epitaxial and highly adherent. To improve upon this we use a new process, which uses an excimer laser to convert diamond-like carbon (DLC) to Q-carbon or diamond directly at the substrate interface. Critical to the successful conversion is the adherence of the film, which is dependent on the sp²/sp³ carbon hybridization ratio. The Raman spectrum of DLC is deconvoluted to determine the fractional percentages of sp² and sp³ hybridization. For example, the peak around 1580 cm⁻¹ is of sp² hybridization, as in graphite and the peak around 1332 cm⁻¹ is of sp³ hybridization, as in diamond. By determining the sp²/sp³ ratio, and using optical microscopy to study the structure of Q-carbon, we try to find the relationship between its specific properties and theoretical predictions. Finally, we use Q-carbon as a seed layer to grow epitaxial diamond films by hot-filament CVD. In this way, the diamond film will have improved adherence because of lack of an intermediate graphite layer.

Poster Number: 91

Gold Nanoparticles (Au-nps) Used in Diagnosing Disease Integrating with Smartphone Platform

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MicroRNAs (miRNAs) are a family of single strand, small, endogenous non-coding RNA molecules (containing about 18-25 nucleotides) that serve as critical regulators of gene expression. Lots of previous literatures have shown that the overexpression of miRNA in human plasma/serum is associated with a number of diseases, including cancer. The detection of miRNAs in plasma/serum is therefore crucial for the human healthy. However, miRNA assays are challenging because of their short sequences and ultralow abundance. Some traditional approaches, such as Northern blotting and polymerase chain reaction (PCR) have been applied for the detection of miRNAs, but have encountered significant challenges in point-of-care (POC) use simply due to the drawbacks of cross contamination and time-consuming. In this work, we aim to design an enzyme-free DNA circuits on the surface of gold nanoparticles (Au-NPs) that rely only on hybridization and strand-exchange reactions to achieve signal
amplification, and combine this approach with a smartphone-based portable fluorescence plate reader platform as a potential solution for miRNA diagnostics. Compared with hybridization chain reaction (HCR) and catalytic hairpin assembly (CHA) in solution, this entropy-driven DNA nanomachine is designed to be simpler, faster, and more stable, may thus be useful in applications like vitro imaging and point-of-care (POC) diagnostics.

Poster Number: 93

**Scene Segmentation for Robotic Applications in Construction**

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The automatic robot with camera needs to detect surrounding environment through camera. Therefore, real-time video image segmentation is very important for the construction of an automatic robotic system. The purpose of this project is to train and validate a deep learning network by transfer learning process and provide visual segmentation solution for a robot vision system. As part of a mobile robotic system, this project will provide an appropriate algorithm for the stereo camera mounted on the ground robot and make the robot contextually aware about surrounding environment. The segmentation network architecture will be based on the ENet method under Caffe Framework. Finally, a set of network parameters that can be used in robot vision system will be obtained. The accuracy and reliability of the final model will be shown by ROC curve and confusion matrix. Project results will be used for subsequent research of the robotic projects.

Poster Number: 94

**Activity-based Protein Labeling of Particulate Hydrocarbon-oxidizing Monooxygenase (phmo) in Mycobacterium Sphangi Env482**

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*Mycobacterium sphangi* ENV482 is an ethane-utilizing bacterium that was isolated from a site in MA that is highly contaminated with ethylene dibromide (EDB). The genome of this bacterium encodes three different monooxygenase enzymes that are potentially involved in the oxidation of gaseous alkanes and EDB. These include two distinct soluble diiron monooxygenases (SDIMOs) and one copper-containing particulate (membrane-bound) hydrocarbon-oxidizing monooxygenase (pHMO). In this project we have used an activity-based protein labeling approach to investigate growth conditions that impact the expression of the pHMO in this bacterium. This labeling approach involves initial use of diyne probes that act as mechanism-based inactivators of diverse monooxygenases. The resulting covalent/probe adduct is then reacted with AlexaFluor 647 azide using a copper-catalyzed azide-alkyne cycloaddition (CuAAC). The results of an SDS-PAGE analysis and infrared (IR) scanning showed a 30-kDa fluorescent polypeptide was detected in cells grown on gaseous alkanes in a copper-containing medium but absent in cells grown
on copper-deficient medium. This suggests the expression of pHMO is copper-dependent. Additional aims of this research are to (a) identify the growth conditions that maximize the expression of pHMO, (b) identify which diynes are the most effective probes for detecting active forms of both SDIMOs and pHMO and (c) use nano-high performance liquid chromatography (nHPLC) combined with mass spectrometry to confirm that the fluorescently-labeled polypeptides detected by our activity-based labeling approach are the expected hydroxylase components of the pHMO and SDIMOs.

Poster Number: 95

**New Neural Network Training Based on Lnsnet For Vision-based Autonomous Robots on Construction Sites**

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Construction industry suffers from cost overrun and delays, which endangers social and environmental sustainability economically. Our research works on AI, including robotics, computer vision, and machine learning to increase the degree of automation in construction industry. One of the project we are developing is a robot intended to be used in the construction sites based on Husky Platform with a stereo camera, sensors, and a robotic arm controlled by several NVIDIA Jetson TX1 Stacks. It is supposed to implement SLAM (Simultaneous localization and mapping) algorithm, motion planning, scene segmentation to provide necessary requirement for the robotic arm to remove the obstacles such as bricks to clean the path to make the construction site safer (less people involved) and more productive. My goal is to make the robot become context-aware using segmentation algorithm in Tensorflow as a deep learning framework. So that the robot will be able to recognize the ground, which it can pass safely and the obstacles. As a part of CARL lab I am working on training a new neural network based on LNSNet on Tensorflow and I am also cooperating with my lab-mates to transfer the segmentation codes from Tensorflow to Caffe (to be applicable on Jetson TX1).

Poster Number: 98

**An Example of Applying Biclustering To Crime Prediction**

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Today people raise increasing concerns about their community safety. To help people avoid encountering with crimes more efficiently, police office has made constant efforts by recording the key elements of every crime - time, place, type (e.g. theft, robbery, attack, burglary) and description. The data of this project are obtained from a city's real crime statistics to ensure their authenticity as well as practical significance of the results. The purpose of the project is to give a relative security level of a certain area in a certain period of time for one kind of crime. Then we try to decide an overall security level taking all kinds of crimes into consideration, which would be great help for predicting the probability of a crime that happens in the future and giving instructions or warnings of safety. We use biclustering, a method often used for analyzing gene expression data, to analyze historical crime data. In this project, given a
type of n×p crime matrix, the columns represents time periods of a day, the rows represents locations, and the elements of the matrix represent the corresponding number of such crimes. Biclustering clusters rows and columns simultaneously, and the result will present a new matrix, which is divided into several submatrices characterized by different coherent patterns of the data. The comparison between estimated and real data will assist with the amendments and improvements of the model.

Poster Number: 102
**Label Multiple C. Elegans Tissues**
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Caenorhabditis elegans (C. elegans) is a small, free-living, nematode worm, which has become established as a standard model organism for a huge variety of genetic investigations. It is important to do some research about this small worm, for it can give us a hint about humans’ nerve function, aging, etc. However, some mysteries remain about C. elegans’ gene networks. The goal of the project is to use labeled gene expression lines to train a machine learning tool. We are going to label three kinds of tissues separately in C. elegans body. The three tissues are pharynx, intestine and body wall muscle. First, construct plasmids with red florescent protein (mCherry) and tissue-specific promoters. Next, inject the plasmid into wildtype C. elegans using microinjection. After a period, the injected C. elegans will lay eggs, and we can look for transformants, who will show red fluorescency in certain locations. Finally, image acquisition of the fluorescence channel and brightfield channel, and use of a machine learning algorithm developed with MATLAB tools will enable automatic recognition of tissues. After establishing the machine learning tool, we can get numerous data sets, which enable us to trace the activity of gene networks.

Poster Number: 103
**Robust Asynchronous Stochastic Gradient Descent**
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While machine learning has achieved remarkable results in a variety of domains, the training of models often requires large datasets. Recent advances in networking enable the connection of various devices to the Internet and therefore allow data collection in a collaborative manner. In particular, in systems like Internet of Things (IoT), a large number of devices collect valuable data and communicate with each other. As one of the mostly adopted methods for large-scale machine learning, stochastic gradient descent (SGD) is considered a good candidate for learning in IoT systems since it admits decentralized implementation with low complexity. However, the nature of collaboration renders it vulnerable to malicious insiders which can mislead others by deliberately sharing wrong information. Therefore, there is a compelling need to develop more robust SGD-based machine learning algorithms. Existing works
usually consider the scenario in which multiple nodes compute and share gradients derived from their local training samples and the robustness is achieved by properly aggregating the shared gradients. However, such mechanisms demand a central node to collect all the gradients from the collaborative nodes and therefore may suffer from single point of failure (SPOF). In addition, existing mechanisms are often synchronous in nature. In this summer research project, a robust asynchronous SGD algorithm is proposed, which assumes that each node trains its own model and collaborates by sharing its local model instead of the gradient. The effectiveness of the proposed algorithm against attacks is evaluated through extensive simulations.

Poster Number: 104
**Recent Trends in FDI Flows on Forest Products in the U.S. And Canada**

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Foreign direct investment (FDI) is a significant element to bring in various assets and procurement networks to expand business opportunities of any firm in international markets. It is a form of a transnational investment, which transfers financial resources, technology, and managerial skills from home countries to host countries for improving technical and production efficiencies in a competitive environment. The United States and Canada are the major trading countries in forest industry in the world. Since trends in the forest product trade and FDI flows change in response of change in economy as well as trade policies over the period, it is important to study the positions of the U.S. and Canadian FDI outflows and the trading situation on forest products. In this study we will first track the recent trends of FDI outflows in forest product industries from the U.S. to other countries abroad. Similarly, since in recent years there is an increase in FDI inflows into the U.S. from Canada, this study will also focus on Canadian FDI outflows on forest products into the U.S. and other countries. Moreover, this study will examine the factors driving Canadian FDI outflows to the U.S. on forest products. Data will be collected from several secondary sources. The findings of this study will be useful to understand the recent trends in forest products FDI flows in the U.S. and Canada.

Poster Number: 105
**Real-time Scene Segmentation on a Robotic Platform for Construction Applications**

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An autonomous mobile robotic system conduces to automating construction applications such as monitoring. Obstacles on its route must be identified and removed. Semantic segmentation is critical in achieving the goal. Segmentation algorithms with low computational complexity are necessary for mobile robotic platforms. The objective is to implement a segmentation system on Jetson TX1 platform in order to detect small obstacles such as bricks in its field of vision captured by a stereo camera. Given mature architectures for real-time segmentation like ENet, transfer learning methods are applied. The network topology is modified to reduce the computational complexity to be applicable on Caffe as an
appropriate deep learning framework on Jetson TX1. In the data collection step, images containing bricks are collected and labeled. They are used for training the aforementioned convolutional neural network (CNN) architecture. The system is expected to detect any bricks in front of it with low latency and cooperate with a robotic arm mounted on the ground robot to remove the obstacles. As a CARL (Construction Automation and Research Lab) member, I will also have contributions in integrating the stereo camera, robotic arm and Jetson TX1 to make the whole pipeline applicable. It is promising to extend these methods to detect more classes of objects. The methods are conducive to transferring existing segmentation models to embedded systems in new application scenarios. Based on the system, autonomous robotic systems can be further developed to automatically move on the construction site for construction monitoring task.

Poster Number: 106

**Edge Detection Through Richer Convolutional Features**

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Edge detection is a fundamental process for many computer vision related tasks, and convolutional neural networks (CNNs) have been proved to be effective in this area. The richer convolutional features (RCF), one of the state-of-the-art edge detection algorithms, performs the image-to-image edge detection by fully utilizing multiscale and multilevel information of objects through a pre-trained image classification network. However, the final result fuses the multiscale detection results by learning a set of input-independent weights for each scale. In this project, we explore how input-dependent fusion approaches can improve the prediction performance. We first reproduce the result of the original RCF edge detection on BSDS500 dataset. Then, several different input-dependent fusion approaches based on mixture of experts learning scheme will be implemented and evaluated.

Poster Number: 107

**Object Detection Using Auto-context Based on Faster-rcnn**

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Object Detection is a significant task which prevails in Computer Vision for its extensive applications in daily life, military purpose or so. Faster-RCNN, which makes a great contribution of presenting Region Proposal Network, sets a trend for current algorithms. Nowadays, many state-of-the-art methods are based on this framework to achieve better performance. In that our basic goal is to improve the detection accuracy, considering the value of context information, we substitute the original ROIPooling Operator into a new ROICtxMing Operator. Moreover, instead of manually predefining the context, we present a novel way to compute them automatically. Our basic intuition is to utilize the context of each ROI from
RPN, mine the Context-ROIs according to several rules and then concatenate them together for final classification and regression. I'll use Pytorch to carry out this project for its applicability for building deep neural networks and great computational ability for high-dimensional datasets. After training and fine-tuning, we implement our method on Pascal VOC, COCO to test its performance, especially the mAP. Compared with the original Faster-RCNN or other modification ways, the result will prove whether we make a competitive improvement. In conclusion, our proposal provides a promising auto-way to capture context information without changing the framework of Faster-RCNN in order to improve detection accuracy.

Poster Number: 108

**Designing Robust Demand-supply Networks Under Load And Resource Fluctuations**

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In a two-layer demand-supply network, supply nodes provide resources to demand nodes to maintain their functionality. In this context, a supply node can split its resources among different demand nodes. To have a stable supply node, the total resources it provides should be less than or equal to its total available resources; otherwise the supply node becomes overloaded. For a demand node, the total resources received from the supply nodes should meet its demand in order to remain functioning. The first goal of this study is to design a robust network that can effectively handle load/resource fluctuations on the demand/supply nodes without node failure. The goal is achieved via formulating the problem as a convex optimization problem. An efficient (cost-effective) design is also developed for resource allocation with heterogeneous cost of resource sharing among the nodes. The second goal of this work is to avoid or limit an ongoing cascading failure upon failure of supply nodes. This is addressed through load re-adjustment by an efficient network adaptation algorithm. Through simulations, the effectiveness of the robust network design is verified as compared with baseline design methods.

Poster Number: 110

**Building an Integrated Mobile Robotic System for Construction Monitoring and Safety Purposes**

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Recently, robotic systems have been wildly used in the construction industry in some dangerous environments. The capability of autonomous navigation and scene understanding are becoming essential in many applications. Our main goal is to develop an autonomous mobile robotic system intended for applications such as autonomous monitoring of a construction site with little human manipulation. Our project is based on a ground vehicle (Husky) equipped with a robotic arm (Jaco) and we use a stereo camera (ZED) to capture the environment information. Image segmentation is used to identify obstacles, and the ZED camera calculates the location of that object with respect to its coordinate system. We also use simultaneous localization and mapping (SLAM) to localize our robot in the environment and reach
the target location. ROS (Robot Operating System) is implemented to integrate the entire system. We expect that the robotic system can autonomously detect the obstacle location and remove that. In this way, the robot can move safely. Once we complete our project, we can expect this model to real engineering problems such as handling an object in hazardous environments. By using more advanced sensors and algorithms, we can complete a fully automated robotic system for construction work in the future using the similar system framework to our project.

Poster Number: 111

**Multiple Peaks Phenomenon in Non-markovian Epidemics on Multilayer Networks**

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Classical mathematical models studying information propagation in networks, such as the SIR (susceptible-infected-recovered) model, rely on the memoryless assumption on the infection and recovery times of nodes, where the probability of an infection spreading and the probability of an infected node recovering are both assumed to be exponentially distributed. Recent studies, including both real life instances and theoretical models, have indicated that infection and recovery time distributions can be dramatically different from the exponential distribution, and these variations lead to non-trivial effects on the dynamics of the propagation in single layer networks. Our focus is to study these effects for the case of multilayer networks. In particular, we examine the effects of variable delays and different distributions of the infection and recovery times. Under these variations, the time series plots for the infected and recovered fractions of the population show some oscillating behavior with multiple peaks. This phenomenon is in stark contrast to classical models which only predict a single peak in the fraction of the infected population. We aim to discover the relationship between the infection and recovery time distribution with the phenomenon of multiple peaks. We will be using synthetic graph models, such as Erdos-Renyi graphs and Scale-Free graphs, as well as real world network topologies in our investigation. We expect to build a theoretical model incorporating arbitrary distributions of infection and recovery times that can support the simulation results analytically.

Poster Number: 112

**A New Formulation of Variational Reconstruction Based on Finite Volume Method for Solving 1d Advection Equation**

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Computational Fluid Dynamics (CFD) has become an indispensable tool for a variety of applications in science and engineering. Among all the CFD methods, finite volume method has already been one of the
most classic ones. Although the variational reconstruction method has already been implemented for finite volume method, it still remains a difficulty when it comes to strong discontinuities. Traditionally, this problem is solved by using limiter. In the presented work, a new formulation of the variational reconstruction method is proposed here. The new reconstruction method is to minimize the time integral of the total jump of flux function. The resulted derivatives are compared with cell-centered method. Both 1D linear advection and Burger’s equation are to be tested.

Poster Number: 113
A Design of Rectangle Antenna for Flexible Radio-frequency Identification Tags
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In recent years, the use of flexible radio-frequency identification (RFID) tags has increased in various application fields. However, most of the existing designs of flexible RFID tags focus on a flat state instead of a deformed state. The goal of the design is to develop a rectangular coil antenna for a flexible high frequency (13.56Mhz) RFID tag and analyze its performance in a deformed state. Formula derivation and software simulation are applied for antenna design and characteristic analysis. The antenna is 3D printed with Field’s Metal on Polydimethylsiloxane (PDMS) substrate. The performance of manufactured antenna would be tested and analyzed compared with simulations. The result is expected to be that the designed flexible RFID tag antenna meets the high frequency RFID requirements within a certain bending angle range. This antenna design allows flexible RFID tags to be attached directly to the surface of the human body, providing convenient medical care functions like information transfer of human health status and quick query of past medical record.

Poster Number: 114
A Moving Finite Volume Method for 1d Advection Equation
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To fully understand the behavior of fluids, it is significant to find the exact solution of the control equation. However, exact solutions are always impossible to gain, thus necessitating numerical solutions, which is the focus of computational fluid dynamics (CFD). Now one of the main difficulties for CFD is how to capture strong discontinuities like shock waves. A moving finite volume method is implemented for solving 1D advection equation. Instead of using the traditional finite volume method where the mesh is fixed, a moving method is used here where the mesh velocity is determined by minimizing the total jump of flux function. C++ is used here for coding. It is expected that the presented method can capture sharp shock waves.

Poster Number: 117
Constructing Sparse Data-dependent Affinity Graphs for Clustering
Clustering is a fundamental technique for exploratory data analysis. Standard methods such as k-means and hierarchical clustering are beset by local minima. Recently, the clustering task has been formulated as a convex optimization problem, which ensures a unique global minimizer and can be recovered as a generalization of the Fused Lasso when $l_1$ penalty is used. However, the performance of the method depends on the parameters setting in the penalty term. Some methods have been employed such as KNN weights and sparse Gaussian kernel weights. In this work we present some novel data adaptive refinements inspired by related work in sparse local linear embeddings. We demonstrate the performance of our method on both simulated and real data examples. And we expect our method will be significantly more efficient in the complexity analysis and numerical experiments.

Sharp Interface Capturing for One-dimensional Advection Equation

The linear advection equation is a simplified PDE which has few applications in the practical world. However, certain numerical and theoretical studies based on advection equation can be applied to more complex systems, such as the two-fluid system of two-phase flows. A second-order finite volume numerical method (also called reconstructed Discontinuous Galerkin rDGP0P1) is used to solve the advection equation and perform such studies. The key is to find a better way to reconstruct the derivative of “u” so that a second-order method in space can be realized and the error can be reduced. The problem that the solution won’t be monotone by Godunov’s Theorem can be solved by introducing nonlinearity in the solution discretization via limiter functions. However, common TVD limiters usually don’t sharply retain material interfaces, effectively smearing these discontinuities, sometimes beyond recognition. Different limiters will be studied in this work to demonstrate this phenomenon. Further, various interface sharpening techniques will be studied and the improvements in interface capturing capabilities will be presented. Effectively, the aim of this work is to find a limiter function that introduces enough dissipation to make the solution monotone, but also sharply resolves interfaces. The time-marching solution algorithm will be programmed using the C++ programming language and numerical testing will be performed to assess performance benefits. Comparisons with other limiters will find the one that can most accurately calculate the moving solution. This interface sharpening limiter will then be applied to two-fluid system of equations to sharply resolve material interfaces.

Reinforcing Intelligent Tutoring Systems Using Reinforcement Learning
Reinforcement Learning (RL) is one of the most effective machine learning methods for decision making in interactive environments such as Intelligent Tutoring Systems (ITSs) in STEM domains. Generally speaking, tutoring in such domains is often structured as a two-loop procedure: the problem-level outer loop and the step-level inner loop. The proposed project will investigate tutorial decisions at both levels of granularity. Previous research concluded that the pedagogical policy induced by RL can significantly improve students’ learning. While most of the previous research used the student learning gains as reward function and in this proposed project, we will explore both learning gains and learning efficiency. The purpose of this project is to evaluate the induced policy from two different aspects by investigating two types of reward functions: Learning Gains (LG) vs. Learning Efficiency (LE) at two levels of granularity: Problem level vs. Step level. We will apply RL to the datasets collected in an ITS called Pyrenees using the Markov Decision Process (MDP) framework to generate the optimal pedagogical policy using policy iteration. We will explore whether the RL-induced policies using LG as rewards will agree with those using LE as rewards at either level of granularity. In other words, whether the instructional interventions that would improve student learning gains would be the same as those that would also improve students learning efficiency at the step level vs. problem level.

Poster Number: 137

Two Stage Clustering for Multivariate Time Series

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The goal of this research is to cluster multivariate time series data and find some patterns within data. Since lots of time series data are high-dimensional and non-stationary, it is inefficient to cluster them directly. Thus, we adopt the two stage clustering method which combines dimensionality reduction and clustering analysis. First we conduct dimensionality reduction on data. This research uses diffusion maps which are nonlinear and focus on geometric structure of the data to reduce dimensions. Traditional techniques for dimensionality reduction such as PCA and MDS cannot capture non-linear structures of data. Diffusion maps can embed data in a lower-dimensional space, making the Euclidean distance between points in the embedded space equal to the diffusion distance in the original feature space. After we have reduced the dimensions of the data, we use ISO-split to do clustering analysis. ISO-split is a non-parametric density-based clustering method and we do not need to tune the parameter for ISO-split like the conventional methods such as k-means and DBSCAN. Therefore, ISO-split is robust for clustering low dimensional data. We expect that the two stage clustering method will help us work on high-dimensional time series, group similar objects together and find some patterns.
Predicting the Stock Price Using ESG

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Sustainable and socially responsible investing (SRI) continues to flourish in the global markets. At the same time, the investors desire reliable empirical evidence that demonstrates how social and environmental performance impact the investment returns. There is a considerable body of literature on socially responsible investing in the American market while the notion of SRI hasn’t gained much attention in the Chinese market. This research aims to establish the correlation between the Environment, Social and Governance (ESG) rating and the stock price in the Chinese market. Moreover, this project reveals the usefulness of ESG rating to the investors in the Chinese market. Based on the method developed by Derwall et al. (2005), this study constructs high-ESG-rating and low-ESG-rating portfolios of companies for comparison. Secondly, we evaluate the performance of different portfolios utilizing their cumulative return and Sharpe ratio. Thirdly, we apply the Capital Asset Pricing Model (CAPM) and the Fama-French 3-factor model to analyze the differences between these two groups of companies using the regression tools. These evaluation methods highlight the significance of considering ESG rating in the process of investing. Furthermore, we may expand our research by identifying the ESG influence on different industries and presenting various ways of constructing portfolios.

Low-cost and Adaptable Grid System for Controlling Precursors Mixing and Nanocrystals Synthesis

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For synthesizing colloidal nanoparticles solution in microfluidic systems, the early stage mixing rate is a crucial parameter affecting the nucleation of nanocrystals and the optical properties of the resulting nanocrystals. Prior microfluidic studies using microfabricated reactors have demonstrated that the chaotic advection created by serpentine microchannels can improve microscale mixing of miscible fluids compared to the laminar flow pattern within straight microchannels. However, the material and labor-intensive fabrication of microfabricated reactors impose a substantial limitation towards efficient and comprehensive screening studies of colloidal nanocrystals. In an effort to rapidly characterize early-stage micromixing of nanocrystal precursors within a low-cost off-the-shelf fluoropolymer tubing, we developed a modular microfluidic strategy which allows rapid alteration of curvature dependent mixing patterns. We divided the channel system into adjustable modular units and a mounting grid patterned substrate, all custom designed and fabricated on a 3D printer. From this low-cost and adaptable grid structure, we may construct a wide range of channel configurations by simply rearranging the block units, without any need to microfabricate a new reactor. To evaluate the microscale mixing efficiency of this modular flow reactor strategy, we implement a fluorescein and potassium iodide quenching reaction as a complete mixing indicator. We will measure precursors mixing rate within the varied channel assemblies of curvature whose radii range from 2 to 9 mm in varied tube shapes. Utilizing this microfluidic
platform, we can study the main factors affecting early-stage mixing rate of precursors in colloidal synthesis of semiconductor nanocrystals.

Poster Number: 194

3d Reconstruction of Textile Surfaces for Bloodstain Measurement
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This project focuses on reconstructing 3D surface structures of textile from multiple images for bloodstain measurement. Conventional work that uses 2D images for textile bloodstain measurement always underestimates the blood amount as they fail to account for the blood trapped in the 3D structures of textile. In this project, we propose a surface reconstruction method to allow measuring the bloodstain from a 3D surface. The surface reconstruction contains two steps. First, we generate the height map of the textile using images captured from different viewpoints. Second, we map from the most appropriate image a color value to each point of the height map. With the bloodstain on the reconstructed 3D surface, analyzing the bloodstain using image processing algorithms will be more precise.

Poster Number: 218

A Comparative Study on Optical Flow Algorithms in Heart Rate from Video Applications
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Optical flow is a fundamental computer vision method that has been used in video compression, 3D reconstruction, moving target detection, motion detection, key frame excitation, etc. The accuracy of a particular optical flow algorithm can significantly affect the overall performance of a system. Heart rate estimation using facial videos is one application that optical flow plays an important role. We will examine how different optical flow algorithms affect the heart rate estimation accuracies. We will also examine the tradeoff between the accuracy and computational complexity.

IMSD Intensive Research & Training Program (IRTP/IMSD)

Poster Number: 25

Black Families Project: Examining the Influences Of Parental Mindsets On Teens
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In psychology, mindsets are the beliefs one has about themselves and their abilities (Dweck, 2006). Growth mindsets are when someone believes their traits can be developed through work and dedication and fixed mindsets are when someone believes their traits are predetermined and fixed. Mindsets have been examined in different capacities, but little research has examined the influence parental mindsets may have on outcomes for their children. In this project, I used data collected from 604 Black parents and their adolescent child to understand the relationships between parent mindsets, and adolescent mindsets, mental health, and gendered racial socialization. This project explores 3 questions: (1) Are teens who have parents that have a fixed mindset more likely to have a fixed mindset themselves? (2) Are parents with fixed mindsets more likely to give their teens negative gendered racial messages? (3) Do parents with fixed mindsets have teens that report more symptoms of depression and anxiety. Bivariate correlations were conducted to test these research questions.

Poster Number: 186

**Stimulating Anti-osteosarcoma Tumor Immunity Using Canine Distemper Virus**

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Osteosarcoma (OS) is the most common malignant bone tumor in people (children and young adults) and dogs; however, there have been few advances in treating this cancer in the last 25 years. Recent studies have demonstrated that infection of brain tumors with poliovirus can stimulate an immune response to the tumor. Based upon these findings we asked two questions: 1) can we infect OS tumor cells with canine distemper virus (CDV) in vitro and 2) does infection of OS cells with CDV enhance the immune response to the tumor? Previous reports suggest CDV infects a wide range of cell types. Our hypothesis was that CDV infects canine OS cells in vitro and that infection induces lymphocyte proliferation. Methods: A canine OS cell line (Abrams cells) were maintained in culture and infected with CDV previously acquired from a naturally infected dog. Canine peripheral blood monocytic cells (PBMCs) were isolated from healthy dogs (n=3) and were cultured with the following: OS cells, OS cells infected with CDV, OSA cells plus concanavalin A (ConA, positive control for proliferation), and CDV supernatant alone. Following a culture of 2-3 days, T lymphocyte proliferation was measured by flow cytometry using a combination of CD25 surface expression and a standard proliferation assay. Results: Fluorescence microscopy demonstrated that CDV infects OS cells in vitro. Flow cytometry results indicated that CDV infection of OS cells does not enhance lymphocyte proliferation. Conclusion: Canine distemper virus infects canine OS cells; however, infection alone does not stimulate anti-OS immunity.

**Integrative Molecular Plant Systems (IMPS)**

Poster Number: 5

**The Use of Nanofibers to Mimic Growth Conditions**

Author: Natacha Namphengsone Biology NC State University
Maintaining or improving food security in a growing world population has been the focus for many research scientists who aim to combat the environmental stresses that plants face. Research in improving plant development has largely focused on discovering what pathways are used in response to these stresses. However, in order to conduct research in a laboratory setting, scientists must be able to mimic the conditions in which the plants actually face in their current environments that impose stressors simultaneously or at different frequencies. Therefore, translating these lab findings into methods of creating stress tolerant crops that can be used out in the field is one of the biggest obstacles scientists face because of the inability to mimic real life growth conditions. This collaboration project between North Carolina State University’s College of Agriculture & Life Sciences and the College of Textiles aims to use a combination of material science and plant biology in order to create a nanofiber system to be used in lab settings. This system will be used to mimic real life growth conditions that inflict stress on crops, specifically iron deprivation and drought conditions. In order to develop this nanofiber system, preliminary tests must be conducted through toxicity testing and determining root growth metrics. From these tests, appropriate nanofiber modifications will be made in order to provide the nanofiber the ability to absorb water and/or iron. By developing this tool, researchers will be able to obtain more accurate data and efficient crop engineering.

Poster Number: 129

Engineering an Efficient Sor-olef Fusion Enzyme for Terminal Alkene Production and Stress Tolerance in Fatty Acid Producing Bacteria

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Natural oil supply obtained from fossil fuels is available at a finite quantity and raises environmental concerns. According to BP’s Statistical Review of World’s Energy 2016, there are 50.7 years of fossil fuels reserves left. In response to this critical concern, alternative biofuel production methods are being researched. Current biofuel production methods require an expensive metal catalyst, which has a finite life-span, to decarboxylate biological free fatty acids. OleT is a CYP 152 peroxygenase present in the Gram positive bacterium Jeotgalicoccus sp. 8456. It is a highly efficient free fatty acid decarboxylase capable of replacing the current metal catalyst. Being a peroxygenase, OleT requires H2O2 to catalyze decarboxylation. The enzyme superoxide reductase (SOR) found in hyperthermophilic archaeon Pyrococcus furiosus produces H2O2 in small quantities as a result of reducing superoxide and has been shown to reduce oxidative stress in organisms (enteric bacteria, cyanobacteria, plants) in which it is expressed. In this study, we attempt to fuse the enzymes SOR and OleT to provide controlled production of H2O2 necessary for OleT to decarboxylate free fatty acids. Using enzyme activity assays, we will determine the efficiency of free fatty acid decarboxylation and if, in addition, SOR provides stress tolerance. Currently, we are creating all constructs necessary before transformation and confirming expression.
Automated Plant Root Imaging Via Lightsheet Microscopy

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Plant root imaging experiments provide a powerful approach for studying root physiology and behavior. The advent of gene expression visualization via gene-tagging with fluorophores and fluorescence microscopy has enabled detailed spatio-temporal gene expression analysis of root images. We image with the Zeiss Lightsheet Z.1 microscope, in part for its’ ability to perform long-duration experiments due to the benign nature of the low-intensity lightsheet laser. However, long imaging experiments place a burden on the researchers operating the microscope, since researchers must configure and initiate imaging at regular time intervals throughout the experiment. Because the root grows throughout the experiment, researchers must re-position the microscope to keep the root within view. The goal of this project was to create a software-based solution for automating plant root imaging experiments that are completed via lightsheet microscopy. We used image analysis and machine learning techniques to identify regions of interest within Arabidopsis thaliana roots modified to express the GFP-tagged Cyclin B11 and Scarecrow genes, to determine where to image in 3 dimensions as the experiment progresses. The GUI-automation language AutoIT was employed to interact with the ZEN software interface that controls the lightsheet microscope, using values obtained from MATLAB scripts. We created MATLAB scripts that identify expression and root tip location within A. thaliana lightsheet images and process this information to return input values for ZEN to adjust the microscope. Additionally, we created a mock-GUI that resembles the ZEN interface and AutoIT scripts that input values obtained from the MATLAB scripts into our GUI.

Does Segs-1 Or Segs-2 Promote Cassava Mosaic Begomovirus Infection Of N. Benthamiana?

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Cassava Mosaic Disease (CMD) is a harmful viral disease caused by begomoviruses that negatively impacts cassava production in Africa. During the 1980s, two species of cassava mosaic begomoviruses (CMB) recombined to create a more virulent hybrid known as East African cassava mosaic virus-Uganda (EACMV-Ug). The hybrid spread throughout east Africa during the 1990s-2000s causing a pandemic, until resistant cultivars were developed. CMD remains a threat today with the recent discovery of two DNA molecules, SEG-1 and SEGS-2, that enhance symptom severity and break resistance in cassava. To
understand how the SEGS function, *N. benthamiana* plants were infected with different combinations of two CMBs, African cassava mosaic virus (ACMV) and EACMV-Ug, alone and with SEGS-1 or SEGS-2. The experiment will determine if the SEGS can promote disease in a plant species that is not readily infected by CMBs alone.

**Poster Number: 190**

**Gene Expression Analysis of the Ein3/eil Transcription Factor Family in Arabidopsis Seedlings**

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Ethylene is a phytohormone that plays a key role in plant responses to environmental stressors and in numerous physiological processes, including cell elongation, fruit ripening, and leaf senescence. When seeds are germinated in the dark in the presence of ethylene or its precursor ACC, seedlings demonstrate a triple response phenotype: short and thick shoots and roots and exaggerated apical hooks. At the molecular level, ethylene is known to trigger changes in gene expression. ETHYLENE INSENSITIVE3 (EIN3) and EIN3-LIKE1 (EIL1) are transcriptional master regulators of the ethylene pathway that bind to the target gene promoters and induce a cascade of ethylene responses. EIN3 and EIL1 are homologous to EIL2-5, four additional family members whose function in the ethylene signaling pathway has not been addressed. An essential step towards understanding the unique roles of individual EIN3/EIL family members in ethylene signaling is to characterize the expression patterns of these genes during ethylene treatment in wild-type plants and in various classical ethylene mutants. For this project, we grew an array of ethylene mutants (*ein2, ein3, eil1 and ein3 eil1*) and wild-type plants in the dark for 3 days with and without supplementation with ethylene or ACC, extracted RNA from these plants, converted the transcripts to cDNA via reverse transcription, and assayed *EIN3/EIL* expression by qRT-PCR. This work is expected to shed light on the levels of gene activity of *EIN3* and *EILs* in seedlings and uncover potential ethylene-mediated regulation and compensatory expression, if any, within this transcription factor family.

**Poster Number: 195**

**How Do Plants Detect Heat?: Thermocycle Sensing And Gene Expression In Arabidopsis Thaliana**

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It is vital to understand how plants detect excessive heat, in light of climate change and the observed increase in both day- and nighttime temperatures. In agriculture, such an understanding could be the solution to mitigating projected crop yield decreases due to heat stress. Plants express certain genes in response to daily temperature cycles, which can be referred to as thermocycles. Analyzing how plants sense thermocycles could answer questions on this topic. To do this, we identified five genes that cycled
uniquely in thermocycles or in both photo- and thermocycles. Reporter lines were generated for five genes: (AT2G41990 (10)- Companion of cellulose synthase 3/ CC3; AT5G66740(11)- spindle assembly abnormal protein; AT1G76410 (12)- RING/U-box superfamily protein; AT2G27420 (13)- Cysteine proteinases superfamily protein; AT3G18560 (14)- hypothetical protein; At1G05170 (15)- Galactosyltransferase family protein). The promoters of these genes were then cloned into a vector with a luciferase marker, which was then transformed into Arabidopsis thaliana plants. Seeds from the T1 generation of three reporter lines were grown on a selection medium and were screened for expression of their respective reporters after seven days. Ones that luminesced confirmed the presence of the luciferase marker, indicating the transformation was successful. Plants from the AT3G18560 promoter line had the most transformants and were transplanted to soil. Seeds from these plants will be collected, and this process of screening and collecting seeds will continue for several generations of the plants. Transformants will be used in experiments designed to understand how these promoters operate in thermocycles.

Poster Number: 212

Development of A Qpcr Assay for Detection of Pseudoperonospora Cubensis Aerial Sporangia Using Genetic Markers Identified Through Ngs Technology

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Cucurbit Downy Mildew (CDM), caused by the obligate oomycete pathogen Pseudoperonospora cubensis, is an economically devastating pathogen on a variety of cucurbit hosts. Airborne sporangia of P. cubensis are the most important source of inoculum to initiate disease as well as cause secondary plant infections. Furthermore, airborne sporangia of this obligate oomycete are known to be able to travel long distances and survive for prolonged periods of time to solar radiation. Using Next Generation Sequencing (NGS) and bioinformatics tools, several unique and conserved candidate genomic regions were identified to serve as diagnostic genomic markers for P. cubensis. Specific primers and probes were designed using one of the candidate markers to develop a qPCR detection assay and the threshold detection level of P. cubensis sporangia DNA was determined to be 100 fg. Sensitive and robust DNA extraction methods are being developed to eliminate PCR inhibitors in samples collected using an impaction type roto-rod spore trap. The optimized qPCR assay will be used for detecting and monitoring airborne P. cubensis sporangia inoculum level in the field following entrapment with spore traps. This assay will significantly improve P. cubensis biosurveillance efforts and decision tools for growers by monitoring inoculum levels throughout the growing season.

Poster Number: 227

Endosperm-based Hybrid Inviability In Mimulus Plants

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Plants in the genus *Mimulus* exhibit varying degrees of post-zygotic reproductive isolation. Such reproductive barriers may be both a result of speciation and potentially a driving force of speciation events. Incompatible crosses between *M. guttatus* and *M. nudatus* produce inviable hybrid seeds because of the disruption of endosperm development. However, crosses between *M. guttatus* and *M. pardalis* form viable seeds. Studying both viable and inviable crosses allows us to test for the parent-of-origin effect in developing seeds. Imprinted genes, in which the parent-of-origin effect occurs, are found in the endosperm and are expressed predominantly from either a maternally or paternally inherited allele that facilitates the amount of resources allocated to the offspring. Paternally expressed genes (PEGs) are thought to be deregulated in incompatible crosses, which may be a cause of endosperm-based reproductive barriers. By examining potential imprinted genes in these crosses, we aimed to gain a better understanding of the mechanisms behind hybrid seed sterility. The overall goal of this project was to identify loci that support reproductive isolation between closely related *Mimulus* species. We successfully validated a PEG gene in *M. guttatus* and *M. pardalis*. In the future, examining this PEG in the incompatible cross of *M. guttatus* and *M. nudatus* could broaden our understanding of imprinted genes’ role in reproductive isolation. We also phenotyped seeds and completed a germination assay to analyze the germination success of hybrid seeds compared to parental self-crosses. Examining these factors will illuminate how seed development and speciation are influenced by genomic imprinting.

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**Interface of Computations and Experiments – Chemistry**

**Poster Number:** 51

**Tunable Energy Transfer Between Perovskite Nanocrystals and Surface-integrated Molecular Chromophores**

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Semiconductor nanocrystals have been shown to exhibit size-tunable energetic properties and to undergo energy transfer phenomena with surface-integrated molecular chromophores. As such, this class of materials shows great potential for applications in photonics and optoelectronics. While the synthesis and characterization of perovskite nanocrystals have become well explored in a short time span, perovskite nanocrystals with chromophoric molecules integrated onto the surface is a relatively unexplored topic. It has been shown previously that the bandgap of CsPbX₃ nanocrystals can be altered post-synthetically through anion exchange with a LiX reagent (LiCl, LiBr, or LiI). These tunable energetic properties have the potential to allow the nanocrystal excited state to be transferred to a variety of chromophores. In this study CsPbX₃ nanocrystals were investigated for their potential to act as singlet and triplet energy donors or acceptors with different molecular chromophores. Computational studies on the chromophores were completed to supplement the experimental data. Through computational studies, the energy gaps and frontier orbitals of potential molecular chromophores were explored in order to determine the ideal conditions for observing energy transfer. Steady state and time-resolved photoluminescence and absorption spectroscopies were used to observe experimentally the energy transfer from the nanocrystal to the chromophore. Through steady state photoluminescence spectra, it
was shown that the nanocrystal was effectively quenched by a modified derivative of 9,10 – diphenylanthracene, suggesting that energy transfer was successful. In the future, the CsPbX₃ nanocrystals can be integrated with chromophores possessing different energetics to better understand the nanocrystals’ utility as energy donors or acceptors.

Poster Number: 52

**Computational Study of Ground and Excited State Properties of A Series of Azo Dyes**

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Azo dyes are a large class of organic dyes with a R-N=N-R’ functional group, where R and R’ are most often aryls. Azo dyes are widely used in the textile and pharmaceutical industries, as varnishes, crayons and industrial paints, and were even used as food additives in the past. This work describes a computational study of a series of eight azo dyes derived from azobenzene (R = R’= phenyl), with the goal being to understand how functional groups on the phenyl rings change the potential energy landscape of azobenzene derivatives and modify their excited state properties. Density functional theory (DFT) calculations at the B3LYP+D2 level with 6-311G* basis set were employed to optimize structures of the dyes in both cis and trans conformations, while time-dependent DFT (TD-DFT) with the same functional and basis set was utilized to obtain UV-Vis spectra of all dyes. We found that substitutions on the phenyl rings reduce the HOMO-LUMO gaps and shift absorption spectra of the dyes to lower energies. These substitutions also affect the energy difference between the cis and trans conformations of the dyes, stabilizing the dyes in their trans conformation. Keywords: DFT, azo dyes, cis and trans conformations, and HOMO-LUMO

Poster Number: 58

**Biosynthesis of Saxitoxin: Identifying the Construction of Its Core Structures**

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Saxitoxin, a natural product biosynthesized by *Gonyaulax cateralla* and *G. excavate*, is a potent paralytic shellfish poison. In humans, saxitoxin causes food poisoning upon ingestion and its propensity to accumulate in certain shellfish species has contributed to decline in shellfish populations. Biosynthetic routes for saxitoxin have been proposed through a transformation starting from L-arginine, and several early-stage intermediates have been identified using in vivo and feeding experiments. However, the enzymes and mechanistic details responsible for the construction of the saxitoxin core structures have yet to be identified. In this work, we have made efforts to chemically synthesize proposed intermediates and products to probe the saxitoxin biosynthesis in conjunction with computationally modelling the
enzyme-substrate interactions that are hypothesized to be involved in constructing saxitoxin tricyclic core structure. We chose to model the calculations with the enzyme’s cofactor, in this case an iron porphyrin. The calculations were performed with Alrichs VDZ** basis set, enhanced with a p-function, for the iron atom and 6-316* for all of the remaining atoms. The geometry optimizations, frequency calculations and potential energy scan were done for each step of the synthesis. With the obtained information, we are able to calculate the thermodynamics for each net reaction, activation energy, identifying intermediates that might be relevant to saxitoxin and the stability of the two products that are formed.

Poster Number: 63
**Mechanistic Study of Oxime Ligation Via In Situ Oxidation of N-phenylglycinyl Peptides**

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The bioorthogonal nature of the oxime functionality makes it an effective bioconjugation strategy. A variety of novel hybrid materials with a wide range of biomedical applications have been developed taking advantage of the relative ease of oxime bond formation between alkoxyamine- and aldehyde-/ketone-containing molecules. Oxime ligations proceed through pH-dependent imine-based reactions with low reactivity at pH 7.0 in the absence of aniline catalysts. However, the ability of anilines to readily react with endogenous aldehydes and ketones render oxime ligations “biorestricted”. We previously reported the pH-dependent chemoselective oxidation of N-terminal N-phenylglycines to form α-imino amide intermediates *in situ*, followed by coupling with aminooxy functional groups to give oximes under mild conditions. In this study, we use a small molecule approach to dissect the mechanism of oxime ligation via *in situ* mild oxidation of N-arylglcines. Density functional theory (DFT) methods were also employed to examine the proposed mechanism on model systems, with primary focus on the energetics of the reaction steps in neutral and acidic conditions.

Poster Number: 65
**Experimental and Computational Determination of Acid Dissociation Constant (pka) and Hydricity in Rhenium Hydrides**

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Rhenium hydrides can be cleaved to produce a metal hydride (H-), a proton (H+), or a radical (H·), along with the corresponding metal species. The heterolytic cleavage of Re-H bonds was studied computationally (DFT) to determine the acidity or hydricity of a given Re-H. For this purpose, the term
net hydricity (ΔΔG) was defined as the difference in free energy for the acidity of a given metal hydride from the hydricity of this same hydride. Computational data supports the claim that a negative ΔΔG for a specific rhenium hydride will result in a more acidic Re-H bond while a positive ΔΔG will be more hydridic in nature and more readily participate in hydride transfer. A strong linear correlation with ΔΔG and the NBO charge was observed and found to be a useful way to predict the hydricity and acidity of rhenium hydrides. This new method allows for the prediction of acidity or hydricity from a single NBO calculation and greatly reduces the number of calculations required to determine hydricity or acidity of a given metal hydride.

Poster Number: 70
Reactivity Studies of Dehaloperoxidase with Epa Priority Pollutants: A Combined Spectroscopic and Computational Approach
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As a part of the Clean Water Act, the Environmental Protection Agency (EPA) maintains a list of priority pollutants that are toxic to humans and other living organisms. Phenols and cresols are among the chemicals found on the EPA list and are known to be toxic chemicals produced by oil refining, coal production, wood-preservation, and several other industrial processes. There are known mechanisms for the biodegradation of pollutants found in aquatic environments. One of interest is the detoxifying abilities of the enzyme dehaloperoxidase (DHP), the coelomic globin found in the marine organism Amphitrite ornata. Dehaloperoxidase is the first globin found to possess a biologically-relevant peroxidase activity, which allows DHP to oxidize a wide variety of native and non-native toxic compounds such as halophenols, haloindoles, halopyrroles, and haloguaiacols. To investigate the detoxification ability of DHP further, we selected o-cresol, 4-methyl-o-cresol and pentachlorophenol, phenolic compounds found on the EPA priority pollutant list, and studied their reactivity with DHP using biochemical assays (HPLC, binding studies) and spectroscopic/spectrometric methods (LC-MS, UV-Vis, and stopped-flow UV-Vis). Through these methods, we found that DHP is reactive in the order: 4-methyl-o-cresol, o-cresol, pentachlorophenol, with 4-methyl-o-cresol being the most reactive and pentachlorophenol being the least reactive. The substrate binding affinity also follows this same order, with 4-methyl-o-cresol exhibiting the greatest affinity, and pentachlorophenol the least. Our results suggest that DHP could be advantageous as an alternative method for detoxifying polluted environments.

Poster Number: 169
Structural and Mechanistic Features of a Carbene Complex Involved in Hydrosilation
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An oxorhenium (V) carbene complex was shown to be a precatalyst for the hydrosilylation of aldehydes. A substrate scope showed moderate to good yields for a variety of aryl and aliphatic substrates with a range of 30-78%. Based on preliminary experimental evidence, the mechanism of hydrosilylation was modeled with DFT (B3PW91-D3) using a Re (III) complex as the active catalyst. A comparison of the calculated Re (III) complex with an X-ray crystal structure of the oxorhenium (V) precatalyst suggested that agostic interactions are important for stabilizing the active catalyst.

Poster Number: 209

Accessing the Triplet Manifold in Thionated Perinone Chromophores

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The synthesis and photophysical properties of a series of thionated molecules with analogous structures to naphthalenebenzimidazole chromophores, or perinones, is presented. In previous work, the photophysical properties of perinones were shown to exhibit broad absorbance bands with significant charge transfer character, as well as near unity fluorescence quantum yields in some cases. However, since these molecules lack sufficient spin-orbit coupling to induce efficient intersystem crossing, they have inaccessible triplet manifolds and relatively short-lived singlet excited states. In this work, thionation of the carbonyl moiety resulted in population of low energy π→π* excited singlet states, which supported rapid intersystem crossing to low energy π→π* triplet excited states. Since the triplet manifold was efficiently populated, fluorescence was quantitatively quenched, which resulted in long-lived triplet excited states with lifetimes extending into the microsecond time domain. Formation of the thioketone also resulted in a significant red-shift to the lowest energy absorbance bands, which cover a broader range of the visible spectrum. Through the support of density functional theory (DFT) calculations, transient absorption, and photoluminescence spectroscopy, a mechanism for excited state decay through the triplet manifold is proposed.

Poster Number: 215

Computational Study Of 1-(arylsulfonyl)cyclopropanol And Cyclopropanone Equilibrium

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Computational studies of the formation of cyclopropanone in situ from 1-(arylsulfonyl)cyclopropanol precursor is presented. Cyclopropanone is an important building block in organic synthesis for the development of more complex molecules. However, cyclopropanone is highly reactive, very difficult to isolate and it’s formed from precursors in situ. Recently, 1-(arylsulfonyl)cyclopropanol has been identified as an efficient cyclopropanone precursor over the hemiacetal forms due to its higher reactivity and stability. Two mechanisms for the equilibrium of cyclopropanone and its precursor have been proposed. The developed of RB3LYP as the calculation method and 6-31G (d,p) as the basis set provided
us the equilibrium’s pathway and how different substituents at the sulfonyl position affects the equilibrium constant. By using electronic structure calculations, our work focused on determining the most favorable mechanism along with the effects of the equilibrium rate of the different analogs. Computational results were compared with Grignard additions with different 1-(arylsulfonyl)cyclopropanol analogs.

Poster Number: 225

**Room Temperature Hydrosilylation Of Imines by Triethyl Silane Catalyzed by an Air Stable Rhenium(v)-oxo Complex**

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Hydrosilylation of imines presents an alternative toward the synthesis of amines without the use of high-pressure hydrogenation. This work is focused on the catalytic hydrosilylation of substituted aryl imines with triethylsilane under mild conditions. The reaction is catalyzed at room temperature by a rhenium (v)-oxo cationic complex, bis[2-(2'-hydroxyphenyl)-2-oxazoline] oxorhenium (V) tetratetrafluorophenylborate (1). The catalyzed hydrosilylation of a series of imines was evaluated and substituent effects on reactivity were explored. Synthesis and characterization of a series of aryl substituted imines as well as the 2-(2'-hydroxyphenyl)-2-oxazoline ligand (2), catalyst precursor chlorobis[2-(2'-hydroxyphenyl)-2-oxazoline]oxorhenium(V) (3) and the active catalyst (1) is presented. In addition, electronic structure methods using Gaussian 16 were used to probe functional group effects in the rate-determining step of imine formation from substituted anilines and aryl aldehydes.

Poster Number: 240

**Investigation of The Oxidizing Capability of Homoleptic Copper(i) Complexes**

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Metal complexes of electron-deficient ligands have gained interest because of their potential use as photo-oxidants, and therefore, their application as photo-catalysts or in photo-induced atom transfer processes. In this work, the synthesis, characterization, and electrochemical and photophysical properties of homoleptic copper(I) complexes bearing 1,10-phenanthroline ligands with bulky fluorinated substituents in the 2 and 9 positions are reported. The design of such complexes is aimed at increasing the Cu(I)/Cu(II) redox potential and the lifetime of the MLCT excited state. In order to optimize the desired electrochemical and photophysical characteristics of these systems, a family of copper(I) complexes was investigated using density functional theory (DFT) and time-dependent DFT (TDDFT) calculations. These computational simulations brought insight into the MO energy levels, electron
density distribution, redox potentials, and the structural reorganization between the excited and ground states of the studied complexes.

Poster Number: 243

**Investigating the Ligand Properties Necessary for Effective Cobalt-based Nitrate Reduction**

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Experimental investigations have led to the discovery of a cobalt complex, [Co(DIM)]⁺, that acts as an electrocatalyst for the selective reduction of nitrate to ammonia in aqueous solution. Other potential Co-based catalysts such as [Co(cyclam)]⁺ and [Co(TIM)]⁺ have also been investigated. [Co(cyclam)]⁺ can catalyze nitrite reduction but is not selective and stops at harmful intermediates, such as nitrite and hydroxylamine. [Co(TIM)]⁺ is inactive for the reduction of nitrate. In order to understand the differences between cyclam, DIM, and TIM ligands, density functional theory (DFT) calculations were employed to investigate the mechanism for initial reduction of nitrate to nitrite. All calculations utilized the B3LYP functional with D2 dispersion correction, and SDD pseudopotential and accompanying basis set on cobalt. The 6-31G* basis set was used on non-cobalt atoms for structure optimizations, while single point energy calculations employed 6-311+G** on non-cobalt atoms. All complexes were optimized in water using the SMD model to account for the solvent effects. Three mechanisms for nitrate reduction were obtained and analyzed to determine the structural and electronic features that make [Co(DIM)]⁺ more successful catalyst. This study reveals how a combination of redox non-innocence, hydrogen bonding, and ligand flexibility dictates Co-catalyzed nitrate reduction.

Poster Number: 262

**Evaluation of Boroxines for the Synthesis of β-amino Esters From β-lactams**

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β-amino esters are of great interest in the biochemical field due to their vast biological activity including possible HIV and HSV inhibition. β-Lactams provide an efficient platform for β-amino ester formation through nucleophilic attack of the carbonyl. β-Lactam openings readily occur using simple alcohols (methanol or ethanol) under acidic conditions. The use of acidic conditions limits functional group tolerability and does not allow for the use of more complex alcohols to open β-lactams. Experimental evidence suggests that boroxine and its derivatives might be good reagents to enable the formation of more complex β-amino esters from β-lactams under mild conditions. In the present study boroxine-mediated β-amino ester formation from β-lactams has been evaluated both computationally and experimentally. Using DFT B3LYP/6-31G(d,p), a mechanistic pathway for the β-amino ester formation has been proposed and the mechanism in the presence of boroxine was studied using a several substrates.

**Kelman Scholars – Plant Pathology**

**Poster Number: 21**

**Identification of Unknown Industrial Hemp Diseases in North Carolina**

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Industrial hemp (*Cannabis sativa*) is an annual crop with a variety of uses such as textiles, plastics, medicines, and carbon sequestration. The increasing recognition of hemp as an industrial crop highlights the necessity of establishing a foundational understanding of industrial hemp pathology for wide-scale pest management. To determine the potential virulence of common pathogens within hemp, six pathogens isolated from diseased hemp from NC were used in Koch’s postulate testing. *Cannabis sativa* var. ‘Carmagnola’ plants were grown in 6” diameter pots with a Sunshine Redi-Earth Pro Growing Mix (50:50 soil substrate) and cement sand. Each plant was inoculated with a pathogen isolate and observed for 4 weeks in a controlled growth chamber. Pathogens from each plant were then re-isolated and cultured for analysis. Following extraction and PCR amplification, DNA from each pathogen was processed via NGS Sequencing. Geneious (Auckland, New Zealand) was used to compare previously obtained sequences of known organisms. The results from this study will be used to establish disease management recommendations for North Carolina producers.

**Poster Number: 27**

**Characterizing Sources of Resistance In Sweetpotato to Black Rot Caused by Ceratocystis Fimbriata**

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Black rot, caused by *Ceratocystis fimbriata*, is a soilborne fungal pathogen that affects sweetpotato storage roots and currently threatens the industry in the United States. *C. fimbriata* impacts sweetpotato production by causing black, sunken cankers on the developing roots, which result in stunting, wilting, chlorosis, and eventually death. The purpose of this study was to assess levels of susceptibility among a diverse panel of sweetpotato accessions. Roots of sixteen different accessions of sweetpotatoes were inoculated with an isolate of *C. fimbriata* and incubated for 21 days in a growth chamber at 23°C and >95% humidity. Lesion diameter was measured every 3 days. The cross-sectional area of lesion was calculated at the end of the experiment through image analysis of each sweetpotato accession. All accessions of sweetpotatoes displayed similar levels of susceptibility with Covington exhibiting the lowest susceptibility to *C. fimbriata* while NC05-198 and Hatteras portrayed the highest susceptibility. In addition, we inoculated 10 slips from 22 sweetpotato accessions including cultivated, advanced breeding lines, and historical accessions. Slips were submerged in a *C. fimbriata* spore suspension (10^6 spores/ml) for 10 minutes and immediately transplanted into potting media. The incidence of above and below ground symptoms was recorded over four weeks. NC-413 presented the lowest disease incidence values at 20% followed by Apache with 50% incidence. The highest disease incidence was observed for Jewel and Norin 4. Results obtained in this study are beneficial to sweetpotato producers as they improve decision making to reduce yield losses due to black rot.

Poster Number: 31

Expressing Magnaporthe Oryzae Plant Cell Death Suppressing Effectors In Rice

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Rice blast, caused by the fungal pathogen *Magnaporthe oryzae*, is a devastating disease in rice. *M. oryzae* secretes numerous effectors when invading rice plants. However, many effectors have yet to be fully characterized. In our previous study, utilizing the transient expression of candidate effectors in the leaves of the model plant *Nicotiana benthamiana*, we identified 11 suppressors of plant cell death (SPD) effectors from *M. oryzae* that were able to block the host cell death reaction induced by Nep1. Some SPD effectors have been partially characterized and shown to be required for virulence or are homologs in other pathosystems, or shown to be expressed in rice epidermal cells prior to infection by *M. oryzae*. However, other SPD effectors are completely uncharacterized. In this study, we further investigated the role of *M. oryzae* SPD effectors in rice. Five SPD effectors genes (MC69, BAS52/MoHEG13, BAS3, BAS126, and SPD4) containing His- tag were cloned into the plant expressing vector, pBDLO3, and then transformed into rice calli by *Agrobacterium*-mediated transformation. Viable rice transformants were confirmed using selection media and successful insertion of SPD effector genes were verified by PCR. Creating these effector expressing rice plants will enable detection of rice protein binding targets, and determine if the SPD effectors have a role in pathogenicity.

Poster Number: 75

Identification and Characterization of Fusarium Oxysporum F. Sp. Lycopersici from Greenhouse Tomatoes in North Carolina
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*Fusarium oxysporum* f. sp. *lycopersici* (FOL) is a fungal pathogen that causes Fusarium wilt in tomatoes, characterized by vascular wilting and yellowing of the plant. Currently, the main method of control is the selection of resistant tomato cultivars (Takken & Rep, 2010). However, mutations in FOL can cause previously resistant cultivars to become susceptible to the pathogen. These mutations have led to the rise of three known races of FOL, which appear morphologically identical but have unique mechanisms of pathogenicity. In recent years, vascular wilt and yellowing have been observed on tomato plants growing in nine greenhouses across North Carolina. Thirty-five isolates were collected from symptomatic plants and identified as FOL based on preliminary tests. These isolates were further characterized by race typing using differential cultivars, polymerase chain reaction (PCR)-based race specific primers, and mating type loci. All three FOL races were detected, and both MAT1-1 and MAT1-2 loci were present. Isolate sequences were analyzed to determine the correlation of three housekeeping genes and twenty-seven fungal effector genes with wilt symptoms. The results imply that FOL isolates are genetically highly diverse and that the pathogen has been introduced into greenhouses in North Carolina through contaminated seeds or tomato transplants. Continued monitoring of FOL races and the deployment of new tomato varieties with multiple disease resistance genes remains the best Fusarium wilt management strategy.

**Poster Number: 82**

**Effect of Inoculum Age in Sweetpotato Black Rot Disease Incidence Caused by Ceratocystis Fimbriata**

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*Ceratocystis fimbriata*, a fungal plant pathogen which recently reemerged in 2014, has become a major concern for the United States sweetpotato industry. This pathogen causes the disease known as black rot when infecting sweetpotatoes and has resulted in economic damages of up to $150 million nationally for sweetpotato producers. Research on pathogen biology is still in its early stages, as very little information regarding the interactions between *C. fimbriata* and the sweetpotato host is available. The purpose of this study was to understand the effect of spore age on the ability of *C. fimbriata* to successfully infect its host. Spore suspensions of 5x10^3 were prepared from live cultures and aged for 0, 24, 48, 96, and 144 hours. At each time point, 20 sweetpotatoes were sterilized and half were wounded. Of these sweetpotatoes 5 wounded and 5 non-wounded sweetpotatoes were soaked in aged spore suspension for 20 minutes, while the remaining 10 roots were soaked in water to serve as a control. After treatment, the sweetpotatoes were placed into clear sterile bins, and held at 29°C in the dark for 14 days, with incidence ratings occurring every other day. Study results indicate that disease incidence was greatest with fresh inoculum but the pathogen was still able to successfully infect sweetpotatoes when
spores were 48 hours old. The findings of this study highlight the risk of using recirculated water in sweetpotato wash tanks, which can contain small amounts of fresh spores and large amounts of older inoculum.

Poster Number: 124
**Are Malagasy Ants Morphologically Adapted To Their Habitats?**

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Most species are adapted to the environment they live in. Adaptation is one of the main reasons for the morphological variations in closely related species. In my study, I compared the morphology of 85 ant species in the genus *Camponotus* occurring at 12 locations in six different habitat types in Madagascar. The purpose of this study was to test for morphological adaptations the ants may have as a result of their environment and how those differ between ants from different habitats. I measured six characteristics of the ant body in order to assess those morphological adaptations and used these measurements to calculate body size indexes. All species were scored as present or absent at each location. The data was then analyzed using packages vegan, ape, and picante on R. The littoral forest had the lowest amount of species richness of all the habitats (18), while the rainforest had the most (42). Beta diversity tests showed that the localities were relatively dissimilar (0-55%) in species composition. Bray-Curtis dissimilarity clustering showed that the montane rainforests and rainforests were more similar to each other than to the rest of the localities. The dry and littoral forests localities were similar to each other. The spiny forests localities were most similar to each other, and so were the grass/woodlands localities. No significant differences were found in the measurement means between localities. While the species composition varies between habitats, the measurements do not, which could mean that those traits are not related to their environment.

Poster Number: 138
**The Occurrence of Quinone Outside Inhibitor and Carboxylic Acid Amide Resistance in Cucumber and Squash NC Populations of Pseudoperonospora Cubensis**

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*Pseudoperonospora cubensis*, the causal agent of cucurbit downy mildew (CDM), is the obligate airborne oomycete pathogen responsible for the overwhelming loss of crops in the *Cucurbitaceae* family in the United States (US). Prior to 2004, host resistance was a successful way to manage the disease but after the resurgence, growers have had to rely on extensive fungicide programs. Due to this, only a few fungicides remain efficacious because of the development of fungicide resistance in populations of *P.*
**Poster Number: 177**

**QoI Fungicide Resistance In North Carolina Cercospora Sojina**  
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Cercospora sojina is a fungus that causes a foliar disease of soybeans (Frogeye leaf spot) and can cause significant yield losses. Recently, QoI fungicide resistance was identified in several counties of NC, but the extent of the distribution of fungicide resistance is unknown. To determine the distribution of fungicide resistance in NC, samples were taken from across the state. DNA was extracted from soybean leaf samples using a Qiagen DNeasy Powersoil kit, then samples were assessed using primers designed to amplify the G143A mutation present in fungicide-resistant C. sojina. PCR products were visualized using gel electrophoresis (2% agarose gel at 70V for 50 minutes). Fungicide resistance was found in Franklin, Johnston, Columbus, Person, Pasquotank, Rutherford, Cleveland, and Camden counties. Further assessment of DMI fungicide chemistries in in vitro assays is being used to determine what fungicides are best deployed in NC.

**Poster Number: 189**

**Development of A Rapid P. Nicotianae Race Assay**  
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Phytophthora nicotianae is a pathogen that causes black shank of tobacco and can result in up to 100% loss in fields. Two races of *P. nicotianae*, Race 0 and Race 1, affect tobacco in North Carolina, but to distinguish the races requires testing that can last 2-3 weeks, making present identification methods time ineffective. Using the sequenced genomes of Race 0 and Race 1 of *P. nicotianae*, primers were developed utilizing SNPs in dissimilar regions of the two genomes and tested for accuracy using PCR reactions and gel electrophoresis. DNA from known isolates of Race 0 and Race 1 were extracted and used to test the developed primers. Primers were assessed based on specificity and sensitivity to each mating type, and potential formation of primer dimers, which were visualized using gel electrophoresis. Using the
developed and tested primers, the assay will be further used for testing unknown samples found in North Carolina to determine the race of *P. nicotianae* infecting tobacco samples. Furthermore, they will be incorporated into a handheld device (Biomeme, Inc.) for rapid testing of *P. nicotianae* race structure.

Poster Number: 232
**Effect of Multiple Stressors (nematicides, Neuroinhibitory Compounds and Temperature) on the Growth and Behavior of the Model Nematode Caenorhabditis**

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Over the course of three days, mixed populations of *Caenorhabditis elegans*, strain N2, were subjected to different concentrations of: nematicides abamectin and fluopyram, the antihypertensive drug phentolamine and the antihistamine epinastine and temperatures. Four replicates per treatment were included and the treatments were placed in two groups, one in a solid medium and the other in a liquid medium with food (NA22 *E. coli*) in wells of a 24 well plate. Solvent (0.1% acetone-triton) and buffer controls were also included. Observations were made after 24hr, 48hr and 72hr for population growth, movement, reproduction, and general behavior. After 48hr, all worms in the fluopyram-treated wells, in both media, were either dead or immobile at all concentrations. Abamectin had higher concentration wells exhibiting almost no mobility (paralyzed or dead) and the lower concentration wells displaying growth patterns like the controls, although restricted movement was occasionally observed. The nematicides appeared to be more effective in the liquid medium since the paralysis seemed to set in quicker than the solid media. With phentolamine and epinastine, the population at 48hr was made up of mostly active adults, suggesting that development was not impeded but reproduction was inhibited. For observing the effect of temperature on nematode growth, mixed populations of worms were placed in liquid media with and without food in at room temperature (24°C) and incubators with temperatures set at 28°C and 37°C. Most worms, particularly at 37°C, exhibited limited or no movement after 24 and 48 hours compared to worms incubated at room temperature.

Poster Number: 241
**Evaluation of Pepper Varieties for Control of Sclerotium Rolfsii**

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*Sclerotium rolfsii* is a soilborne plant pathogen that can impact a large selection of host crops including bell, hot and sweet peppers (*Capsicum anuum*). This fungus is the direct cause of southern blight: a disease that infects the lower stem of pepper plants near the soil causing yellowing and wilting of the leaves and rotting at the soil line. This disease typically occurs in mid-summer and can cause light outbreaks in specific areas of the field or can result in the total loss of the crop depending on
environmental conditions. A greenhouse study was conducted using five pepper varieties to determine the resistance of these varieties to *Sclerotium rolfsii*. The pepper varieties evaluated were ‘Aristotle’, ‘Jupiter’, ‘Big Bertha’, ‘Inferno’, and a *Phytophthora capsici* resistant variety, ‘Criollo de Morelos’. To also evaluate the effect of inoculum amount on disease level, each variety was inoculated with *Sclerotium rolfsii* at varying rates of 0, 2.5, 5, 7.5 and 10 grams of inoculum per plant for a total of 20 inoculated plants and 5 controls. The plants were assessed daily for 5 days for signs of disease incidence. Findings of this study will assist in developing management strategies for southern blight on pepper that rely on reducing inoculum levels and deploying less susceptible varieties in infested fields.

Poster Number: 242

**Characterizing Root Secreted Metabolites of Iron Replete and Starved Arabidopsis Varieties Via CEs/ms/ms**

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Plants form complex relationships with both biotic and abiotic factors in the rhizosphere, resulting in symbiotic relationships in which metabolites are exchanged. Previous research suggests that environmental and nutrient stressors can influence plant metabolomic profiles and change its interactions with the rhizosphere. The full effect of iron stress on *Arabidopsis* and its secreted metabolites is yet unknown as past work has focused on coumarin biosynthesis under such conditions. By collecting sterile *Arabidopsis thaliana* exudates and characterizing them via high resolution Capillary Electrophoresis Tandem Mass Spectrometry (CE-MS/MS) analysis, this study determines if two variations of *Arabidopsis* have different compositions in iron replete and iron starved media, expanding our knowledge of how iron deficiency affects the exudate profiles of each accession. Genetically, the two variations are identical with the exception of the PYE-1 gene in Popeye which exacerbates the effect of the iron starvation response. Under our conditions, plants were severely iron limited as evident by extremely stunted growth and chlorosis. Consequently, a significant difference in metabolomic profiles was expected compared to Col-0. Between iron starved and replete samples, we observed strong differences in both specific metabolite quantity and total secretion per plant mass. Total carbon and nitrogen data from the dried plants was obtained in order to make estimates about how much available material was extracted. In order to then assess the effects on typical rhizosphere bacteria, we developed bioassays with an emphasis on nitrogen using bulk tomato exudates.

**MAE REU in Composites**

Poster Number: 39

**Fabricating Soft Robotic Actuators For Use In Artificial Muscles**

Author: 
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Fiber-reinforced soft actuators (FRSAs) are a composite component of a soft robot that carry out movements such as bending, twisting, extending, and contracting. FRSAs offer a low-cost, biomimetic solution to problems where high compliance to deformation and human safety are priorities. Previously the fabrication of FRSAs has largely been an artisan task which requires experience and manufacturing skill. We investigated a FRSA fabrication method that addresses the challenges in fabrication and repeatability in existing methods. We developed an injection molding process for molding the elastomer; injection molding is preferred over the traditional method of casting because it introduces fewer air pockets and reduces human error in evenly pouring the elastomer. We used deep grooves to better guide the fiber reinforcements along the actuator and handles on the 3D printed molds to assist in demolding. Using the FRSAs as artificial motor units, we explored novel variable stiffness artificial muscle designs. FRSAs are arranged at different pennation angles, which are angles relative to the muscle actuation axis, in the artificial muscles we created to mimic the architecture of human muscles. This allows for the future study of the effect of pennation angle and FRSA arrangement on the force and strain characteristics of these artificial muscles.

Poster Number: 193

**Impact Analysis of Ballistics on Kevlar at High Speeds with Varying Projectile Geometries**

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Behind armor blunt trauma (BABT) is the result of a projectile impacting a personal protection system without armor penetration. It has become an increasing concern as lightweight armament have been dominating the modern battlefield. Depending on the projectile injuries can vary from minor bruises to internal bleeding. Analysis of back-face deformation that results in BABT is needed to help mitigate these injuries. For this project, the geometry of the projectile head and projectile mass were investigated to determine its effect on the depth and width of the back-face deformation over time. This experiment was conducted with a gas gun connected to a chamber where projectiles were fired at selected speeds. The rounds were chosen due to how they vary in either mass or projectile head geometry. After the data was recorded with high-speed footage and analyzed, notable differences were shown amongst the deformations caused by the projectiles. As the projectile got heavier, it not only created a greater width and depth but caused more rippling upon impact. As the projectile’s head became sharper, the width decreased, and the depth increased even causing some rounds to slip through the fibers themselves. These key differences among the deformations reveal that there is a direct relationship between mass and head geometry with impact area. There is a positive correlation between mass impact area and a negative correlation between the angle of the projectile head and deformation.

**McNair Scholars**

Poster Number: 213

**Photothermal Heating as a Strategy to Align Anisotropic Metal Nanoparticles Within Polymeric Films**

Author:

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Thin polymer films containing aligned anisotropic metal nanoparticles are desirable for potential optical applications (e.g., polarizers and filters), as well as for fundamental research (e.g., micro-rheology). Experimentally, achieving alignment at dilute particle loading levels is challenging as reduced inter-particle coupling prevents self-organization or packing. Mechanical sample stretching (to several times its original length) or applications of a strong electric field during film casting are common approaches. However, both schemes result in polymeric systems that are fundamentally altered (with highly elongated chains) and thereby, limit the ability to probe the innate polymer dynamics. An alternative approach is to apply an electric field while simultaneously undergoing photothermal heating. In this case, application of light resonant with the surface plasmon of the nanoparticle results in localized heating, melting only the immediate surrounding polymer and enabling electric field driven reorientation. Because the environment within the small (1 μm) molten region is highly constrained and entangled, effects from fabrication on the polymer should be minimized.

**Poster Number: 222**

**The Roar and Howl of Rancho La Brea's Top Predators**

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The “Sabertooth Tiger” (*Smilodon fatalis*) and the “Dire Wolf” (*Canis dirus*) are two of the most iconic prehistoric carnivores from ice-age North America. Fossils of both of these extinct predators can be found in large numbers within the Rancho La Brea (RLB) tar pits of California. Communication would have been essential in both species, but, as with all extinct species, we have little understanding of the sounds they were capable of making and hearing. If they were similar to their extant relatives, we would expect that *S. fatalis* roared like modern big cats and *C. dirus* howled like modern wolves and both had similar hearing capabilities. To test these hypotheses, we are evaluating the morphology of the hyoid (vocal bones) and ossicles (ear bones) in the two species through photographing and morphometric measurement of these bones in these two extinct species as well as their extant relatives for comparative analysis. We hope to establish an understanding of the acoustic generating and hearing capabilities of these extinct species. If successful, our study will be the first to deduce the vocalizations of these species, and possible the first to reconstruct the communication abilities of any extinct species.

**Poster Number: 228**

**Dicect Visualization of Lemuroidea Mimetic Musculature**

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The muscles of facial expression, or “mimetic” muscles, are often associated with social communication in visually oriented species. For instance, primates use their mimetic muscles in social signaling for nonverbal communication. While the facial musculature in primates has been extensively studied,
especially by one of our collaborators on this project, little is understood about their three-dimensional fiber orientation. The musculature related to facial expressions is thin and highly integrated with connective tissue; therefore, traditional gross dissection methods used to study muscles’ architecture are not practical. However, through the use of DiceCT, we can now digitally dissect the mimetic musculature. This technique, in which specimens are stained with iodine that binds to specific soft-tissues, changing their opacity in micro-CT scans, allows us to digitally isolate and differentiate between individual muscle fascicles, which makes it feasible to evaluate critical architectural variables such as physiological cross-sectional area (PCSA) and fiber length (FL). In this study, we are digitally dissecting the mimetic muscles of three lemurs: an aye-aye (*Daubentonia madagascariensis*), a blue-eyed lemur (*Eulemur flavifrons*), and a mongoose lemur (*E. mongoz*). Our intention is to take digital measurements of the muscle fibers and calculate PCSA and average FL for each muscle. Once successful, the method of using DiceCT technology can be applied to other species within Lemuroidea as well as other members of the primate orders.

Poster Number: 253

**Jezebel, The Virgin: An Intersectional Critique of Sex Positive Feminism**

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Sex positive or pro-sex feminism is based on the notion that sexual freedom is an essential component of women’s liberation. However, the conversation of sex positivity or sex-positive feminism, more often than not, centers cisgender, heterosexual (cis-het) White women meaning that the experiences of women of color, especially Black women, are left out of the conversation (Butler, 2013, p. 40). Thus, sex positive feminism fails to critically analyze the implications of sex positivity for marginalized identities. While “disparaged sexual identities and styles” are revalued, “the political and economic conditions that are responsible for the devaluation” are left unaddressed and unchallenged (Glick, 2000, p. 26). Sex positive feminism lacks an intersectional critique revolving other systems of power that impact the social constructions of race, womanhood, and the pure/promiscuous dichotomy. With this literature review, I am looking to explore these social constructions and their implications for Black female virgins through a conceptual framework that integrates power as a discursive tool that analyzes systems of power through the tenets of critical race theory and that centers the experience of Black female virgins through Black feminist ideology.

Poster Number: 277

**Urbanization Effects on Relative Weight of Redbreast Sunfish**

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Urbanization, or the process of converting land into urban development, is increasing at a rapid rate. Since 1980 urban land area in the U.S. has nearly doubled and is expected to increase 139% by 2060.
Previous research has documented the degradation caused by urbanization to terrestrial systems, however little research has examined how continued anthropogenic disturbance will affect freshwater systems. Previous studies on freshwater system health have utilized fish as bioindicators of habitat health and provide important information on how anthropogenic impacts affect stream systems. Therefore, we used the common freshwater species, redbreast sunfish (Lepomis auratus), as a bioindicator of urban stream health within the Upper Neuse Watershed in North Carolina. We collected the otoliths of redbreast sunfish from urban (n=3) and rural (n=6) streams. The otoliths were used to calculate the age and growth of the different populations, and we used the relative weight information for North Carolina redbreast sunfish to compare the relative health of the populations. The redbreast sunfish were weighed, and otoliths extracted. The otoliths were viewed with imaging software to determine age and length of otoliths. In the future this data could be used to determine whether a stream should be restored.

**MEAS – Wake Tech Program**

**Poster Number: 6**

**Good Neuse And Bad Neuse: The Effects of Increased Discharge and Precipitation on Carbon Cycling in A Coastal Watershed**

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Increases in the intensity and duration of precipitation events can have a major impact on carbon cycling in riverine systems. The aim of this project is to observe levels of dissolved organic carbon (DOC), CO₂, and alkalinity, to determine how CO₂ is cycled through the Neuse River (NR) watershed in response to storm events. DOC is a key reactive pool of carbon that is important to the release of CO₂ to the atmosphere in riverine ecosystems. From 30 May to 26 June 2018, surface water samples were collected weekly from five locations along the main stem of the NR. Water quality measurements (temperature, pH, dissolved oxygen) were combined with dissolved organic and inorganic carbon (DOC and DIC) analysis to examine the spatial and temporal changes of DOC. Then estimates of the partial pressure of CO₂ (pCO₂), CO₂ flux, and total alkalinity were made along the river. We found that as discharge increased due to precipitation events, DOC and pCO₂ increased along with declines in alkalinity and DIC, leading to an increase in the CO₂ flux from the river to the atmosphere. This indicates that during rain events, rivers act as major sources of CO₂ to the atmosphere as well as major conduits of carbon transfer from landscape to receiving waters (such as estuaries in the case of the NR). These results can be used to better understand how precipitation from increasing storm events can affect the transfer and processing of carbon throughout coastal river basins.

**Poster Number: 23**

**Sources of Nutrient Pollution in Falls Lake**
This study is designed to determine the source of one of the most important nutrients, nitrogen, in Falls Lake which is the main water supply for Wake County. Elevated nutrient concentration in drinking water supplies is a problem across the United States. High nutrient concentrations are detrimental to both drinking water quality and are harmful to the ecosystem. It can cause excess algae growth which depletes oxygen levels in the water (eutrophication), causing harm or death to marine and plant life, and requires the need for more treatment which degrades drinking water quality. To determine the source(s), we sampled all the major tributaries of Falls Lake for nitrogen concentration (TKN and Nitrate). Initial results indicate that streams that have discharge from waste water treatment plants (WWTP) have higher nitrogen concentrations than streams that do not. Although multiple samples were taken both above and below WWTP discharges on each stream, analysis is still in progress on many of these samples. If this is confirmed by all samples, it suggests that reduction of nitrogen discharge from WWTP would be the most effective way of reducing nitrogen load to the lake. The samples were analyzed by the EAD Lab at the Biological, Agricultural, and Engineering Department at NCSU.

Poster Number: 59

Visualizing Oyster Restoration in the Pamlico Sound

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Oysters are a crucial member of estuarine ecosystems. They provide valuable food and habitat for several aquatic species. Oysters ensure high water quality by filtering organic material. They are also a major component of North Carolina’s fishing industry. In past decades, the oyster population in the Pamlico Sound has decreased due to overharvesting and changes in water quality. Planktonic larval oysters require a hard substrate to settle onto to grow to their adult form. To help restore oyster populations, cultch, a mixture of oyster shells, limestone and clamshells is deposited by the North Carolina Division of Marine Fisheries to create new reefs for oyster larvae to attach to. To evaluate these conservation efforts, it is useful to know the precise location and layout of the cultch. Due to low visibility conditions in the Pamlico Sound, visual examination methods are ineffective. To obtain accurate pictures of six restoration sites, side scan sonar and bathymetric data were collected during August 2016 and May 2018. These data were processed to create maps of the study sites. Cultch areas range in size from approximately 1900 to 16,000 square meters. Structural relief is typically less than 0.5 meters. Decreases in cultch surface area due to sedimentation were observed at some sites. These maps will be used to aid ongoing biological studies, and can be updated with future sonar collections to monitor changes.

Poster Number: 109

Geoscience Education: Confidence Levels of Students in Introductory Level Geology Courses and Accuracy Based Learning
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Students rely on their ability to monitor their learning as they progress through a class. Unfortunately, they are often inaccurate in their estimation. A student who either overestimates or underestimates their understanding of critical concepts has calibration gaps in their learning. Calibration gaps can result in students spending excessive time reviewing concepts they already understand, and/or failing to spend sufficient time to review weakly understood concepts. Measures of student confidence levels can reveal the severity of the calibration gap and can be readily obtained. In this study, lines were added to exams to accompany each test question and students intuitively placed a mark along the line to indicate how confident they felt about their response. The position of each mark was then measured to determine the accuracy of their self-evaluation. The absolute value of their confidence level reveals how severe their calibration gap was for that question. Averages of these confidence levels can be used to determine which concepts the class were most calibrated on and which concepts represented the greatest challenge to their understanding. By using these results to provide students with the necessary tools to self-regulate their learning, students will be able to correct poor study habits. Similarly, instructors will be able to identify key concepts that may need to be taught differently or given greater emphasis. Accuracy-based learning supported by calibration measures can help students have a better understanding of geology later in life when issues like climate change and clean energy become more prevalent in society.

Poster Number: 162
Urban Water Supply Vulnerability
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In the United States 68% of the population relies on surface water (streams, reservoirs) for drinking water. 36% of large cities water supplies are vulnerable to failure in the future from overuse, and this number will increase to 44% in 2040 due to population growth. Raleigh and the surrounding metropolitan areas are rapidly expanding and rely upon Falls and Jordan Lakes for drinking water. These lakes develop anoxic bottom waters during the summer stratification periods. Depth profiles show that an oxycline develops in early spring and persists until late fall in the lower portions of Falls and of Jordan lakes above the dam. Above the oxycline, a Chl_a and BGA maximum develops, and below the oxycline DOM (dissolved organic matter) concentrations increase. We have investigated this lower anoxic layer with a GOPRO anchor-cam and found bacterial mats on the floor of the lake, and “lake snow” or floating bacterial colonies in the anoxic bottom layer. We have quantified the numbers of floating colonies and found that they are absent in highly turbid shallow bottom water areas, and increase in size and density in the lower portions of the reservoirs above the dam where the DOM increases. This is not a problem in Jordan Lake because drinking water is taken from the shallow middle portion of the lake, but can be a problem in Falls Lake because the drinking water is taken from 15 feet in the lower portion of the lake where DOM and "lake snow" is concentrated.
New Turtle Specimens from the Moreno Hill and Menefee Formations (Turonian-Campanian) of Northwestern New Mexico

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Mentors and/or Co-Authors: Lindsay Zanno  College of Sciences NC State University

In contrast to the extensive record known from the terminal Cretaceous (Campanian and Maastrichtian), turtles from the early Late Cretaceous (100 Ma) through early Campanian (80 Ma) of western North America are poorly sampled. Recent expeditions by the North Carolina Museum of Natural Sciences and North Carolina State University are attempting to fill in gaps in our knowledge of terrestrial vertebrates during this data-poor interval. Here we report on new turtle fossils recovered in 2016 and 2017 from the Turonian-age Moreno Hill Formation (Zuni Basin) and early Campanian Menefee Formation (San Juan Basin), both of which crop out in northwestern New Mexico. During this time, this region of New Mexico was a coastal swamp-like environment, with many meandering streams, and deltaic environments (Hamilton et. al. 2008). The specimen from the Menefee Formation is well preserved, represented by a nearly complete carapace and plastron. Due to absent shell bones, measurements are not exact. Characteristics of the shell structure indicates that the shell could be classified as either from the Baenidae or Adocidae. The specimens from the Moreno Hill Formation are represented solely by fragments collected from the surface. The ornamentation on the fragments suggests that the shell could belong to the Baenodda clade, which could date the known lifespan of Baenoddas at least 10 million years older.

The Early Campanian Menefee Formation

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The early Campanian Menefee Formation, San Juan Basin, northwestern New Mexico, preserves fossils from a poorly understood interval in Earth’s history. Yet, to date, the formation remains understudied. In 2017, crews from the North Carolina Museum of Natural Sciences began field collecting efforts in the Menefee Formation in an attempt to increase our understanding of the terrestrial vertebrates that inhabited the early Campanian of western North America. The crew collected remains of turtles and dinosaurs and a variety of ichnofossils (trace fossils) including a large, well-preserved track attributed to a crocodylian. Crocodylian tracks have not yet been reported for the Menefee Formation, and few crocodylian tracks are documented in Cretaceous deposits of the Western Interior Basin (Simpson et al. 2010) relative to the abundance of skeletal remains. Here we describe the newly discovered track, including integumentary impressions, create a 3D photogrammetric model of the track, and use measurements to estimate the body length of the trackmaker. We report the first crocodylian track from the Menefee Formation of northwestern New Mexico. Body size estimate of the trackmaker suggests it is referable to Deinosuchus, one of the largest crocodylians to have inhabited North America.
Utilizing A Modified Multifunctional Hemoglobin with A Nonnative Manganese Cofactor to Detoxify Small Molecule Pollutants

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As a hemoglobin from the marine worm Amphitrite ornata, dehaloperoxidase (DHP) is unique due to its ability act as a biocatalyst to detoxify both anthropogenic and native small-molecule pollutants in the environment. In conjunction with an oxidant (H₂O₂, mCPBA, or O₂), the enzyme is capable of utilizing multiple oxidation functions including, peroxygenase, peroxidase, oxygenase, and oxidase activities. The oxidation activities of DHP utilize the heme cofactor, known as protoporphyrin IX, during catalysis. Our goal is to exchange the iron cofactor for a nonnative manganese cofactor to attempt to discover new or enhanced activity of the enzyme. We seek to compare the reactivities of wild type DHP with the manganese DHP (Mn-DHP) analog using halophenols, haloguaiacols, and haloindoles as substrates. Substrate reactivity and product formation were determined using high-performance liquid chromatography. These results show a substrate reactivity change but similar product distribution in comparison to WT DHP. Substrate binding affinity was measured using UV/visible spectroscopy and demonstrated an uncorrelated difference when compared to WT DHP. Mechanistic and kinetic details of the activation of Mn-DHP with mCPBA and the subsequent substrate oxidation were also examined using stopped-flow UV-vis spectroscopic methods. The mixing time for Mn-DHP with mCPBA was determined to be 130 ms, at which point the substrate was introduced to the activated Mn-DHP to quickly reduce the Mn porphyrin back to its MnIII resting state. Taken together these results support that the nonnative cofactor exchange in DHP will provide an excellent platform in tuning the reactivity of a multifunctional enzyme.

Visual Representation of Evolution in College Biology Textbooks, 1930–today

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A common visual used in teaching evolution is the evolutionary tree diagram. Research indicates that students frequently misinterpret this visual for many reasons, including diagram design. In this study, we analyzed 82 textbooks published since 1930 to quantify five tree traits: tree shape, tree complexity, direction of time, presence of time guides, and placement of man. We found that: 1) tree shapes have increasingly showed punctuated equilibrium, compared to gradual evolution, over the past 20 years, 2) level of complexity, as defined by number of branches, has decreased from an average of 30 before 1960 to less than 10 today, 3) a growing percentage of evolutionary trees (0% before 1990 to over 20% today) are shown horizontally 4) a high percentage (95%) of trees published since 2010 show no explicit time guides, and 5) humans are consistently placed in the upper right, indicating superior placement. Evolutionary tree figures in modern texts show a higher percentage of trees (from less than 10% before
1980 to over 70% today) but the percent of textbook dedicated to evolution chapter(s) has decreased from 5% to 1.5%.

Poster Number: 12
**Teacher Question Types and How Teacher Questioning Changes from Beginning of Year to the End of Year**

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A teacher's questions during a lesson in mathematics with her students have the ability to change how the students make sense of mathematical concepts. For example, questioning can elicit students' explanations of their thinking or generate discussions where students are clarifying or sense making with their peers. This study focused on types of questions posed by second-year elementary school teachers during mathematics instruction, specifically probing and generating discussion questions. The study also examined how teacher questioning changes from the beginning of year to the end of the year. The research questions were “What part of a teacher's talk during a lesson is questioning, and what type of questioning is taking place? Does this change from the beginning of the year to the end of the year?” Video-recorded mathematics lessons of three elementary teachers were coded to track the number of questions asked during a lesson and whether or not these questions probe or generate discussions. Each teacher was observed at the beginning of the school year and the end of the school year. The results will be presented at the Undergraduate Research Symposium.

Poster Number: 16  
**Polydimethylsiloxane (pdms) Spray Deposition**  

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Polydimethylsiloxane (PDMS) is a silicone-based elastomer. It is known for being non-toxic and affordable in micro-technology. It has found use in soft electronics as an encasing material for liquid metals. In our research studies, Eutectic Gallium Indium (EGaIn), consists of 75 wt% Ga and 25 wt% In, is preferred since it has more applicable advantages in comparison to mercury (Hg). Moreover, alloys of gallium (Ga) have low toxicity, and high electrical and thermal conductivity. There are different ways to deposit elastomers onto various types of surfaces such as the spin-coating and casting methods, however these methods fail to satisfy the need of thin and conformal layers. Spray deposition method allows us to produce both thin and conformal films with the layer-by-layer assembly method. Sprayed PDMS have the ability to prevent soft and thin devices patterned with liquid-metal from being exposed to human skin since the encasing material is needed for structural integrity to make it applicable for sensors for soft robotics, implantable electronics, antennas, flexible circuits, textiles and clothing. Encapsulating such devices in PDMS with the spraying method allows them to protect their form and electronic functionality. An optical profilometer is used to measure the surface chemistry of sprayed and spin-coated PDMS films to understand the role of viscosity in thickness and surface roughness. Instron, a tool evaluating mechanical properties, is used
to understand the difference between the spin-coating and spraying methods and how the viscosity affects the tensile strength of such films.

Poster Number: 24
**Site-directed-mutagenesis of the Rep Gene of an Infectious Clone of the Tomato Mottle Virus**

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Geminiviruses are circular, single stranded DNA plant viruses that replicate via double stranded intermediates. Geminiviruses replicate in the nuclei of infected cells by sequestering the host’s DNA replication machinery. A critical viral protein required for replication is Rep (aka AL1) which binds to the Retinoblastoma-Related-Protein (RBR), a host protein that assists in cell proliferation and chromatin remodeling. We seek to determine if mutagenizing the binding site on Rep for RBR would disrupt the replication process enough for the tomato host to produce fruit. We will attempt the mutagenesis via PCR site directed mutagenesis in an infectious clone that contains the Rep gene. Once we verify that the mutagenesis was properly performed, we will use the mutant to test for infectivity by bombarding tomato plantlets and scouting for symptoms and viral titer. We will use this mutant to complement studies in viral evolution by using it to estimate rates of begomovirus mutation in tomato.

Poster Number: 28
**Dmso Reduction Increases Both Anaerobic Growth and Biofilm Formation in Salmonella Typhimurium.**

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*Salmonella* Typhimurium (STM) must overcome anaerobic stress and nutrient competition in order to colonize the mammalian gastrointestinal tract. *Salmonella* possesses three genes that encode putative dimethyl sulfoxide (DMSO) reductases suggesting that anaerobic DMSO reduction may be important for colonization of the anaerobic intestine. A DMSO reductase catalyzes the reduction of DMSO into dimethyl sulfide (DMS). DMS inhibits STm intestinal invasion through reduction of the expression of *hilA*, the master regulator of virulence gene expression, suggesting a role for this molecule during intestinal infection. We hypothesize that DMSO reduction is important for intestinal colonization. Using a calf ligated ileal loop model, we demonstrate that a triple DMSO reductase mutant (ΔSTM0964ΔSTM2530ΔSTM4305) exhibits defective colonization under non-inflammatory conditions, but not in the presence of inflammation. To establish a mechanism for these findings, we performed growth curve and biofilm formation assays in the presence and absence of DMSO and DMS using the virulent wild-type bacterium and the triple DMSO mutant. We found that the addition of 0.1% DMSO to the media provides a growth advantage to wild-type STm under anaerobic conditions but not to the DMSO reductase mutant. In addition, DMSO increases WT biofilm formation in a dose-dependent fashion. Finally, we found that DMS itself induces biofilm formation *in vitro* in both the WT and DMSO reductase mutant. Together, our data suggest that DMSO reduction may be important for the infection...
cycle of STm. Future work will establish which of the DMSO reductases are important for anaerobic growth, intestinal colonization, and biofilm formation.

Poster Number: 34

**Recidivism Rates for Women With and Without Potential Mental Disorder**

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The prevalence of mental illness in the United States prison system has become a national public health crisis. Studies show that 15–24% of U.S. inmates have a severe mental illness, while only one-third of inmates in the United States with mental health disorders receive treatment. In this study, the Wake County Jail database was used to compare recidivism rates for 53,912 male and 8,132 female inmates, with and without potential mental health disorders. Jail staff referrals and the Brief Jail Mental Health Screen were used to identify potential mental health disorders. Using a negative binomial regression, women with potential mental health disorders had 1.200 times the risk of recidivating compared to those without. Men with potential mental health disorders had 1.117 times the risk of recidivating compared to those without. Additionally, women with potential mental health problems recidivated 0.72 times on average whereas women without recidivated 0.60 times on average. Men with potential mental health problems recidivated 3.01 times on average whereas men without recidivated 2.69 times on average. These findings suggest that the expansion of mental health treatment in and out of prisons is beneficial in reducing the revolving prison door phenomenon. This study also supports the use of rehabilitation rather than strict punishment for offenders with mental health disorders.

Poster Number: 38

**Examination of Local and Global Sensitivity Analysis Techniques on a Baroreflex Model**

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Sensitivity analysis is the practice of interpreting and quantifying the variation in a mathematical model’s outputs in relation to its inputs. Parameter sensitivities can be computed both locally and globally. Local sensitivity methods assess changes in the model outputs within a small neighborhood about given parameter values, while global sensitivity methods explore variations over the entire parameter space. Both types of methods ranks how sensitive a parameter is to the model outputs. Numerous numerical techniques exist for computing sensitivities, we discuss local methods approximating sensitivities using finite differences and using a complex-step method, and global methods including Morris screening and generalized Sobol’ indices, which account for elementary effects and temporal correlation, respectively. This study compares these techniques for a neurological model predicting the baroreflex response to the Valsalva maneuver. Results from all the methods revealed a similar set of important parameters,
although not identical. From these results, it is possible to separate the list of parameters into classifications of most and least sensitive.

Poster Number: 47

**Impedimetric Measurements Reveal Variable Carbon-fiber Microelectrode Performance for Fast-scan Cyclic Voltammetry**

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Fast-scan cyclic voltammetry (FSCV) is a technique in which a voltage waveform is scanned at an electrode to drive electron transfer from molecular species. Paired with carbon-fiber microelectrodes (CFME), FSCV permits real-time measurements of fluctuating neurochemicals from discrete brain regions in freely-moving animals. However, calibration of permanently implanted electrodes used in long-term experiments (>6 months) is unreliable. Previous work demonstrates that inherent differences in sensor performance, variability in electrode environments, and electrode fouling results in changes to electrochemical impedance and performance, which can contribute to misrepresentation of data. Herein, electrochemical impedance spectroscopy (EIS) is utilized to assess changes in impedance that occur at the CFME during FSCV recordings in situ. The data demonstrate that changes in CFME impedance properties directly correlate with electrochemical performance. Electrochemical pretreatment using FSCV results in a decrease in impedance through an increase in capacitance, resulting in enhanced sensitivity to multiple analytes. Furthermore, it is demonstrated that CFME impedance increases that occur throughout tissue implantation can be reduced by continual application of the FSCV waveform. These findings are vital for improving data interpretation and sensor development for FSCV. Additionally, these findings support the development of new *in situ* calibration paradigms that will help to remove user bias from analysis and improve long-term FSCV recordings.

Poster Number: 49

**Mechanical Anisotropy in Elastollan Tissue Scaffolds**

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Cell morphology and ultimately the structure of developing tissue is dictated by the arrangement of fibers in the surrounding matrix. Biological scaffolds can be engineered to mimic the fibers in the extracellular matrix (ECM) unique to certain types of native tissue. Mechanical anisotropy is an indicator of fiber arrangement in these scaffolds since they will be strong in the direction of the fibers but weak in the bonds connecting the fibers in an aligned scaffold. Once an engineered scaffold has been mechanically characterized, it can be designated for potential tissue applications. The purpose of this study was to
assess the mechanical anisotropy of different batches of Elastollan as scaffold candidates and to investigate the factors that led to these properties in manufacturing. It was hypothesized that die to collector distance (DCD) would be the most influential processing variable on fiber anisotropy within the material since this is associated with fiber entanglement. Samples were gathered for tensile testing in two different orientations corresponding to directions parallel to the edges of each rectangular sheet of material. Each Elastollan batch was fabricated under different conditions. Sample groups were created for both orientations of each batch. The yield points and moduli of these samples were calculated from stress-strain curves in Matlab. Batch number 15 (lowest DCD) was selected as a possible scaffold candidate due to its most prominent anisotropic properties. Elastollan scaffolds that match tissue-specific mechanical properties must next be cultured with adherent cells to determine the material’s compatibility in vitro.

Poster Number: 50
Influences of the Sert Gene-environment Interaction on Stress Recovery in Drosophila
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Decreased levels of the neurotransmitter serotonin are associated with mood disorders, and the serotonergic system is a common target for antidepressant drugs. However, the ways in which the interaction between genetic and environmental influences affect serotonin utilization by the brain remain incompletely defined. In order to better understand the relative contributions of genes and environment to the regulation of the serotonergic system, we have established a Drosophila model for a polymorphism that affects serotonin signaling and is associated with increased incidence of mood disorders in humans. In this pilot study, we have compared stress responses of Drosophila expressing a hypomorphic serotonin transporter (dSERT) allele to those of wild type flies. Age- and sex-matched flies were subjected to acute stress, treated with drugs used in human mood disorders, and then observed in a behavioral assay. In the absence of drug treatment, dSERT mutant flies displayed abnormal behavior regardless of stress. This abnormal response was not altered by treatment with a drug targeting the serotonergic system, but treatment with a drug targeting multiple neurotransmitter systems positively affected dSERT mutant behavior. These results demonstrate that decreased dSERT function alters both behavior and drug response, indicating that the dSERT mutant fly can be used to model gene-environment interactions in serotonergic signaling. Based on this pilot study, we plan to perform a larger scale study that includes an additional behavioral assay, chronic stress, an additional drug targeting the dopaminergic system, and single-fly tracking to allow statistical analysis of gene-environment interactions.

Poster Number: 53
Making the Organic Chemistry Lab Greener: Microwave-assisted Dehydration of an Alcohol
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The purpose of this project was to adapt a traditional experiment in the sophomore organic chemistry laboratory (Dehydration of 2-methylcyclohexanol) from the conventional heating and distillation procedure to the use of microwave heating (CEM Synthesis Microwave) followed by microextraction. Heating time, elution time, injection volume, as well as the microscale extraction work-up for isolating the product after reaction were all varied to find optimal conditions that gave consistent results. It was determined that 9 M Sulfuric Acid combined with 2-methylcyclohexanol would form the desired mixture of products. Microscale extraction with saturated Sodium Bicarbonate allowed the isolation of the two isomers produced in the reaction, a result that could be verified via gas chromatography. The microwave adaptation allows for a shorter heating time, a safer procedure, uses 2.1% of the energy consumed by the hot plate in the conventional method, and fulfills 4 out of the 12 principles of green chemistry: accident prevention, energy efficiency, safe auxiliaries, and less hazardous synthesis.

Poster Number: 54

**Analyzing Methods of Molecular Diagnostic Technology for Late Blight of Tomato Plants**

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The purpose of the research conducted was to analyze current methods used to detect plant diseases. In this case, Late Blight of tomato plants was the disease these technologies had to detect. The traditional method includes the CTAB protocol of extracting fungal DNA, PCR, and gel electrophoresis. These steps were analyzed to see how efficient it was. Efficiency was determined by two factors; how pure the DNA sample was and how long the process takes. When the methods were performed it concurred that the traditional method is not efficient due to the DNA samples not being pure when analyzed on the spectrophotometer, the gel electrophoresis not having the right bp, and the process being tedious thus taking a long time. The research being conducted is very important due to Late Blight of Tomatoes and Potatoes being the worst pathogen that wipes out millions of potatoes and tomatoes per year. If the process for detecting Late Blight was more efficient then farmers and scientist can save time and money which is a life saver for countries with limited resources, and farmers with limited time. If Late Blight can be detected efficiently then farmers can plan for the disease accordingly and save their crops without them having to waste millions of dollars on fungicide that also harms the environment.

Poster Number: 55

**Investigating the Role of Additives on the Properties of Polyvinyl Alcohol Fibers with High Performance Applications**
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Currently, polyvinyl alcohol (PVA) fibers are used in a range of applications from apparel to industrial. However, they have not been adapted yet for high-performance use. Recent work of Lu and coworkers indicates that the mechanical properties of PVA fibers can be improved by incorporating additives that can act as antiplasticizers. As an extension of this work, the focus of this study is to investigate with molecular dynamics simulations the molecular-level details that lead to antiplasticizer effects, which then can be used to identify other additives that may have similar or even stronger effects. Molecular models were built of low molecular weight additives incorporated at 3.5 wt% into PVA; focus here is on six different dicarboxylic acids: aspartic, citric, glucaric, malic, mucic, and tartaric. We will discuss how these dicarboxylic acids change the tensile strength and elastic modulus relative to pure PVA, and whether we observe induced chain alignment and adhesion among the PVA chains with each dicarboxylic acid.

Poster Number: 57

Crispr/cas9 Targeting of Tomato Yellow Leaf Curl Virus
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Tomatoes are a very lucrative crop, and they are in high demand all over the world. TYLCV (tomato leaf curl virus) threatens the tomato crop, with global consequences of tomato scarcity and lost profits. TYLCV is a single stranded DNA virus that is transmitted by a white fly vector [4]. Transgenic tomatoes expressing CRISPR-Cas9 constructs are being used to target the TYLCV viral rep gene in order to create resistance to the virus. Three CRISPR-Cas9 constructs were tested in tomatoes for resistance to the virus, which was determined by viral loads. Plants that were positive for CRISPR Cas9 had very little or no viral DNA. The gRNAs were used to target two different places on the Rep helicase domain on the TYLCV genome, either in tandem or separately. The constructs expressing tandem gRNAs showed the greatest resistance, because both targets were thought to be necessary for Rep function.

Poster Number: 61
My NC State Experience
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While weaning is a natural process in a calf's life, it often is one of the most stressful experiences in their life span. Research has been conducted to find the least stressful method of weaning on calf and its dam. It is important to reduce the stress of the cows and calves as it may affect the dam nutrition causing a decline in fetal calf growth and development. This research investigates using three strategies of weaning: abrupt separation of calf, fence line separation, and a late weaning group. This is similar to another method of weaning where they use nose clips on the calves, so they are still in presence of dam but unable to nurse. It was hypothesized that the late weaning group will experience the least amount of stress because calves are naturally approaching the age in which cow calf pairs would wean on their own. To investigate weaning stress cattle were monitored for stress behaviors before and after weaning. The three groups were observed two times a day, three days a week. Cow and calves' behaviors were categorized; grazing, walking, drinking water, laying ruminating, laying idol, standing ruminating, standing idol, bawling, and nursing. Utilizing knowledge of herd behaviors, stress can be determined by changes in behavior patterns.

Poster Number: 72
Computational Study of Birefringence in Cellulose Nanofibers
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This research presents a novel method for predicting the birefringent properties of cellulose nanofibers (CNFs) and their derivatives. Using computational molecular dynamics, the birefringence of ordered and disordered CNF material was measured. The simulated materials were modeled through layer-by-layer aggregation with precise control of surface chemistry. As a result of this research, we will establish a structure-property relationship. Eventually, this data will help guide the design of cellulose materials with tunable optical properties for biosensors, electronics, and biomedical applications. Keywords: birefringence, molecular dynamics, cellulose nanofibers, layer-by-layer aggregation.

Poster Number: 77
Secondary Metabolites Released by Trichodesmium Epibionts And Bacterial Isolates from Sargasso Sea Water in Response to Iron-limitation
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This study was on iron and nitrogen limitation of microbial growth and primary production in the North and South Pacific. *Trichodesmium* is a cyanobacterium that fixes atmospheric nitrogen and which acts to fertilize oceans. It is unable to release siderophores, secondary metabolites which are secreted to take up otherwise unavailable ferric iron sources (FeIII) from the surrounding environment. However, *Trichodesmium* contains many bacteria on its surface (epibionts). It is still unclear how these bacteria and *Trichodesmium* interact and what chemicals they produce to work around the iron and nitrogen limitations. In this study, we analyzed *Trichodesmium* epibionts, along with seawater isolates taken from Sargasso Sea water to determine the production of siderophores and other secondary metabolites. To assess the capacity of these bacteria to utilize secondary metabolites to react to iron-limitation stress and to cooperate or compete under nutrient limitation, we grew the isolates alone and together in a defined seawater medium with and without added ferric iron. The results indicate the release of high concentrations of metabolites under all conditions, including siderophores. We present a characterization of these metabolites by high-resolution liquid-chromatography tandem mass-spectrometry (HR-LC-MS/MS) measurements and discuss potential biological function based on the identified chemical structures and conditions in which they were produced.

Poster Number: 100
The Morality of Brain Damage: How Frontal Lobe Pathology Impacts Moral Judgment
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Findings in neuroethics have led to increased understanding of moral cognition. Prior moral judgment research has focused on normal populations, but patients with Fronto-temporal dementia (FTD), Frontal lobe damage and Psychopathy have been shown to have deficits with socio-moral judgment and decision making while retaining cognitive function. The precise deficit in neural correlates of moral cognition is unknown although the Agent-Deed-Consequence (ADC) model with its empirical and predictive value could help. This model postulates three factors for steering moral judgment: the intuitive evaluation of the agent (A), the deed (D), and the consequence (C). These subconscious heuristics are integrated creating a judgement of moral acceptability or unacceptability. Utilizing this model, we plan to survey twenty patients with Fronto-temporal dementia and frontal lobe damage by utilizing low and high-stake vignettes designed for the model and administering Preferences for Precepts Implied in Moral Theories (PPIMT) scale for testing conscious preference for virtue ethics, deontological and consequentialist judgment. The control group will consist of five hundred people recruited via Amazon Mechanical Turk who will rate vignettes, the PPIMT, and an established measure of psychopathy (PPI-R) to create an additional psychopathic tendencies group. This will test the hypotheses: that those with psychopathic tendencies lack deontological intuitions, that frontal lobe damage patients lack the integration function, and that deontological intuitions are selectively diminished in low-intensity moral dilemmas in Fronto-temporal dementia patients. This project determines clinical viability of the ADC-model and will elucidate specific socio-moral deficits of individuals with frontal-lobe pathology which can impact legal proceedings.

Poster Number: 125
Design Considerations of the Lignin Biosynthesis Circuit
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The Lignin Biosynthesis circuit (LBC) is intended to become a teaching tool in biochemistry classes, serving as a physical model of the rates at which cellular metabolites are synthesized. The purpose of this project is to revise the circuit to provide a more stable output along different sub-pathways in Lignin Biosynthesis. Sources of instability were identified using Fourier Analysis to determine unwanted waveforms propagating through the circuit that contribute to noise and undesired operation. The power usage of each metabolite was measured to determine if the power supply was sufficient to power all components including operational amplifiers. Results of the circuit analysis revealed that the power supply will need to be adjusted and additional bypassing will be required to further increase the reliability of the metabolite circuit.

Poster Number: 126  
**High-resolution Observations of Generating Cells in Colorado Snowstorms**  
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Generating cells are small-scale (<2 km horizontal and vertical) overturning air circulations in the upper portions of winter storms which locally increase the size and mass of the ice crystals. The ice crystals can continue to grow through water vapor deposition or by collecting other particles as they fall through the cloud, which can lead to increased precipitation at the surface. The overturning circulations can be caused by many different phenomena, such as the motion of atmospheric waves, differences in cooling rates between the cloud and the cloud top surface, or changes in wind speed or direction between adjacent layers of air. Doppler weather radar can observe many aspects of winter storms, but the radars used by the National Weather Service (beamwidth=1˚) do not have fine enough spatial resolution to observe these small-scale features. In collaboration with the Colorado State University CHILL National Weather Radar facility (CSU-CHILL), we made high-resolution (beamwidth=0.3˚) radar observations through four storms in Greeley, Colorado from this past winter. Our target storms were cases where surface precipitation fell entirely as snow, storm evolution was relatively slow, and the storms were not associated with strong fronts. We observe associations between generating cells and wavelike signatures in the velocity field in some cases. We also observe subsets of generating cells that are more vertically-oriented and others that are tilted by the wind. There is a lack of consistent evidence for changes in ice particle shapes associated with generating cells.

Poster Number: 130  
**Green Fluorescent Protein Organic Liquid Extraction**
Green fluorescent protein (GFP) is a model therapeutic protein that simulates a standard biomanufacturing product. To provide support for the BTEC biomanufacturing processes used to produce GFP, a highly purified and well-characterized reference standard is needed. One method that we have found to provide such highly purified standard is through the use of liquid-liquid extraction. This method involves several steps including ammonium sulfate precipitation, extraction into cold ethanol, extraction with chloroform, and dialysis. This method was used to further purify GFP that had already undergone chromatographic purification by anion-exchange chromatography. By using the method described in this poster, we were able to boost purity from 70% to <99% GFP. After the extraction, the product was characterized by matrix assisted laser desorption ionization mass spectrometry (MALDI), gel electrophoresis, and HPLC. This method is a very simple way to achieve high purity GFP for use as a reference standard in the BTEC Analytical Lab.

Poster Number: 151

Adaptation of Cho Cells to Serum Free, Suspension Based Growth

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Chinese Hamster Ovary (CHO) cells are widely used in the biotechnology industry for the production of recombinant proteins. CHO cells can grow adherently to flasks or in suspension. In order to have an antibody-producing cell line to use for courses, BTEC ordered an DP12/anti-IL8 cell line from ATCC. The growth of these cells required the use of Fetal Bovine Serum (FBS), a supplement that contains multiple growth factors that are difficult to economically replicate. Due to the costs of FBS and adherent cultures, industry prefers cells without these constraints. This requires adaptation of cells that are both adherent and reliant on FBS. The technique often used is a gradual adjustment from adherent, FBS growth to suspension, FBS-free growth. The results obtained using this approach will be discussed. To study the effectiveness of this technique, DP12 CHO cells were thawed from a MCB and placed in an initial adherent flask with DMEM + 10% FBS. The technique focused on reducing the amount of DMEM + 10% FBS in the media over time and replacing it with CD-CHO media without FBS before moving to suspension growth. It was observed that once the CHO cells were in 100% FBS-free media and placed in an adherent flask, the cells failed to attach to the flask’s surface. The technique was changed to accommodate this by moving to suspension growth once the CHO cells were adjusted to 75% FBS-free media, instead of 100%. Currently, monitoring is being done to assess the success of this technique.

Poster Number: 158

Ultrafiltration/diafiltration Membrane Analysis
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This project focuses on the development of an effective cleaning procedure for the intermediate scale UFDF systems which use the Pellicon XL cassettes with a 10 kDA MWCO membrane. Currently a lab module for BTEC short course classes is available in which the students clean a "dirtied" system with either a 0.5M NaOH solution, or a 0.5M NaOH/100 ppm Cl solution. The cleaning efficiency, as measured through the permeate flow rate and NWP (normalized water permeability) has been inconsistent between short course experiment executions. The current cleaning method calls for a 400 mL flush of the membrane with 0.5 M NaOH (room temperature) and a 1-hour contact time with 0.5M NaOH, followed by storage in 0.1M NaOH. Graphical data will demonstrate new cleaning conditions for the UF membrane to provide consistent system suitability from experiment to experiment. This includes analyzing different cleaning solutions, different “dirty” conditions, and different temperatures effect on the suitability of the UFDF membrane.

Poster Number: 159

**Motion Characteristics of Propagating Cloud Clearing Boundaries In The Southeast Atlantic**

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Clouds play an important role in the radiative balance of the Earth and can both warm and cool the air depending on the cloud top height and underlying surface characteristics. Large decks of low clouds (with tops less than 1.5 km in height) commonly form in the subtropical southeast Atlantic off the coast of Angola and Namibia, and often extend thousands of km to the east. Recent work has shown that vast areas of these marine low clouds can be eroded along westward-moving sharp lines 1000s of km long. The propagation speed of the line is a key characteristic that is used to rule in or rule out candidate mechanisms for cloud erosion. Previous work generated a climatology of the occurrences of these boundaries through detailed analysis of 10 years of NASA EOSDIS Worldview satellite imagery. In this project, we use sequences of IR satellite images to generate diagrams (‘Hovmöller plots’) that map out the east-west motion of these boundaries as a function of time based on satellite data in a rectangular box extending from the African coast westward over the ocean. We use the diagrams to estimate the speed of the boundaries relative to increasing distance from the coast. We also look at the sensitivity of the estimated speed to variations in the boundaries of the rectangular box of satellite data used to compute the diagrams. The eventual goal of this project is to determine the distribution of motion characteristics for the several hundred boundaries in the climatology.

Poster Number: 160

**Variability of the Urban Heat Island**

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As cities continue to grow, increasing areas covered by buildings and paved surfaces are creating larger “urban heat islands.” An urban heat island is an urban area with higher temperatures than the surrounding rural area. In this study, we use ASOS and NC State Climate Office data to examine urban-rural temperature differences, as well as small temperature sensors to measure microclimatic variability within an urban area. Within urban areas, local differences such as land cover, tree cover, irrigation, and proximity to tall buildings create a lot of spatial variability in air temperature. These small-scale temperature variations can affect human comfort as well as increase the energy required to cool nearby buildings. For this study, eight temperature loggers, roughly the size of a quarter, are deployed for several weeks across sites on the campus of NCSU and in Raleigh. Google Earth satellite and ground-based images are used to estimate the impervious area and the area with tree cover within a 10-meter radius of each sensor. We compare the temperature time series among sites and analyze differences during both the day and night. Meteorological data such as satellite imagery and precipitation data are also used to account for confounding variables. For example, sky cover modifies surface air temperatures, and storms and their accompanying rainfall and winds often cause sharp drops in temperature. With this information, we are able to examine relationships between the environment of an area and temperature parameters that contribute to differences among microclimates within urban areas.

Poster Number: 165

Age-dependent Changes in the Shape of the Anterior Cruciate Ligament Bundles

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Anterior Cruciate Ligaments (ACL) reconstruction procedures for young patients are currently based on those done for adults, with little focus on the changes that occur in the ACL during healthy growth. Previous studies have suggested that ACL tissue twist influences its biomechanical function. In this study, we analyzed the internal-external twisting and the morphology of the anteromedial (AM) and posterolateral (PL) bundles of the porcine ACL from birth through skeletal maturity. Hind limbs from female Yorkshire pigs were imaged with a magnetic resonance imaging (MRI) scanner. The AM and PL bundles were segmented and exported into a custom MATLAB code. The bundles were digitally rotated onto the superior-inferior axis of the tibia, sliced at 0.5mm increments, and treated as a stack of two-dimensional images. An ellipsoidal model was fit to each image and validated using the measured cross-sectional area of the tissue, with an average percent difference between the two of 9.93%. The AM bundle had greater internal-external twisting along its length compared to the PL bundle. Angle rotations became more significantly externally rotated towards the superior aspect of both bundles after 3 months of age. The ratio of major and minor axes of the AM bundle were significantly larger than that of the PL bundle across all age groups. The axis ratio decreased with percent length of the AM bundle at all age groups. These findings contribute to a better understanding of how soft tissues in the knee change throughout growth.
Investigation of Dioh Enzyme Selectivity Using a Substrate Triggering Approach

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In nature, the DiOH enzyme catalyzes two consecutive hydroxylations on its native substrate as part of a greater biosynthetic pathway. The objective of the project is to test the selectivity of the enzyme; this would be accomplished by redirection of its enzymatic pathways using a substrate triggering approach. Instead of hydroxylation, we hypothesize that DiOH would be able to catalyze nitrile group installation to amino acid derivatives when an azide (N₃) functional group is appended to the substrate. To this end, DiOH was overexpressed using E. coli BL21 and purified with Ni(II)-affinity column chromatography. The L-glutamic azide derivative was synthesized and characterized with 1H and 13C nuclear magnetic resonance spectroscopy.

Believable Virtual World Generation for Interactive Story

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Most interactive games include a virtual world in which the narrative is played that adds to the engagement and immersion of the player. However, manually creating a believable virtual world takes a lot effort with the slightest change in a story requiring reauthoring and designing a new world. In the past, researchers have studied procedural content generation of virtual world generation, but not many have researched how to generate an interactive virtual world, where both the player and Non-Player Characters (NPCs) could perform reasonable actions in this world. My research implemented an algorithm using a rule based, context-free grammar and hierarchical graph generation approach to dynamically generate a believable and realistic virtual world. I was able to design an algorithm that would generate connected maps, support the interaction of the user and NPCs behaviors and integrate my work with the current Interactive Narrative Authoring tool, Villanelle, that the lab was working on. Ultimately, this algorithm enables non-expert users to dynamically generate virtual world for the interactive story they designed.

Hepatic Expression Profile of Hif1a and Foxo3 During Chicken Embryonic Development

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Between the fertilization and hatching stages of embryonic development, chickens undergo a transition between lipolytic and lipogenic metabolism as part of a physiological process known as the “metabolic switch”. We hypothesize that the metabolic switch begins as a result of changes in gene expression in response to decreasing oxygen levels in the egg. This study focuses on expression of the HIF1A and FOXO3 genes in the liver throughout embryonic development. The HIF1A and FOXO3 genes were chosen because these have been shown to facilitate metabolic processes by activating transcription of other genes in hypoxic conditions and to regulate apoptosis under stress, respectively. Expression levels of both will directly influence function of the liver, which is primarily responsible for fat metabolism. Liver samples were taken on embryonic days 12 (yolk begins to shrink), 15 (embryo gets into position for breaking shell), 18 (beak turns towards air cell), and 20 (yolk almost completely drawn into body, begins to breathe and vocalize). We used RT-qPCR to measure and compare gene expression among developmental stages. We expect to find that in response to the hypoxic environment in the egg, the expression of genes will change. Specifically, HIF1A activity will increase and FOXO3 activity will decrease to allow the embryo to successfully develop into a chick. We hope this investigation will improve understanding of the underlying genetic mechanisms behind the metabolic transition in chicken embryo liver development, particularly in relation to the HIF1A and FOXO3 genes.

Poster Number: 183

The Application of ”Electrowetting” to Control the Movement of Egain (gallium Indium Liquid Metal)

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A primary concern with using EGaIn (Gallium Indium Liquid Metal) within electronics and channels is the oxide layer that forms on the outside of the liquid metal causing a residue to be left inside of electronics and channels. The ability to control this layer using electrochemistry would allow the metal to be able to flow within channels and electronics so the devices can be used multiple times. The research conducted explores using NaOH and NaF electrolytes to control a plug of EGaIn within a capillary. A function generator was used to compare the electrolytes at 0.5,1, and 2 volts while varying the frequency of the peaks in the positive and negative direction with frequencies of .5,1, and 3 hertz. Even at the smallest voltage the liquid metal was able to flow, meaning that little voltage is required to move a plug within a channel or electronic device. The NaOH and 2-volt application yielded the largest displacement of the plug. The ability to control liquid metal with small voltages will allow for new electronic and flexible devices that could not have been created before using solid connections instead of liquid metal that has the ability to flow and bend within a wearable device.

Poster Number: 199

Analysis of a Spark Assisted Compression Ignition (saci) Combustion Engine Fueled by Dimethyl Ether
Spark assisted compression ignition (SACI) is a combustion system in which autoignition is induced by spark discharge. In the ongoing effort to reduce air pollution, dimethyl ether (DME) has been recognized, due to its good combustion characteristics and low emissions, as a clean alternative for diesel fuel. This research analyzes the combustion characteristics of a SACI engine fueled by DME to determine how to control the combustion phasing. DME-fueled SACI engines have the potential to achieve high efficiencies and low emissions. This paper investigates that port fuel injection (PFI) may allow a better control of the combustion phasing. PFI and direct injection (DI) are two of the most used fuel injection methods. Computer simulations for this study were performed using the one-dimensional turbulence (ODT) model developed for engine simulations by Echekki and Gowda (2012). It is found that, for fuel-air mixtures at stoichiometry – air to fuel ratio of 9: (1) PFI resulted in higher and more uniform heat release than DI, while DI had lower in-cylinder temperatures compared to PFI. (2) For both PFI and DI, temperatures did not rise across the entire combustion chamber, resulting in an incomplete flame propagation and burning of fuel. However, the pressure rise was similar. (3) A combination of early spark ignition with PFI allowed a better control of combustion phasing.

Poster Number: 206

Investigating the Effect of Hydrodynamic Cavitation on the Settling Capability of Fecal Sludge

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In the sanitation chain in low- and medium-income countries, a key-step in decentralized systems is collection of fecal sludge from pit latrines and its subsequent transport to a treatment facility. When transporting fecal sludge, the weight and volume of the sludge results in a large operating cost which can be reduced by improving the dewatering of the sludge. Hydrodynamic cavitation presents a possibility to greatly reduce the cost for sludge dewatering because it involves relatively little energy and could be conducted on site. Fecal sludge was pumped through a lab cavitator with cavitation number .12 and collected at regular intervals. To test the separation of the solids from water, each sample was allowed to settle for 5, 10, 15, and 30 minutes. A total of nine levels of treatment ranging from 0 to 22.5 cycles through the cavitator were tested to see if repeated cavitation affected the settling ability. The 5 and 10 minute settling results showed little clear impact of cavitation with only one or two treatments changing the percent settled significantly. However, after 15 minutes the 5.6, 8.4, 11.3, 19.7, and 22.5 cycle treatments all showed significant decrease. By 30 minutes all but the 14.1 showed significant change from the control with the longest tested treatment of 22.5 cycles having an average settling of 42% compared to the control’s 81.67%. These results indicate that more intensive research into the effects of hydrodynamic cavitation on fecal sludge is warranted.

Poster Number: 210
Sustainability of Intercropping in Loblolly Pine Plantations
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Switchgrass and Miscanthus are both very viable sources of biofuel, in terms of biomass. They can be grown intercropped in forest plantations of species such as loblolly pine. The purpose of this research was to study the effects of switchgrass-loblolly pine and miscanthus-loblolly intercropping on the soil and growth of the pine in a field study in Oxford, North Carolina. Three treatments were done: 1) 20 plots of Miscanthus-loblolly pine intercropped, 2) 12 plots of traditional loblolly pine production, and 3) 20 plots of switchgrass-pine intercropped. A clip plot of biomass was taken from each plot, except the pine-only plots. The clippings were dried and weighed. Two soil samples were taken from all plots and tested for nutrient levels. The results support that the viability of these types of intercroppings for biofuel. There were no significant differences in pH, calcium, potassium or any of the micronutrients (Ca, Cu, Mn, etc.). However, there were significant differences in the biomass with miscanthus (7643 kg/ha) producing more than the switchgrass (4951 kg/ha).

Poster Number: 219
Reducing Stereotypes About Stem: The Role of Intergroup Contact
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There is growing concern with the lack of diversity in the STEM workforce. According to the Pew Research Center, in January of 2018, African Americans made up 9% of STEM workers, Hispanics made up 7% of STEM workers, and women were underrepresented as physical scientists and in computer occupations. A possible cause for this is implicit bias and stereotypes that may emerge in childhood and adolescence. The current study aimed to understand whether intergroup contact (higher rates of reported cross-group friendships) is associated with reduced stereotypes about who is usually good at math and science with a focus on both gender and ethnicity. Participants included 91 adolescent volunteers working in informal science learning sites (i.e museums, aquariums, zoos, etc.). Participants rated how good girls, boys, their ethnic group and other ethnic groups usually are in science and math (slider scale: 0(not at all good) to 100(very good)). Participants also reported which of their closest 5 friends were cross-gender or cross-ethnic. Regression analyses were conducted to predict stereotypes about science and math ability based on participant gender, participant ethnicity, cross-gender and cross-ethnic friendships. The findings suggest that participants who report higher cross-ethnic friendships were more likely to show equitable attitudes towards who is usually good at science and math. Additionally, ethnic majority participants also showed more equitable attitudes than did ethnic minority participants. Results will be discussed in light of research on encouraging youth from diverse backgrounds to pursue STEM interests and careers.

Poster Number: 231
Platinum-end-capped Gold Nanorods As Photocatalyst For Reduction Of Methylene Blue
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Decomposition of water into hydrogen would be an excellent way to produce a clean source of energy. Noble metal nanoparticles (MNPs) such as gold and silver have this unique optical property known as surface plasmon resonance (SPR), which is the collective oscillation of conduction electrons excited by light. When irradiated by light of suitable wavelength, MNPs produce high energy electrons called hot electrons which can be injected from MNPs into adsorbed reactant species to catalyze chemical reactions. In this study, metal platinum was selectively deposited onto the ends of the gold nanorods (AuNRs) and the resulting particle was used as a photocatalyst (Pt-AuNRs). AuNRs can absorb low energy near infrared (NIR) light and generate hot electrons with sufficient energy to decompose water. By putting Pt at the AuNR ends only, the efficiency of the using the hot electrons and the Pt can be greatly enhanced. The photocatalytic activity of Pt-AuNRs was demonstrated using a model reaction, i.e., the reduction of methylene blue to leucomethylene blue in the presence of a reducing agent. Without Pt-AuNRs, there was no change in the color of the dye, whereas the addition of photocatalyst changed the blue color to colorless, showing the catalytic behavior of the MNPs. The change in the solution absorbance was recorded to determine the rate of reduction. Furthermore, the photocatalytic property of the Pt-AuNRs was demonstrated using NIR light. Enhanced rate of MB reductions was observed with NIR light than without light, proving the involvement of generated hot electrons in MNPs.

Poster Number: 235

Toward Programming Artificial Neural Networks Based on Neuroethics

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Self driving cars, and accidents they are involved in, attest to the need to consider the neuroethics of Artificial Neural Networks (ANNs). As technology progresses we should determine what role we want technology to play in society, and the degree of moral responsibility we want it to bear, and how it could be programmed to achieve these goals. One way to approach programming for ANNs would be to reflect recent work in neuroethics. The ADC model provides a promising descriptive and normative neuroethics account, while also lending itself well to use in programming ANNs. The ADC model explains moral judgments by breaking them down into positive or negative intuitive evaluations of the Agent, Deed, and Consequence of a situation, which combine to produce a positive or negative judgment of moral acceptability. The overall judgment of moral acceptability in a situation in which someone committed a negative action would be mitigated if the agent had good intentions and the action had a good consequence. This aspect explains considerable flexibility and stability of human moral judgment. With the ADC model, technology based on ANNs would be appropriately grounded on research regarding neural networks in human moral judgment and decision making, thus avoiding outlandish machine-learning outcomes and promoting better integration into society. This presentation will examine the advantages and disadvantages to exploring moral algorithms in this manner, and how the ADC model could be applied in programming Artificial Neural Networks.
Evaluating Nutrient Availability in an Intercropping Plantation
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As fossil fuels become less abundant, we need to have new ways of renewable energy. If we keep using non-renewable energy sources, then we will eventually run out. This study analyzed factors involved in biomass intercropping practices. Biomass intercropping entails the cultivation of an organic sustainable energy source in close proximity to another crop species. Because of their high biofuel yields miscanthus and switchgrass were the proposed biomass treatments planted alongside Loblolly pine trees on site. The site was divided into 3 different plots, each with a different treatment. Research objectives were to evaluate rates of production for biomass species and soil nutrient availability to timber in each plot. Data collection methods included one random biomass sample and two random soil samples. All samples were taken in close proximity to the plots center. The diameter of each Loblolly Pine on site was also taken for growth comparison in respect to the plots treatment. Biomass samples were dried and weighted to determine the productivity rates of miscanthus and switchgrass. All soil samples were tested to evaluate the nutrient amounts. Results of the study show that miscanthus (7,643 kg/ha) has higher biomass productivity than switchgrass (4,951 kg/ha).

Global Sensitivity Analysis Using Fisher Information Matrices
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This presentation focuses on the global sensitivity analysis for time-dependent models using mean Fisher Information matrices. Traditionally, the variance-based Sobol indices and Morris Screening methods have been used for this purpose. However, Auder and Iooss describe the application of Kullback-Leibler entropy-based sensitivity indices to provide a different perspective on model sensitivity. Since the Fisher Information matrix is the curvature of the Kullback-Leibler entropy, we expect that analysis of Fisher Information matrices will provide an enhancement to entropy-based sensitivity analysis. In this presentation, we consider two algorithms for using the sensitivity equation formulation to construct the mean Fisher Information matrix for a multidimensional, time-dependent model. We also examine the time dependence of the mean Fisher Information matrices and present a comparison between them and the Fisher Information matrix for the nominal parameter values of a synthetic data set. We then discuss applications to a four parameter SIR model and compare these methods with entropy-based and traditional sensitivity analysis methods in terms of parameter orderings and computational complexity. Our goal is to show that mean Fisher Information matrices can enable relevant sensitivity analysis for multidimensional, time-dependent models at a low computational cost.

Untethered and Magnetically Reconfigurable Elastomers By 3d Printing
Poster Number: 246

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A highly flexible, extensible, and very soft ink embedded with magnetic particles can be 3D-printed into elastin-like structures that act as magnetoactive soft actuators. The ink used in this process is a multiphasic composite of cured polydimethylsiloxane (PDMS) microbeads embedded with magnetic particles, water as a medium, and uncured PDMS precursor as a binding material. Due to the capillary bridging of the beads in the precursor, this ink has high storage moduli and yield stress, allowing for 3D printing. Furthermore, the ratio of PDMS beads and uncured precursor was optimized to 7/3 for a thixotropic but easily flowable paste at high shear stress. This thixotropic ink can be 3D printed by pressurized nozzle extrusion into various isotropic and anisotropic meshes. The embedded magnetic particles allow for the reconfiguration and reshaping of the 3D printed silicone under an applied electromagnetic field. With the magnetic field, the meshes can exhibit isotropic or anisotropic expansion and contraction. This methodology of printing magnetoactive soft materials can have very useful high-technology and biomedical applications such as active bioscaffolds to grow lung and heart cells.

Poster Number: 251

**Autoluc: Automating Image Processing and Analysis for Dynamic Luciferase Reporter Data**

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Luciferase promoters are a useful tool for studying dynamic mechanisms in plants. Data must be measured quantitatively and in a high-throughput manner to achieve maximum precision, accuracy, and reproducibility. To achieve this goal, I created an automatic pipeline called AutoLuc that can process, measure, and graph data from images of plants expressing luciferase. This analysis is currently performed manually and is therefore time-consuming and subject to inconsistencies because of variations in measuring practices, eyesight, and manual processing techniques. Therefore, I have developed AutoLuc to process these luciferase images. AutoLuc processes the luciferase images from beginning to end by removing noise from data, identifying individual plants, and graphing the resulting the intensity over time for each individual plant. AutoLuc balances minimal human intervention while providing users control over the analysis. This flexibility is provided by automatic and manual grouping mechanisms; automatic, manual, and editable regions of interest; the ability to pause the program after the regions of interest have been generated to inspect and edit regions of interest; and providing information to aid the user when manually creating groups of plants. In summary AutoLuc will enable rapid analysis of luciferase images allowing increased productivity, precision, accuracy, and reproducibility. Future work will aim to improve the user interface, add support for custom ROI finding algorithms, and add support for different plant species.
Macro and Micro: The Effects of Active Particles on Granular Materials

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Granular materials exhibit strange behavior. For instance, a heap of sand is able to stay fixed but can also be poured, exhibiting both solid and liquid-like properties. Similarly, a pile of flour will stay dormant if undisturbed. However, active matter behaves very differently; flocks of birds, schools of fish, and other living organisms exert mechanical forces that cause systems to move. Introducing active particles to a granular material will change the behavior of said material. For active particles in our study, we used the larvae of Tribolium confusus, the confused flour beetle. Motivated by the movements of the beetles, we seek to understand how individual motion of active particles affects the macroscopic motion of its environment. We perform experiments by adding active particles into grains of varying sizes - flour, flaxseed, and bulgur to test the importance of the relative size of active/inactive grains. In order to detect particle scale activity, we use Diffusing Wave Spectroscopy (DWS). By observing the changing reflections of a laser on the larvae we determined the amount of correlation in the larval movements. To measure bulk scale flows, we simply designed an apparatus that permits us to observe the flow of larvae in several grain mediums. We report the relationship between these two time-scales.

Characterizing the Effect of Iron Deficiency of Phloem Developmental Regulatory Networks in Arabadopsis Thaliana

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Breanne Bygrave, Imani Madison, Rosangela Sozzani, Terri A. Long*. Iron deficiency in humans is a world’s leading nutritional deficiency, making iron homeostasis an important area of research. Iron deficiency in plants is also a prevalent problem because basic soils, which make up about 30% of the world’s soil, make it difficult for iron to become bioavailable to plants. Red blood cell enucleation in mammals is iron-dependent, causing us to believe that cell enucleation in the phloem of plants may also be iron-dependent. Using RNA-seq, a putative gene regulatory network was computationally built based on genes that are differentially expressed within specific developmental zones in the phloem in response to iron deficiency. In this study our objective is to determine whether key genes in this regulatory network, such as DAG1 and COG1, have an effect on phloem development in an iron-specific way. To answer this question, dag1 (null mutant) and wild-type (col-0) seedling were plated on an iron-sufficient MS media for 4 days, and then transferred to iron-sufficient (+Fe) and iron-deficient (-Fe) MS media for 3 days. Seedlings were then analyzed for differences in developmental and physiological responses to iron deficiency, changes in iron content and localization, and alterations in phloem development. Our results
suggest that loss of DAG1 function negatively affects plant response to iron deprivation. These findings verify the basis of the putative regulatory network, which will lead to further investigation of the link between iron and phloem development.

Poster Number: 261
Shockwaves on Asteroids
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When landing a spacecraft on an asteroid how does the shockwave of the impact affect the opposite side of this collection of loosely bound rocks and dust? This summer we have developed an experiment to simulate this event. Prior work on simulated granular materials has shown that shockwaves propagate via a non-uniform network of strong interparticle forces. By using photoelastic particles, we are able to directly observe the force network created by the shockwave as it travels. To simulate a craft landing on an asteroid, a pendulum strikes one side of a 2D layer of particles in an environment which mimics low gravity. The shockwave and subsequent force network created by this impact is then captured by a camera mounted above the apparatus. This event occurs at high speeds, and the force network is only visible via a faint photoelastic signal. These constraints demanded we determine what speed, resolution, and light sensitivity are required of our camera. We also optimized the tilt of the setup to simulate low gravity, and the impact speed of the pendulum. Using this experimental setup we are investigating the relationship between the force network and the wavefront of the shockwave as it travels through our mock asteroid and out the other side.

Poster Number: 263
Development of an Open-source Automated Image-processing Algorithm for Photoelastic Disks
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Granular materials present a complex system wherein calculating the exact propagation of forces throughout them and the effects of the forces on the systems is unreasonably complex. This makes it hard to create a working model of systems of grains such as sand and soils for understanding the transitions of granular materials from solid to liquid and more gaseous states. Studying granular materials opens questions of granular flows and force propagation that can be applied in situations from landslides to asteroid landings. To study these questions, we use photoelastic disks floating on an airtable that are then subjected to shearing forces and photographed. The goal this summer was to improve the processing of already available data so as to obtain improved accuracy and precision within the systems. Initial testing using newly developed metrics for the success of program modifications has shown improvements. We are evaluating each to determine which will become permanent changes on the GitHub repository.
Sensitivity analysis is the practice of interpreting and quantifying the variation in a mathematical model's outputs in relation to its inputs. Parameter sensitivities can be computed both locally and globally. Local sensitivity methods assess changes in the model outputs within a small neighborhood about given parameter values, while global sensitivity methods explore variations over the entire parameter space. Both types of methods ranks how sensitive a parameter is to the model outputs. Numerous numerical techniques exist for computing sensitivities, we discuss local methods approximating sensitivities using finite differences (FD) and using a complex-step (CS) method, and global methods including Morris screening (MS) and generalized Sobol' indices (GS), which account for elementary effects and temporal correlation, respectively. This study compares these techniques for a neurological model predicting the baroreflex response to the Valsalva maneuver. Results from all the methods revealed a similar set of important parameters, although not identical. From these results, it is possible to separate the list of parameters into classifications of most and least sensitive.

Beyond Intention-outcome Dichotomy: The Role of Negligence in Children’s and Adults' Moral Judgments

When making moral judgments (how okay, or not okay something is), people take many different details into consideration. More specifically, people tend to the level of carefulness, and the actor’s intentions. Earlier studies have investigated this issue within the framework of outcome-intention dichotomy, and more recently, studies have extended this dichotomy to outcome-intention-negligence trichotomy (e.g., Nobes, et al, 2009). In this study we investigated whether transgressors’ negligence plays a role in moral judgments across childhood and adulthood. 87 children, and 38 adults, assessed two scenarios with either a “negligent” victim and a “careful” transgressor (VN/TC), or a “careful” victim and a “negligent” transgressor (VC/TN). The scenarios result in property damage (victim’s cupcake gets thrown away by transgressor), and in physical harm (transgressor riding a bike, hits a hole, crashes into victim and victim gets hurt). Participants were asked to rate the level of acceptability of the transgressor’s actions on a Likert-type scale ranging from 1 to 5, 1 being represented with a sad face saying “very not all right”, and 5 represented with a happy face saying “very all right”. There were significant differences in ratings depending on how careful or negligent the transgressor was, with participants rating negligent transgressions as much less acceptable than accidental transgressions where the transgressor was trying
to be careful. The results demonstrate that both children and adults take into account the context when making moral judgments, which has important implications for social interactions.

Poster Number: 269
Testing Arena Size Significantly Alters the Behavior of Larval Zebrafish

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Environmental factors such as exposures to chemicals and changes in illumination can significantly influence behavior. The size of the behavior testing arena is another factor that likely affects behavior, but how it may do so is not well understood. Here we used larval zebrafish, a powerful vertebrate model system, to test the effect of arena size on a battery of behavioral assays. When introduced to a novel arena, many animals including zebrafish larvae, display a preference for the perimeter, a behavior called thigmotaxis that is thought to indicate an anxiety-like state. 6-day-old TLF-strain larvae were transferred to individual testing arenas, and after a brief acclimation period we recorded their spontaneous movements and analyzed them with automated tracking software. Larvae in medium (13 mm) to large (28 mm) arenas spent ~60% of the time in the perimeter, while fish in the smallest arena (9 mm) spent more than 80%. This may indicate that a smaller arena induces a more anxiety-like state. We also tested the effect of arena size on another anxiety-related behavior, the acoustic startle response. While we did not observe any effect of arena size on startle sensitivity, we found that pre-pulse inhibition, a form of startle modulation impaired in patients with schizophrenia, was significantly reduced in fish in the largest arena. These data indicate that the testing arena size significantly alters the behavioral state of larval zebrafish. Our results present an opportunity for further research into gene-environment interactions and the brain mechanisms that drive these changes in behavior.

Poster Number: 278
Production of a Small Antibody Fragment in Pichia Pastoris: Scale Up From Shake Flask to 2l And 30l Bioreactor

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The objective of this project is to optimize the scale up production of a small antibody fragment (ScFv) from shake flask to 2-liter and 30-liter bioreactor. The expression system is based on the methylotrophic yeast Pichia pastoris. The protein of interest is ScFv13R4 that specifically binds the bacterial beta-galactosidase. Cells were grown in a defined medium using glycerol batch, glycerol fed-batch, and methanol fed-batch methods to achieve high cell densities and production of the protein of interest. In the first 2-liter bioreactor run at 30 °C and pH 5 we could achieve an optical density (OD) of 370 and the product shown in a degraded form on SDS-PAGE gels. The proteolytic effect was eliminated by running 2-liter bioreactor at 25 °C and pH 3.5. The latter conditions were scaled up in a 30-liter bioreactor where
the dissolved oxygen was maintained at 30% using a cascade between the agitation and airflow. In these conditions, we could achieve an OD of 352 and non-degraded ScFv13R4 production of at least 1 gram/liter of supernatant. A standard operating procedure (SOP) was established and will allow the implementation of this process in academic fermentation classes and for the production of large amounts of ScFv13R4 that can serve different proposes like optimization of downstream purification processes.

**NextGen Data Science Fellowship Program**

Poster Number: 144

**Machine Learning for Piezoelectric Property Prediction and Reliability Assessment**

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Piezoelectrics are materials which exhibit an electrical response while under mechanical stress. When under stress, the crystal structures of ceramic piezoelectrics may often experience partial ion shifts within the space of the unit cell, which create a slight charge imbalance, and in turn cause a polarization. Areas of the material with uniform polarization directions are referred to as domains, and these polarization directions may change upon application of a strong enough electric field in a different direction; materials with this property are known as ferroelectrics. Many factors of the material will determine how well it performs as a ferroelectric, but one largely unexplored factor is the tetragonality of the material’s unit cell crystal structure. Tetragonality is measured by the aspect ratio of the unit cell’s longer side, c, to the base side, a. In tetragonal materials, the degree of ferroelectric domain movement is represented by $\eta_{002}$; the value of $\eta_{002}$ was investigated as a function of $c/a$ through literature review. Additionally, piezoelectric coefficients ($d_{33}$) were collected from literature and used in machine learning to help guide the scientific process towards materials with desired properties. The machine learning occurred by use of Citrine’s platform to create models of data collected from literature to form predictions about previously uninvestigated materials. The results of the machine learning model can then either be explored in literature, where data is available, or by experimentation.

Poster Number: 161

**Machine Learning to Investigate Liquid Metal Embrittlement**

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In recent years, liquid metals have been used for new technologies such as flexible circuitry and reconfigurable antennas. However, some liquid metals can greatly reduce the strength of some metals by a phenomenon known as liquid metal embrittlement (LME). The effects of LME makes these new
technologies difficult to integrate because the liquid metal may cause catastrophic failure in a device. A predictive model of LME has been elusive due to a lack of understanding of its mechanisms. Materials informatics was applied to previous research and new experimental data through the Citrin platform to create a model that can predict if a system will display embrittlement and identify factors that affect LME.

Poster Number: 163
**Genetic Algorithm Evolved Aunp Ligand End Groups for Transfection in Cancer Cells**
Author: **Kevin Kronk** Materials Science and Engineering NC State University

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A variety of nucleic acids, including small interfering RNA (siRNA) have been used in the regulation of gene expression and protein creation for therapeutic purposes in cells. Cancer therapy is perhaps the most promising use of this technology. However, naked nucleic acids have low stability due to nuclease activity and are poor at crossing the cell membrane. The use of gold nanoparticles (AuNPs) with functionalized cationic ligand end groups is being explored due to their low toxicity in the cell and ability to the cross the cell membrane (transfection). It is not known what exact charge, structure, and interaction of the ligand end groups is ideal for agglomeration with siRNA and transfection. Using AMBER Molecular Dynamics, ligands were simulated with changes in methyl bonding groups along the backbone of the molecule. This research is attempting to identify important features for creating a fitness function that provides the end goal for a genetic algorithm (GA). One such feature, linear interaction energy, has been assessed for the atoms in each ligand using cpptraj. The GA tests incremental changes in the ligand structure, keeping structure features which perform well based on the fitness function, to ultimately evolve the most fit ligand for agglomeration and transfection. A file ingester is also being created to allow molecular dynamics output files to be uploaded to the Citrination platform for additional materials informatics processing.

Poster Number: 164
**Matching Yeast Polarity with Semiconductor Polarity and Interfacial Properties: A Route to Decode Electro-genetic Information**
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This research uses a data-driven approach to explore how material properties can be altered to encode a cell response in yeast. The main focus of the project is organizing data that measures how accumulation of reactive oxygen species causes cell death and triggers genetic changes in yeast. This involves extracting data from literature, storing and retrieving it in a relational database using SQL, and uploading it to Citrine Informatics’ machine learning platform for materials data. These tools can be useful resources in predicting what properties are important in affecting cell pathways in yeast.
Creation of a Database Storing Properties of Emulsions and Complex Fluids

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An emulsion is a mixture of two immiscible liquids stabilized by an emulsifier. While emulsions play a key role in the pharmaceutical industry, agricultural industry, cosmetic industry and food industry, there is no database that stores information about properties of emulsions. In this work, entity relationship models were created and normalization techniques were used to create a database that organizes emulsion properties. The database generator Vertabelo was used in the initial planning of the database, and MySQL was used in the final creation of the database. A database such as the one developed can be used to submit processed emulsion information to the Citrination platform which will ultimately improve Citrination’s machine learning algorithm with respect to complex fluids. It is the goal of this work to provide a foundation in which scientists and researchers will be able to filter, select and manipulate data from an organized and efficient database of emulsion properties.

A Deep Learning Approach for Real-time Assessment of Electron Microscopy Data

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Convergent beam electron diffraction (CBED) is a method which allows scientists to analyze samples on a structural level. Least squares fitting has previously been used to match the experimental pattern to a simulated CBED pattern with known values to obtain the unique parameters of these samples. However, this method is time-consuming and requires the researcher to identify the pattern’s center as well as the scale to improve the accuracy when selecting a matching simulated pattern. Parameters such as the sample’s tilt further complicate the process, by making the center difficult to identify. We explore the use of convolutional neural networks to resolve these shortcomings. Using the Keras library in Python, the Xception and AlexNet models are tested for speed using simulated images of lead magnesium niobite-lead titanate (PMN-PT). Hyperparameters such as learning rate, decay, and momentum are adjusted to aid the process of training these networks.
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We aim to develop an efficient machine learning approach to predict crystal orientations from Electron Backscatter Diffraction (EBSD) patterns. EBSD is an electron microscopy technique that is used to characterize the orientations of crystals in a polycrystalline sample. The traditional technique for indexing EBSD patterns involves either a Hough Transform or a Dictionary Based Indexing approach. The Hough transform technique, while is computationally efficient, has a low angular resolution. The dictionary approach for classifying EBSD patterns has very high angular resolution but is computationally very slow. The aim of this project is to develop a regression-based Convolution Neural Network to index EBSD patterns efficiently and with accuracy comparable to that of the dictionary approach. Unfortunately, traditionally neural networks perform poorly as they do not account for symmetries in the rotation space while indexing EBSD patterns. To further investigate this issue, we used a synthetic data-set to predict the rotation angle of an image. This study explored the role of symmetry-preserving metrics and representations in predicting the two-dimensional orientation (rotation angle) in images.

NSF EFRI-REM Mentoring Catalyst Initiative
Poster Number: 166
Innovating Marketing with Cyber Security
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Today, massive amounts of data are produced and consumed to power many of the online products and services that we all love to use. Meaning more sensitive data is traveling across these data pipelines. Creating a vulnerability for our data that stalkers, identity thieves or even terrorists could take advantage of. We’ve seen this happen in cases where social media platforms and even credit bureaus like Equifax have had data breaches that lost millions of peoples sensitive data. The main problem our research is trying to solve is eliminating the need for major data collection in the social media/web application market. This involves testing a new form of promotion services. Our goal is to allow users to individually select products, services or events to subscribe to advertisements of their choice. This means users of the application are only marketed to things currently relevant or interesting to them. As a result, we should see increased customer experience and advertising analytics. Our system uses a local engine available to each user account that is kept within their personal device and is only accessible by them. When data is shared the local engine acts as a personal database that can be referenced to by the application for personalization but will not share information with the application’s main database. Our approach reduces the risk involved with interactions online, while still allowing businesses to market profitably. This is the future of cyber security and one solution to one of the 14 grand challenges for engineering.
Application of Unmanned Aerial Vehicles in Targeted Pesticide Spraying for Precision Agriculture

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The ultimate goal of this research is to use the quadcopter UAV to identify the pest on the crop and apply chemicals to the infested area automatically with targeted pesticide spraying. In order to accomplish the missions, the UAV will be modified by mounting an object identification camera, micro-controller board (Arduino Mega Board), and a target spraying system. During past academic year, several research tasks were completed. First, the drone components (frame, flight controller, GPS, motors, and propellers) were purchased and assembled. Several flight tests were carried out to ensure accurate self-leveling and altitude holding performances. Before connecting the camera to the Arduino Board, a control program was written and uploaded to the Arduino board; therefore, the micro-controller board can utilize the information collected by the camera to decide whether the spray system should act or not. The control program also restricts the action of spray system within the target range; since outside the target range, spraying will be insignificant and should be disabled. In the end, several containers were 3D-printed to hold electric components and meanwhile hook up to the UAV. Now the integrated UAV prototype can fly stably with a fixed distance upon the ground and the spray system can automatically deliver liquid when a target object appears in the active range of the camera.

One-pot Synthesis Of β-lactams From Primary Amines

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A common moiety in several antibiotics are cyclic amides, referred to as β-lactams. These compounds are additionally used as substrates for ring-opening reactions, affording versatile asymmetric products. While useful, the synthesis of such products often involves stoichiometric amounts of hazardous chemicals. A method for the transformation of primary amines to such β-lactams within a single reaction vessel, and without the use of highly toxic materials, has been explored utilizing a tunable cyclopropanone reagent developed in the Lindsay lab. The amine of choice is initially functionalized in situ using a peroxide, followed by reaction with cyclopropanone. The resulting intermediate undergoes a bond shift, expanding the ring and forming the β-lactam. This pathway has been demonstrated with two sterically hindered amines and is currently being optimized further.
Determining the Effects of Aging on Cellular Proliferation and Protein Signaling in a Bone-muscle Cross-talk System in Rats

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Aging has detrimental effects on bone and muscle function, contributing to frailty and increased risk of injury in the elderly population. Previous studies show a specialized communication cross-talk system between bone and muscle can directly influence the growth of both tissues. However, the impact of aging on this cross-talk is not well understood. This study examines changes in bone-muscle cross-talk via a cellular co-culture system. Mesenchymal stem cells along with satellite muscle cells were isolated from old (30-33 week) and young (6-weeks, n=10 per group) male rats and cultured to confluence in a previously-optimized indirect co-culture system. Monocultures acted as controls, and all cultures were differentiated for 14 days. Viability was assessed every 3 days using Alamar Blue dye. Insulin-like growth factor (IGF-1), a protein that promotes growth in both tissue types, was investigated by ELISA in conditioned media on day 14 to assess cross-talk. It was hypothesized that aged cells of one tissue co-cultured with young cells of the other tissue would have greater rates of proliferation and IGF-1 expression relative to the monocultures. Statistical analysis of proliferation results suggested that monocultures had higher proliferation rates compared to co-cultures (p<0.05), but age had no effect. ELISA results indicated no increased incidence of IGF-1 signaling, suggesting little difference between cell-type or age. Further research is required to establish the validity of this model, the results of which could inform the future development of therapies to treat degenerative diseases that affect the musculoskeletal system.

Poster Number: 36

Brachial Plexus Birth Injury Alters Muscle Composition

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Damage to the brachial plexus nerve bundle during childbirth results in brachial plexus birth injury (BPBI), the most common nerve injury in children. BPBI causes gross changes in shoulder muscle morphology, leading to limited arm functionality. We hypothesized that BPBI alters muscle composition in the affected shoulder, with normal muscle fibers replaced by fibrotic tissue. Two well-established rat models of BPBI were used, described by the position of the injury relative to the dorsal root ganglion: postganglionic and preganglionic neurectomy (n=6 each). After 8 weeks, animals were sacrificed, and the biceps and subscapularis muscles were harvested, snap-frozen, and cryosectioned. Sections were stained using Masson’s trichrome to identify collagen deposition, indicative of fibrosis, then imaged and analyzed with a custom protocol for color thresholding (ImageJ, National Institutes of Health). Differences between affected and contralateral unaffected muscles were compared for fibrotic/normal tissue area ratios using paired t-tests. Preliminary results for the postganglionic group demonstrate that affected muscles had more fibrotic tissue than unaffected muscles (p<0.05). Future work will analyze muscle fibrosis following
preganglionic injury and compare changes between the two groups. The results suggest a change in the underlying muscle structure following injury, which could partially explain functional changes observed in the murine BPBI model. Understanding muscle changes associated with BPBI is a crucial step for developing targeted treatments and therapies.

Poster Number: 41

Molecular Characterization of Salmonella Enterica Typhimurium Isolated from Humans, Swine, and Environmental Sources in North Carolina

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This project aims to utilize the One Health Approach in order to characterize temporally and spatially related isolates of *Salmonella enterica* Typhimurium across three sources: humans, swine, and the swine production environment. The human samples (n=50) underwent a series of testing to determine their Antimicrobial Resistance (AMR), while the swine (n=10) and environmental (n=10) results were obtained from preliminary data in a related study under the same conditions. Phenotypic characterization included Minimum Inhibitory Concentration (MIC), while genotypic characterization included Polymerase Chain Reaction (PCR) and Gel Electrophoresis. A total of 14 antimicrobials were tested to determine the MIC for each isolate, followed by selective PCR testing for 14 genes, Class I Integrons, and 4 virulence genes (human only). MIC test results showed resistance in all three sources for Chloramphenicol, Tetracycline, Sulfisoxazole, Ampicillin, and Streptomycin. Further analysis determined that swine and environmental isolates were most similar phenotypically, sharing 3 phenotypes between them, and none with humans; likewise, two genotypic profiles were shared between swine and the environment, while none were shared with humans. Yet, similarities do exist for all three on a genetic basis, sharing *aadA1, aadA2, blaTEM, CML, tetC*, and Class I Integrons between them. Overall, humans shared no identical phenotype/genotype profiles with either swine or environmental isolates, while two different profiles matched exactly for the latter two sources. Integrons were identified in 21/26 isolates compared at a genotypic level, indicating the ability of these strains to maintain antimicrobial resistance even without the presence of any selection pressure.

Poster Number: 45

Feasibility of Syngas Pre-adaptation in Improving Single Carbon Gas Conversion by Clostridium Autoethanogenum

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Clostridium autoethanogenum is a microorganism that can convert single carbon gases and sugars to ethanol. Among sugars used in fermentations, *C. autoethanogenum* has typically been grown on the five carbon sugar, xylose, and many studies show the microbial catalyst energetically favors the production of acetate over ethanol. The metabolic pathways and energetics of *C. autoethanogenum* during the production of acids and alcohols from syngas can be redirected by pre-adapting the organism with
various carbon sources. This work examines the feasibility of using sugar-based pre-adaptation to enhance fermentation energetics and the conversion of single carbon gases to ethanol using C. autoethanogenenum. Different pre-adaptation conditions are studied: fructose only, xylose only, fructose-xylose, fructose-syngas, xylose-syngas, and fructose-syngas-xylose prior to fermentation of C. autoethanogenenum in syngas only and syngas-xylose. Experiments have been designed to study two hypotheses related to pre-adapting cells to different carbon substrates and the second evaluating the performance of preadapted cells to syngas fermentation conditions. The work reported focuses on the first hypothesis that C. autoethanogenenum will be able to grow in all pre-adaptation conditions, yet have variable growth rates, and provide cell culture stocks suitable for use in syngas and mixed syngas-sugar fermentations. In these experiments, growth on the different substrates was monitored over time using optical density. In addition, carbon consumption and end product formation (acetate, ethanol) were measured.

Poster Number: 46

**Machine Learning Waveform Fitting to Improve Energy Resolution in Bege Detectors**

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The Majorana Demonstrator is an array of high purity Ge detectors searching for neutrinoless double beta decay in Ge-76. The Demonstrator exploits the excellent energy resolution of high-purity germanium detectors to attain the required low background; trapping of drifting charge can negatively impact the energy resolution and detector performance. Recently, a machine learning algorithm was developed to model Germanium detector waveforms to extract event information from a waveform. Once a number of parameters are determined about the detector and electronics response, this waveform fitting technique can be used to infer the energy deposition origins for a particular event. Using the deposition origin, we can model the drift path of the charge-carrier and use that to develop a charge trapping correction based on the carrier’s drift length. This correction has the potential to improve our overall energy resolution leading to smaller windows when searching for low energy events.

Poster Number: 56

**NCSU Student Perception and Knowledge About Gastrointestinal Microbiota, Probiotics, and Prebiotics: An Initiative to Revolutionize Health**

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The microorganisms inhabiting the gastrointestinal tract (GI) play a large role in shaping our health. The colon houses more bacteria than anywhere else in the human body. Along with the trillions of microbes, the immune system is also primarily located in the GI tract. This establishes an important relationship between our GI microbiota, our immunity, our environment, and our susceptibility to chronic disease. Colorectal cancer (CRC) is one of the most commonly diagnosed cancers in the United States; therefore, research efforts have been made to evaluate the complex interplay between CRC and the composition
of the GI microbiome. Together we must understand that CRC is not only a health issue, but also a societal issue that stems from a gap in scientific knowledge and public understanding about the importance of cultivating a healthy GI microbiome. The purpose of this research was to measure the NCSU student perception and knowledge about GI microbiota, probiotics, prebiotics, as well as behaviors that could be associated with an increased risk of CRC. In order to gauge the student responses, a questionnaire was written to include three categories: lifestyle, perception, and knowledge. A convenience sample of 50 NCSU students was used to complete the questionnaires in Talley Student Union. Overall, the results indicated a lack of knowledge on GI microbiology. Although this sample is not representative of the entire NCSU student population, it provides beneficial preliminary data for future efforts.

Poster Number: 71
Progress Towards the Synthesis of Alotamide A
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Alotamide A, a secondary metabolite of the marine cyanobacterial species Lyngbya bouillonii, was first isolated in Milne Bay near Alotau, Papua New Guinea. This molecule was found to activate calcium ion influx in murine cerebrocortical neurons. Ca^{2+} concentration in neurons is related not only to essential biological functions such as muscle contraction and neurotransmitter and hormone secretion, but also to neurological diseases such as Alzheimer’s and Huntington’s disease. Because of its relevant biological activity, there is much interest in developing a total synthesis of Alotamide A so its neurological properties can be further investigated. Through previous work, a simplified analog of Alotamide A has been synthesized. Current work includes new methods for achieving another analog of the natural product. Our retrosynthesis of this analog involves splitting the molecule into three fragments: a tripeptide based northern fragment and two aliphatic fragments on the southern part of the molecule to be joined by a Suzuki coupling reaction. The left and right sides of the aliphatic chain can be connected to the northern fragment via esterification and amidation, respectively. By synthesizing this analog, we can confirm that this chemistry is effective in creating the core structure of the natural product. In the future, we hope to utilize current work in developing a total synthesis of Alotamide A. By synthesizing Alotamide A and other analogs, we can further evaluate its biological activity and learn more about its pharmacological potential.

Poster Number: 87
Validation of Immersive Level of Hololens Used in Obstacle Cross Training
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Obstacle crossing training is widely used in the rehabilitation of people with mobility limitations. The task poses greater demands on individuals’ balance control, lower-extremity motor strength, and walking ability compared to unobstructed walking. To better simulate real life situations and to construct creative conditions beyond the limitations in labs, many researchers introduced XR (Virtual Reality, Augmented
Reality and Mixed Reality) technology to the trainings. I proposed a pilot study to validate how immersive MR experiences are in order to minimize the side effects of using MR in rehabilitation. The purpose of this study is to elucidate the effects of MR-based Hololens exercise in participants by comparing the results of Hololens training and traditional exercise. The test includes three blocks. In the first two blocks, participants were instructed to walk through an obstacle course. The setup is shown below. The only difference was that in the second testing block, participants were given virtual obstacles instead of the physical obstacles. The trajectories of their walking were generated by motion capture system and then analysed in Matlab. By tracking subjects’ movements, we can see the differences and similarities in their reactions to the physical and digital obstacles in terms of the time used in each trial, numbers of failures etc. Lastly, participants needed to complete the Presence questionnaire, which is a questionnaire used to evaluate the effectiveness of virtual environments. In the future, more creative and complex obstacle crossing courses can be created to further study the effectiveness of MR used in rehabilitation.

Poster Number: 116
Determining the Role of Tnf-alpha in Radiation Therapy Associated-trp-channel Sensitization
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Acute radiotherapy (RT)-associated side effects can cause severe discomfort in head and neck cancer patients. During irradiation, Tumor Necrosis Factor-Alpha (TNF-alpha) levels increase, which is indicative of inflammation. Cells also become increasingly sensitive to pain stimuli, through activation of Transient Receptor Potential (TRP) ion channels. This study was designed to determine the role of TNF-alpha in radiation-induced TRP channel activation. We hypothesized that TNF-alpha inhibition (using pentoxifylline; PTX) would decrease TRP channel sensitization afferent sensory neurons. This was tested using a mouse model of radiation-induced glossitis, with four treatment groups: RT + PTX, RT + saline, sham irradiation + PTX, and sham irradiation + saline, with saline and sham irradiation serving as controls. Efficacy of pharmacologic knockdown of TNF-alpha was determined using ELISA to quantify that cytokine in blood. Body weights and oral glossitis severity scores were measured daily along with daily injections of PTX or saline. Sensitization of the trigeminal nerve was evaluated using a behavioral assay. Furthermore, calcium imaging was performed on trigeminal neurons, ex vivo, using chemical stimuli known to stimulate either TRPV1 (capsaicin), TRPV4 (histamine) or TRPM8 (icilin). Treatment with PTX did not mitigate weight loss or glossitis severity, nor did it alter behavioral responses to application of a noxious stimulus (cold saline) to the eye. Results of calcium imaging and ELISA are pending.

Poster Number: 119
Survey of Brain Morphology with Focus on Cerebellar Granule Cell Populations in Wildtype and Ptch Heterozygous Knockout Adult Mice
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The Sonic Hedgehog Pathway (SHH) regulates neuronal precursor cell division and differentiation during development. Patch (PTCH) encodes the Shh receptor protein which, when activated, causes cerebellar granule cell differentiation. Loss of function PTCH mutations decrease differentiation signaling in the cerebellum and can cause medulloblastomas, a pediatric brain cancer. The impact of PTCH mutations on extra-cerebellar neurogenesis is not well-characterized. Using a single allele knockout Ptch+/- mouse model, the Belcher lab has found that social behaviors of Ptch+/- female mice were altered. To identify structural changes in the cerebellum and other brain regions that may contribute to the observed behavior changes, the morphology of specific structures in brains of WT and Ptch+/- mice were analyzed. Brains from male and female Ptch+/- and WT mice were isolated, cryosectioned, stained with cresyl-violet, and photomicrographed. Neuronal populations in selected structures across selected brain regions were quantitatively compared. Changes in brain regions outside the cerebellum were observed. Neuronal overgrowth was observed in the cerebellum. The width and area of the internal granule cell layer (IGL) of cerebellar lobules IV and IX of Ptch+/- male and female was significantly increased. These findings suggest that abnormal IGL overgrowth in lobules IV and IX may play a previously unknown role in some aspects of behavior. Future studies will investigate what cerebellar networks may be contributing to the changes in behavioral phenotype.

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Oysters: A Temporal Market Analysis
Author:
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The underpinning of price changes of markets captivates economists and historians alike. Economic theory proclaims price is dictated by a “law” of supply and demand, in which quantity supplied and demanded are inversely correlated. However, understanding changes in demand preferences is another factor. Consider the sudden popularity (and unpopularity) of foods. Some foods (for example, sushi, in the mainstream US market) appear and become staples. Other staple foods disappear. Why? The case of oysters demonstrates how drastic changes in pricing and demand schedule can be. Considered a staple working-class food in the early twentieth century, oysters are now much more expensive and are generally a luxury food (Booker 2006, 2013). By combining a dataset with statistical analysis and the contemporary trade journal The Oysterman and Fisherman, this change in US society’s demand schedule can be analyzed. In this project, both market sentiment and price changes over time will be addressed. Volatility will be calculated using a generalized autoregressive conditional heteroskedasticity model (GARCH) via the R (using a GARCH(1,1) model). Market sentiment will be captured from The Oysterman and Fisherman trade journal. The aim of this project is to capture key patterns in price volatility in oysters using GARCH. The implication of this research can be used to understand market movements in market sectors and how this relates to changes in demand, among social classes. The key dataset is the New York Public Library’s “What’s on the Menu?” project, which contains prices of restaurant dishes over time.

Biodiversity and Herbivory in the Urban Environment on Native and Non-native Landscapes

Poster Number: 223

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The underpinning of price changes of markets captivates economists and historians alike. Economic theory proclaims price is dictated by a “law” of supply and demand, in which quantity supplied and demanded are inversely correlated. However, understanding changes in demand preferences is another factor. Consider the sudden popularity (and unpopularity) of foods. Some foods (for example, sushi, in the mainstream US market) appear and become staples. Other staple foods disappear. Why? The case of oysters demonstrates how drastic changes in pricing and demand schedule can be. Considered a staple working-class food in the early twentieth century, oysters are now much more expensive and are generally a luxury food (Booker 2006, 2013). By combining a dataset with statistical analysis and the contemporary trade journal The Oysterman and Fisherman, this change in US society’s demand schedule can be analyzed. In this project, both market sentiment and price changes over time will be addressed. Volatility will be calculated using a generalized autoregressive conditional heteroskedasticity model (GARCH) via the R (using a GARCH(1,1) model). Market sentiment will be captured from The Oysterman and Fisherman trade journal. The aim of this project is to capture key patterns in price volatility in oysters using GARCH. The implication of this research can be used to understand market movements in market sectors and how this relates to changes in demand, among social classes. The key dataset is the New York Public Library’s “What’s on the Menu?” project, which contains prices of restaurant dishes over time.
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Be it either for aesthetics or pest control, non-native plant species have been outnumbering native plants in popularity with landscapers and private gardeners. To understand how this xenophilia affects insect biodiversity and ecosystem health, we examined six identically arranged plots at the US National Arboretum in Washington, DC for herbivory damage and natural enemies. Three of these plots consists of only native species of plants, while the other three consist of only exotic. Random branch sampling showed that there was more herbivory among native plant species than non-native. Beat samples were taken on trees and shrubs in plots to survey the diversity of natural enemies of phytophagous insects, including spiders, ants, predatory thrips, Opiliones, Coccinellidae, Chrysopidae, Orius, Elateridae, parasitoid wasps, mantids, nabids, earwigs and long legged flies. There was no distinction between native and non-native plots when it came to biodiversity of natural enemies, but further research will include details in differences of insect biomass between plots. Our research suggests that, although species diversity of natural enemies does not differ between native and non-native plots, native landscaping may provide more leaf food resources for higher trophic levels in urban ecosystems.

Poster Number: 255
Optical Detection of Velocity in Two-phase Microfluidic Systems
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Researchers in the Abolhasani Lab have developed a high-throughput, droplet-based microfluidic platform for studying the reaction kinetics of colloidal semiconductor nanocrystals, or quantum dots. A translating flow cell with 73 sampling ports along the reactor allows in-situ monitoring of the absorption and fluorescence spectra of colloidal nanocrystals while decoupling the effects of reaction time and precursor mixing within droplets. Tuning these parameters requires precise measurement and control of droplet velocity and length. Calculating the velocity based on flow rates of the reactor inlets only serves as a rough estimate due to the compressibility of the gas phase. We develop an inexpensive, non-invasive droplet velocity meter for tube-based microfluidic systems. Three off-the-shelf optical sensors are attached to a tubular Teflon reactor to monitor changes in absorbance as droplets pass. Knowing the distance and transit time of a single droplet permit calculation of its velocity. The cross correlation of the signals provide transit times from each sensor pairing. The regular flow pattern makes tracking one droplet difficult; thus a flow irregularity or precise droplet count enables a single estimate. The third sensor provides additional constraints for more general performance. Generally, the configuration provides 2-3 estimates, which can be refined with prior knowledge about the system. As a case study of the technique, we utilize the droplet velocity meter with the high throughput quantum dot synthesis platform to systematically study the anion-exchange reaction of colloidal perovskite quantum dots without the confounding influence of uncontrolled mixing rate.
**Poster Number: 256**  
**An Assessment of The Effects of Tillage, Cover Crops, And Cropping Systems on Soil Aggregate Stability In North Carolina**  
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The health and productivity of a soil are dependent on its structure and stability. Physical properties are affected by many factors including crop management, tillage, and surface residues. Agronomic management practices such as reduced or no tillage and cover cropping (CC) have been found to improve aggregate stability (AS), which improves soil structure and reduces erosion. Multiple cropping and tillage rotations were evaluated to determine their effect on soil AS. Soils collected from two research sites were used to analyze the effects of tillage and CC on AS in soils of the North Carolina Piedmont. At the Salisbury site, we hypothesized that soil samples collected in January 2018 would show more AS compared to samples collected in December 2016 due to the no-till practices at this site. For the Reidsville study, we hypothesized that the CC no-till system would have a greater AS compared to tillage cropping systems regardless of the CC treatment. We evaluated soil macro and microaggregate stability using wet sieving and dispersion ratio techniques. Results from the Salisbury site showed that microaggregate stability decreased between December 2016 and January 2018 while macroaggregate stability was similar between the sampling dates. In the Reidsville study, we found that the CC no-till treatment had the highest macroaggregate stability. Preliminary results indicate that no-till treatments resulted in higher levels of macroaggregate stability due to limited soil disturbance compared to the other crop management techniques. This finding suggests that farmers might benefit from no-till practices in areas with soil prone to erosion.

**Poster Number: 260**  
**Genetic Differentiation of Maize Weevils in Oaxaca And Chiapas, Mexico**  
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The maize weevil, *Sitophilus zeamais*, is a common insect that feeds on stored grains, particularly maize. The species is especially a problem in Mexico, which is the center of origin and diversity for maize. If left uncontrolled, maize weevils can inflict serious damage on crops reducing both quantity and quality of grain. This leaves subsistence farmers with less grain to consume for themselves or sell on the market. A previous study has found that little genetic differentiation exists in maize weevil on a global scale. Specifically, more variation is found within populations than between them. Here, I utilized microsatellites to determine the population genetic structure of maize weevil populations sampled in Oaxaca and Chiapas, Mexico. Wright’s F-statistics were calculated to determine the genetic variability between these populations. I hypothesize that my results will also reveal little genetic variation between the maize weevil populations tested. This data will be used to compare against Correa’s findings and to supplement work from our laboratory analyzing genetic differentiation of these maize weevils using single nucleotide polymorphisms (SNPs).
Ameen Rihani: Bridging the East and The West

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Far too often in history, many significant figures go unnoticed or are forgotten. Perhaps the distinguished Ameen Rihani, widely recognized as an intellectual that shaped and revitalized the modern Arab intellectual renaissance, is one of the twentieth century notables whose influence is overlooked and forgotten today. Rihani transgressed the standardized Arabic language into a derivation that is expressional and better understood by a wider audience. His success has reached into the humanities, social sciences, and far beyond. This summer, NC State’s Khayrallah Center for Lebanese Diaspora Studies teamed up with the Ameen Rihani Museum to digitize Rihani’s entire collection, thereby providing an opportunity for an international body of scholars to delve deeper into understanding Rihani both personally and intellectually. I was fortunate enough to be a part of this project by working at the museum in Freike, Lebanon this summer. By working on site, I was acquainted with Rihani’s nephew, Dr. Ameen Rihani, who taught me more about the historic and personal aspect of Rihani as a man of letters and a familial man. I want to tell the story of Rihani’s life as it is truly a remarkable one. I plan to do this by explaining my preparation for this project with the help of Akram Khater and Claire Kempa, detailing the work I performed on site, and sharing the stories Dr. Rihani told me during our oral history interview sessions.

Host Genetics Influence Skin Microbes and Earwax Type

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Skin microbes are crucial to human health, acting as a first defense against pathogens. They are affected by many factors including lifestyle and host genetics. We want to determine how these two factors influence one’s microbes and, consequently, their health. ABCC11, a gene whose product is active in human apocrine glands (sweat glands), contains a single nucleotide polymorphism that determines whether a person has wet or dry earwax. Individuals with African or European ancestry typically have wet earwax, while those with Asian or North American ancestry typically have dry. Based on preliminary findings by the Roberts and Horvath labs, this ABCC11 variant also affects which microbes live in apocrine sites. To test if ABCC11 genotype affects microbes living in both apocrine and non-apocrine sites, we swabbed the skin of volunteers at both types of sites to collect microbes and participants’ DNA to determine ABCC11 genotype. We amplified the 16S rRNA gene to study bacterial comparisons. To test for universal differences between populations (as it is still unclear how much microbial variation is due
to lifestyle), we collected samples from US (RTP) individuals and Malagasy people of Madagascar at the same apocrine (ear and axilla) and non-apocrine (nose and ankle) body sites. To date, we have sampled 126 US and 30 Malagasy individuals and sequenced the 16S region of 30 US and all Malagasy participants. We predict ABCC11 variation affects microbe composition of both apocrine and non-apocrine sites, with trends across body sites common to both populations despite varying lifestyles.

Poster Number: 276

**Efficacy of Photosensistizers In Antimicrobial Applications**

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Increase of antibiotic resistance in pathogens has directly impacted the healthcare industry. With only a few novel discoveries in the field of antibiotics since last two decades, often referred to as the discovery void, drug- resistance in pathogens has increased. Diseases that were previously easily treatable have now become fatal. One solution is photodynamic therapy (PDT). Commercial photosensitizers (PSs) such as Photofrin have been used in photodynamic therapy for treating initial stages of skin cancer, acne and psoriasis. It involves three components: a photosensitizer, a visible light source and cytotoxic singlet oxygen. Initially, the PS is applied to the area affected by the cancer cells. After the PS is absorbed into the cells, the target area is illuminated by red colored light, thus, activating the PS. Activated PS can exchange energy with oxygen that diffuses through the cells, converting it into singlet oxygen. Singlet oxygen, being highly energetic, readily reacts with various components in the cell, ultimately leading to cell death. As the attack is non-specific, unlike the action of most antibiotics, even the drug-resistant microbes are killed. The objectives of this project were to explore an alternative technique that (i) employs UV photocrosslinkable polymers and crosslinking agents to incorporate the PSs (ii) spray coat cellulose substrates with and cure them under UV light (iii) perform chemical, morphological and biological characterization. The biological testing results of this research are still pending.

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**Research Internship Summer Experience (RISE) in Civil & Environmental Engineering**

Poster Number: 2

**Developing an Agent Based Model from Novel Water Column Reactor Results to Forecast Harmful Algal Bloom (hab) Formation**

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Harmful algal blooms (HABs) appear in water bodies (e.g. reservoirs) in the United States and worldwide, threatening human health, the environment, and our drinking water treatment facilities. A key component of HABs is a sub-group of phytoplankton called cyanobacteria, which can produce harmful toxins. Simple, population-averaged differential equation models are currently used to help predict harmful
bloom dynamics, but these models do not consider the life history and stochasticity of each individual organism, which can greatly impact growth rates and therefore community dynamics as a whole. More sophisticated models, such as agent-based models (ABM), are being developed for microorganism populations because they can consider more environmental factors to better simulate natural microbial population dynamics. Therefore, I intend to create an ABM to use in freshwater supply reservoirs that can more accurately predict the abundance of potentially toxin-producing phytoplankton present in a bloom under various engineered and natural conditions. To accomplish this task, I will use four novel water column reactors (WCR) built in the lab to isolate one variable, vertical mixing, and measure its impacts on the algal community structure grown in the columns. I will use WCR experimental results to develop the ABM framework in NetLogo, an open-source ABM platform. To validate the ABM, I aim to reproduce statistically similar results to the WCR experiments, results from other papers, and case-studies. Furthermore, I will compare the performance of the ABM with existing models to create a more accurate method of predicting HABs.

Poster Number: 3
**Evaluation of Alternate Inocula for Biochemical Methane Potential Testing**

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There is an increasing interest in developing biodegradable packaging materials and disposable cups/cutlery to substitute for traditional non-biodegradable plastics. As these materials are produced, manufacturers require reliable and reproducible tests to document anaerobic biodegradability for landfill disposal. There have been instances in which the same material tested at different commercial laboratories has exhibited inconsistent results with respect to anaerobic biodegradability using biochemical methane potential (BMP) tests. The major factor involved in BMP testing that can be expected to vary between labs is the inoculum. The objective of this study was to evaluate four alternate inocula to analyze the impact of inoculum sources as a factor in these BMP tests. The materials used to evaluate each inocula were a set of four plastics, as well as positive and negative controls. BMP tests were conducted at 37°C in 160-mL serum bottles that contained the sample, inoculum and biological growth medium. BMPs were monitored regularly for gas production and methane content over a 150-day period. The four alternate inocula resulted in carbon conversions of 0.6 – 1.8%, 0.6 – 1.4%, 18.8 – 22.8%, and 0.8 – 2.7% in the four plastics tested. Given these results, the same determination of biodegradability for each material can be reached regardless of chosen inoculum. Thus, this study concludes that inoculum source does not appear to explain why BMP results are not reproducible across laboratories.

Poster Number: 13
**Assessment of Lateral Spreading Case Histories from Recent Seismic Events: Port-au-Prince, Haiti 2010 and Christchurch, New Zealand 2011**

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Liquefaction-induced lateral spreading following an earthquake has proven to be very complex to assess and it remains a threat in many earthquake-prone regions. Despite a lot of research that has been done on the topic by many scholars, there is still not a database that puts together different sources of variability that make the assessment of lateral spreading compound. The objective of this research is to collect and curate different case studies to identify sources of variability in the measurements and predictions of lateral spreading. This was accomplished by collecting observed data and estimating lateral spreading using different semi-empirical and empirical methods, and then analyzing how different parameters may contribute to the discrepancies. This poster presents the various sources of variability, using data from different case studies on 2010 Port-au-Prince and on the 2011 Christchurch earthquakes, with a focus on the latter due to substantial liquefaction observed as well as the wealth of geotechnical data in the area. The identified sources of variability were divided into three main categories, which are: subsurface conditions, geologic and hydrogeologic conditions, as well as earthquake ground motion characteristics. Ultimately, these factors will be ranked in order to improve current prediction models and methods.

Poster Number: 80

**Low Cycle Fatigue Failure of Elbow Pipes at High Temperature**

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Fukushima nuclear power plant disaster has clearly shown us the catastrophic effect of an earthquake on critical structures. Here, the high temperature components used inside the nuclear power plant underwent cyclic fatigue failure due to the earthquake. Researchers have tried to find about the fatigue failure of critical components such as piping and have often focused on the room temperature conditions. This work consists of investigating cyclic fatigue failure in elbow piping components at high temperature (upto 350°C). Factors influencing fatigue life such as Temperature, Internal Pressure, and Elbow Geometry were studied. Experiments were done on a MTS loading system – where the elbow specimen was clamped and experienced loading. An internal pressure of 1500 psi was also introduced inside the elbow using a pneumatic pressure device. The elbow was kept inside a mobile furnace to experience temperature upto 350°C. Due to the low strain limit (<1%) of high temperature strain gauges and insufficient opening in the furnace to take pictures for the DIC (Digital Image Correlation) setup, the Grid-Image method was developed and used to measure strain in the elbow specimen throughout the experiment. The method was calibrated using different grids and thickness. Finally, it was established that there is a clear dependence of temperature on the fatigue life of the elbow components and is presented in the results.

Poster Number: 92
Stochastic Approach for Hurricane Wind Loads on Transmission Towers

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In September 2017, two hurricanes hit the island of Puerto Rico, leaving all residents without electricity. The reason that led to this catastrophe was the transmission tower fails throughout the island. Current tower designs only consider the static approach established by the building codes, which may result in an under or overestimation of wind effects. As a solution, this project establishes an alternative analysis for the design of power transmission towers for Puerto Rico using SAP2000 software. To accomplish this, a step-by-step analysis method for non-linear dynamic wind loads is presented. First, the tower model is designed, complying with the static analysis procedure established in the ASCE 7-10 building code for Puerto Rico. Then, the time-history loads are defined using a One-dimensional Stationary Gaussian Vector Process solved with the Spectral Representation Method (SRD). Finally, to minimize the time of analysis, a load application technique is validated, presented and explained using flexible linear elastic links that distribute the loads uniformly from a specific center node to connected joints.

Poster Number: 96

Assessing the Impact of Fatigue Loading on Mechanically Fastened Fiber Reinforced Polymers.

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The use of fiber reinforced polymers (FRP) to strengthen deteriorated bridge structures has become increasingly popular due to the material’s corrosive resistant properties. In past research, FRP has been used to strengthen structures by adhesive bonding, mechanical fastening without prestress, or a hybrid system of the two. Adhesively bonded FRP is difficult to install and inspect. Prestressed mechanically fastened FRP (MF-FRP) provides an easy to install and inspect solution which may extend the service life of damaged bridge structures without load posting or closing the bridge. It is necessary to prestress the MF-FRP to restore prestress lost from corrosion and deterioration of flexural elements. However, there is uncertainty in the long-term performance of MF-FRP once prestressed. In this project, we examined the effects of fatigue loading on an FRP material for use in mechanically fastened applications. MF-FRP plates with 12.7 mm diameter bolts were cycled in uniaxial tension between the prestressed and maximum expected traffic load. Each test was stopped at a predefined cycle number and loaded to failure to determine residual capacity or permitted to cycle until fatigue failure occurred. The fatigue loading results inform the development of a failure envelope, which enables the practicing engineer to predict the lifespan (or endurance) of the MF-FRP retrofit solution under various loading conditions. It is
concluded that prestressed MF-FRP, as a temporary restoration solution, enables the restoration of deteriorated bridges such that they may remain open without load posting, or closure, for a number of years based on given traffic patterns.

Poster Number: 134

**Industrial Symbiosis Waste Exchange Identification Program**

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Industrial parks and processes are responsible for a large portion of waste emitted to the environment. Current methods of waste management do not take full advantage of the value of this waste. Industrial symbiosis is the concept that waste from industrial processes can be reused as inputs for other co-located industrial entities. Present literature focuses on optimizing the utilities in established industrial parks to turn them into parks that practice industrial symbiosis or eco-industrial parks. Available literature fails to produce tools and optimizations to assist in the creation of new eco-industrial parks. In this project, we study how industrial symbiosis can be modeled and optimized from the development stage to assist in the creation of new eco-industrial parks. In order to do this, we developed a database framework and a waste exchange identification program. The database framework and waste exchange identification program also support an optimization model. The database outlines the necessary information to scale different industrial scenarios. Additionally, the database uses binary descriptors to allow for the characterization of the material flows. The waste exchange identification program utilizes the database to compare the binary descriptors for the inputs and outputs to provide the user with industrial symbiotic connections between industries. Python is used to develop the program. This work allows for developers and researchers to further explore the possibilities of industrial symbiosis. The database framework and waste exchange identification program start filling the gaps within industrial symbiosis research by providing tools to identify waste connections.

Poster Number: 139

**Removal of Orthophosphate from Wastewater by Lanthanum Carbonate Nanoparticles: A Kinetic Study**

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Effective removal of phosphate (P) from wastewater is essential to impede eutrophication and improve water quality. Extensive studies have shown that lanthanum(III) (La)-doped substrates exhibit promise in removing phosphate from aqueous solution. La(III)-modified materials previously tested demonstrate unstable behavior at typical environmental pH levels (4-8), releasing La(III)ions into the environment.
This study evaluates the uptake performance of a more stable material, lanthanum (III) carbonate \( \text{La}_2(\text{CO}_3)_3 \), for the removal of phosphate from water and wastewater. Batch experiments were conducted to investigate the influence of pH (3-11) and background matrix constituents; i.e., deionized water and domestic wastewater on P removal. The \( \text{La}_2(\text{CO}_3)_3 \) presented high selectivity towards P in the presence of competing ions found in domestic wastewater. A dose of 1g/L \( \text{La}_2(\text{CO}_3)_3 \) efficiently reduced the phosphate concentration from a dosed level of 140.3 mg \( \text{PO}_4^{3-}/L \) to below 1 mg \( \text{PO}_4^{3-}/L \) in both DI water and wastewater. While the uptake capacity of P was not affected by the presence of wastewater constituents, removal kinetics were retarded in the wastewater. It took 16.75h to remove 95% of P in DI water and 133.5h in wastewater, both at pH 7. The estimated removal rate in wastewater (0.0003 h\(^{-1}\)) was about one-sixth of that in DI water (0.0018 h\(^{-1}\)). Additionally, phosphate removal kinetics were pH-dependent, the reaction decelerated with increasing pH of the solution. The fastest removal rate was observed in the pH range of 3-4 (0.0769 h\(^{-1}\)). This analysis highlights the potential of using lanthanum carbonate nanoparticles as an effective medium to remove phosphate from complex matrices.

Poster Number: 142

**Integrated Leachate Treatment System Using Sequential Treatment, Constructed Wetland and Biochar Embedded Barricades**

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In Sri Lanka, leachate generated from municipal landfills and open dumps has become an environmental problem as it contains high concentration of organics, ammonia, nutrients, heavy metals, and other pollutants. Leachate treatment with cost effective and robust technologies is thus a major engineering challenge. Given the highly variable and multi-faceted nature of leachate, no single unit process is adequate, a combination of diverse unit processes working in conjunction is necessary. Our pilot project, based at Karadiyana open dump site in Sri Lanka, utilizes biological treatment by anaerobic ammonia oxidation (ANAMMOX) followed by biochar adsorption and constructed wetland to treat leachate. ANAMMOX processes have been developed for tertiary wastewater treatment but have only recently been explored for control of excess N in landfill leachate. The relevant literature on ANAMMOX process adaptations for leachate will be therefore reviewed and summarized. Biochar has been shown to have adsorptive properties similar to activated carbon. A preliminary investigation on the use of biochar generated from the organic fraction of municipal solid waste (MSW) for controlling trace organics in leachate will be presented. This work uses the Rapid Small-Scale Column Test to compare uptake of chlorinated organics, flame retardants, and fluorochemicals from leachate by biochars generated from MSW and hardwood processing waste and activated carbon as a reference sorbent. Future work will involve pilot scale study and observation of water quality in a constructed wetland tertiary treatment system at the Karadiyana open dump site in Sri Lanka.

Poster Number: 143

**Using Diffusion Models to Develop the Framework for a Lake Mixing Support Tool**

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Algal blooms are a concern in many water bodies due to their ability to form toxins, deplete dissolved oxygen, and impair recreational and functional uses. The amount of mixing in lakes affects the risk of algal blooms due to the disruptive influence mixing has on bloom-forming cyanobacteria. Extensive models exist for the simulation of diffusion and the resulting mixing in lakes; however, the accessibility and generalizability of these models are lacking. There is a necessity for a tool that would allow lake managers to benefit from the predictive ability of these models without the required technical knowledge or software access. This project focuses on the use of previously developed models to create a framework for a support tool with the intention of highlighting bloom risk factors and informing decisions about the implementation of bloom management technologies. The models in use were previously developed by other members of the research group. Created in MATLAB, the models use meteorological inputs, physical characteristics of the lakes, and data-based calibration to simulate diffusion. This project utilizes these models, in conjunction with weather station data, to correlate physical variables, such as depth and wind speed, to mixing-determining diffusion values from the model output. Through an investigation of the observed correlations, generalizable trends were identified to develop a tool to support lake managers and water treatment utilities with decisions about artificial mixing form harmful algal bloom control. With continued investigation, the objective is to produce an accessible way to share complicated model results while retaining accuracy.

Poster Number: 148

Industrial Symbiosis Exchange Optimization Framework
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As production increases and the need to prioritize environmental quality intensifies, the issue of safely disposing of industrial wastes grows. One of the most efficient ways to minimize industrial waste is through industrial symbiosis, a process in which colocated industries are able to reuse waste from one industry as an input for another. Although a great deal of research has been conducted investigating the origin and evolution of successful cases of industrial symbiosis, little work has been done related to planning industrial symbiosis, and the eco-industrial parks which take advantage of industrial symbiosis, from scratch. In this study, we lay out the framework for an industrial symbiosis exchange optimization model intended to help planners organize cases of industrial symbiosis in preexisting or newly designed industrial parks. We first reviewed case studies detailing successful eco-industrial parks and researched common material exchanges in order to determine characteristics common to the effective uses of industrial symbiosis. Then, we created an artificial database containing industries which we knew shared favorable material exchanges. We used this database to build the framework for an integer linear programming model which then determines the industries and corresponding scaling factors that will optimize the minimization of waste. In future years, researchers and planners will be able to build upon
this framework we have developed in order to organize more eco-industrial parks that will take advantage of industrial symbiosis as a way to minimize industrial waste.

Poster Number: 152

Potential Smoke Impacts of Prescribed Burning in North Carolina State Parks

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Prescribed burning is an essential fire management tool in North Carolina state parks, contributing to the health of ecosystems and helping prevent dangerous wildfires. However, prescribed burns emit significant amounts of PM$_{2.5}$, a pollutant with substantial health impacts, especially for at-risk populations including children, elderly, and those with preexisting respiratory conditions. Although North Carolina is using prescribed burning on increasing amounts of public land every year, little research has been done to accurately characterize and understand nearby communities that could be adversely affected by smoke exposure. This work explores the demographics of these communities and evaluates their vulnerability in relation to the last five years of prescribed burning in NC state parks. By analyzing available census information, in addition to the Center for Disease Control’s Social Vulnerability Index (SVI), and comparing these to burn records from the NC Division of Parks and Recreation we were able to rank the vulnerability of populations living near state parks employing prescribed burning. Individual burns were then modeled using NOAA’s HYSPLIT to characterize smoke dispersion from the fires and PM$_{2.5}$ concentrations communities experienced. Considering average burn acreage, population density, and social vulnerability, Carvers Creek is the most at-risk, followed by Morrow Mountain and Falls Lake. This characterization of populations at risk to smoke exposure will help guide NC State Parks’ burning program and encourage increased communication between the state parks’ staff and residents. In addition, educational campaigns and advanced warnings of prescribed burns can reduce the exposure of vulnerable individuals.

Poster Number: 156

Using Bacteria to Strengthen Offshore Infrastructure: The Effects of Mg/ca Ratio on Stiffness, Strength, and Mineral Morphology of Micp-treated Sand

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Renewable offshore energy infrastructure often requires ground improvement of the ocean floor, which has historically been performed using synthetic cementation processes. Microbially Induced Carbonate Precipitation (MICP) offers an eco-friendly alternative to these methods, but little is known about its performance in saline environments and ionic groundwater, where Mg$^2+$ is common and has been shown to incorporate into carbonate precipitation. This work investigates the effects of the aqueous Mg/Ca ratio on MICP-treated sands. Recent studies indicate a reduction in soil strength and a fibrous
crystal morphology due to Mg incorporation. This work aims to confirm these trends: four soil columns of varying Mg:Ca ratios were treated with Sporosarcina pasteurii and monitored using shear wave velocity, pH, and electric conductivity. Each column was evaluated via penetration resistance and microscale analysis to determine strength and crystal morphology. Shear wave velocity results indicate an inverse relationship between Mg/Ca ratio and rate of cementation, and CPT results indicate stronger behavior at low Mg/Ca ratios, as well as dilative behavior at a ratio of 1:0 [Mg:Ca]. Two duplicate columns were kept under sealed, saturated conditions for six months (ongoing) to monitor shear wave velocity over long periods of time, which provides the information on the durability of MICP in saline water, a topic of concern for field implementation. If MICP is to be used for offshore infrastructure, understanding the effects of ocean chemistry on the process is essential information.

Poster Number: 168
**Formation of Fat, Oil, and Grease Deposits in Sewer Systems from Unsaturated Fatty Acids**

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The growing population in urban environments has created a greater market for more restaurants. This change in the urban landscape leads to an increase in the discharge and potential accumulation of fat, oil and grease (FOG) in the sewer system. A unique chemical reaction that occurs inside sewer lines is saponification, which is the process that produces solid deposits from FOG. Recent studies have suggested that unsaturated fatty acids alone do not contribute to the saponification reaction that creates these harden FOG deposits. However, the work performed in the literature were conducted under certain experimental conditions. Therefore, the current research study seeks to understand whether there are environmental conditions that would allow unsaturated long chain fatty acids to participate in the saponification reaction and form FOG deposits in sewers. A series of experiments were performed using oleic acid as the main source of unsaturated fat. Tests were performed with oleic acid alone and with safflower oil at constant neutral pH and pH of 10. These tests were performed at room temperature in 300 mL of deionized water with continuous mixing for a length of ten to fourteen days. Preliminary results suggest that unsaturated fatty acids do participate in the saponification reaction to produce FOG deposits.

Poster Number: 178
**Evaluation of High Strength Reinforcing Steel for Seismic Applications**

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Advancements in technology allow for higher strength reinforcing steel to be produced more rapidly than research can establish an accurate performance model. In 2009, The ASTM A706 Standard was revised to include Grade 80 reinforcement steel for structures. However, building codes specifying Grade 80 was prohibited in the plastic hinge regions of Earthquake resistant structures due to lack of research. The goal for this research is to simulate column loads on reinforcing steel using the Buckled Bar Tension (BBT) Test. This test consists of compression to buckle the bar to a prescribed level of bending, followed by tension loading to assess the mode of failure. The test outcome is identification of the ‘critical bending strain’ which represents the transition from a ductile to brittle fracture. Comparing the critical bending strain will help identify the most ideal steel to use for bridge columns’ plastic hinge region. The BBT Test has shown good agreement with full scale column tests. Originally, the BBT Test simulated one cycle of cyclic loading. The BBT Test was modified to assess the impact of multiple cycles of loading, and to determine if correlation with column tests is still present. Effects of chemical composition and varying rib radii are also being analyzed. This research continues to correlate the BBT Test, Cyclic BBT Test, and Column tests, and may be an accurate representation of a bar experiencing cyclic loads. With further development, this test will expand knowledge to allow for engineers to accurately predict performance of reinforcing steel.

Poster Number: 181

Methods of DNA Extraction from Personal Protective Clothing Used by Pit Latrine Workers

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DNA analysis can determine the composition of the microbiome in personal protective equipment (PPE) of pit latrine emptiers, and more specifically identify the pathogens to which workers are exposed. Although DNA extraction from textiles has been used for decades in forensics, there is little research on prokaryotic DNA extraction from textiles. The goal of this research is to evaluate different DNA extraction and purification techniques applied to four types of textiles inoculated with a complex environmental sample (activated sludge) to enable subsequent metagenomic analysis. Inoculated textile samples were processed with either: a two-step method of biomass concentration followed by mechanical cell lysis, or combined biomass concentration and enzymatic cell lysis. Both extraction methods produced reasonable yields of DNA, with non-purified, Qiagen kit-purified, and magnetic bead-purified means of 136.9, 133.7, 81.1, 73.2 ng/ul, respectively, for the two-step method and 72.3, 8.6, 28.2, 20.0 for the combined method. Yields from first stage PCR were lower than expected, suggesting that inhibitors in the textiles may be carrying over into the lysate. The lysate was difficult to purify, with low extraction efficiencies for common purification methods. We are continuing with library preparation from those samples and evaluating a novel method which employs permanganate-driven oxidation to remove organic dye PCR inhibitors associated with textiles. Once a valid method is developed, this protocol will be applied to the PPE samples worn by pit latrine emptiers in Malawi and Zambia to identify the pathogens they are being exposed to and to develop a microbial risk assessment.

Poster Number: 187

Effect of Multidimensional Vasculature on Mechanical Properties of Laminated Fiber Composites
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Microvascular fiber-reinforced composites (FRC) are an emerging class of structural materials that impart multiphysics attributes via circulation of functional liquids through internal, hollow conduits. For example, self-healing of delamination damage can be achieved by fracture-induced vascular release of reactive chemistries. As the demand for such multifunctional materials continues to grow, vascular complexity increases and composite manufacturing requirements become more stringent to attain high-fidelity, multi-dimensional networks. Investigating the effect of vascularization on structural integrity is critical to understanding these nascent materials and a requisite for widespread adoption. While several prior studies have examined the influence of 1D microchannels on in-plane and interlaminar fracture properties of fiber composites, there has yet to be any investigation into the effects of 2D/3D vasculature. The focus of this research is to assess the impact of multi-dimensional, microvascular architectures on the mechanical properties of woven FRC laminates. Both in-plane tension and interlaminar fracture testing of glass-fiber composites containing through-thickness, undulating microvasculature was conducted and compared to several types of unvascularized controls. The results indicate that the mechanical properties of laminated composites are altered by the inclusion of vascular networks, and depend on the type of loading applied. Similar to prior 1D studies, inclusion of microvasculature decreases in-plane tensile strength as a result of load-bearing fiber waviness and reduction in cross-sectional area, while interlaminar fracture resistance increases on account of crack tip blunting. Continued research aims to develop a set of vascular design parameters in order to strike a balance between multifunctional attributes and structural performance.

Poster Number: 201
Low-cost Analysis for Elemental and Brown Carbon

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There exists large uncertainty in influences of elemental carbon (EC) and organic carbon (OC) as radiative drivers of regional climate, and a need for improved combustion and atmospheric EC and OC data. However, analysis of [EC] and [OC] (concentrations) using a reference analyzer can be expensive, and likely unrealistic in many areas where biomass combustion can be a regional issue (e.g., Africa, South Asia, Central America). In this study, the measurement of light absorption for EC using a low-cost tool is investigated. The EC analyzer used a Raspberry Pi computer, Pi Camera, and LED light running on an open-source Python script, and costs less $100. Transmission of red (wavelength, λ= 665 nm), green (λ= 550 nm), and blue (λ= 470 nm) light through field samples was used to establish a relationship between absorption and [EC]. EC absorbs all wavelengths of visible light and OC absorbs only at shorter wavelengths (Andreae and Gelencser, 2006), therefore, absorption of red light was thought be the best indicator of high [EC]. To determine [EC], red pixel values captured by the Pi Camera were calibrated against [EC] found using the Sunset Labs analyzer. When fitting red values and [EC] to a double exponential model, it was possible to estimate [EC] from samples of low to medium loadings (1.0 to 10.0
μg/cm²). In this range, there was a median residual of 1.24 μg/cm² between estimated and actual [EC]. Future work is to be done on multiwavelength analysis for brown carbon.

Poster Number: 208
**Stress Testing Improved Cook-stove - Mimi Moto**

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Globally 40% of people burn solid fuels for cooking daily (Bonjour et al., 2013). Household air pollution from solid fuel use accounts for 5.5 million deaths annually (Forouzanfar et al., 2015), and contributes to 20% of all black carbon and 2% of carbon dioxide (CO2) emissions, both large contributors to climate change (Bond et al., 2004). Recently, many improved biomass cookstoves have been developed in the hopes of replacing traditional stoves. These stoves have the potential to reduce health and climate affects associated with biomass burning substantially. One gasifier stove that burns hardwood pellets, the Mimi Moto, has shown to have emission factors (EFs) of particulate matter (PM) and carbon monoxide (CO) similar to those of a propane gas stove (Global Alliance for Clean Cooking, 2018). However, field data collected in Rwanda by the Grieshop Group, occasionally shows EFs closer to those of traditional stoves, suggesting the Mimi Moto is sensitive to operation conditions. To explore contributors of high emission events, seven baseline measurements were taken for the Mimi Moto using the Water Boiling Test (WBT) Version 3.0 for PM, CO, CO2, and organic and elemental carbon. So far, baseline CO data compares well to GACC data (4.x vs 6.0 g-CO/kg-fuel, respectively). Adjusted WBTs will be conducted with the inclusion of a kindling-ignition and mid-test pellet refueling to reflect common practices observed in the field. Additionally, stove “stress-testing” will be conducted to characterize high-emissions events. Findings may help inform best use practices for Mimi Moto and other improved cookstove customers.

Poster Number: 230
**Understanding the Effects of the Micronutrient Cyanocobalamin on the Growth of Dunaliella Viridis**

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Microalgae that have the potential to accumulate a high lipid content such as Dunaliella viridis are a promising biofuel source. Improving culture density would allow for easier and more energy efficient harvesting. Little is known about how vitamins such as cyanocobalamin affect culture densities and lipid content of Dunaliella viridis. Cyanocobalamin, a common synthetic variant of vitamin B₁₂, has been shown to improve growth of many microalgae that utilize this vitamin to synthesis methionine, an amino acid which assists in DNA and protein synthesis. This project would examine how the presence of cyanocobalamin affects the growth and cell density of Dunaliella viridis. To test the dependence of Dunaliella viridis for cyanocobalamin, Dunaliella viridis would be cultured in four different concentrations of cyanocobalamin with a control that lacks cyanocobalamin. The effect of cyanocobalamin on cell growth would be determined by measuring cell count and biomass. If Dunaliella viridis has improved
biomass in the presence of cyanocobalamin, future work could test how cyanocobalamin affects the lipid content of *Dunaliella viridis*.

Poster Number: 247

**Biomethane Potential and Kinetics of Anaerobic Degradation of Food Waste**

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Methane is a greenhouse gas released from landfills through the anaerobic decomposition of municipal solid waste (MSW), but if captured, can be used as fuel. Food waste is one-third of America’s MSW, and plays an important role in the anaerobic reactions in landfills due to its high organic content. In this study, anaerobic digester sludge and food waste were used as inoculum and substrate respectively in anaerobic co-digestion to generate methane in batch reactors. Two types of food waste were tested simultaneously: meat waste (MW), and fruit and vegetable waste (FVW). Mesophilic temperature conditions and adequate mixing were provided. A 1:1 ratio of inoculum to substrate was used in the reactors. The biogas production of these reactors was quantified using a liquid displacement mechanism. Measurements were taken with an automated time-lapse set-up using two web cameras to take pictures of the displaced liquid every five minutes. The goal was to quantify the rate of biochemical methane production of MW versus FVW using a known composition of the samples. It was found that FVW is easier to biodegrade and has a faster rate of biogas production compared to MW. After the first five days, during lag phase, the FVW reactors produced an average of 378 mL of biogas where 60% consisted of CO2. On the other hand, the MW reactors produced an average of 409 mL of biogas where 17% consisted of CH4. The methane production increased every day as the anaerobic bacteria adapted to the conditions provided.

Poster Number: 250

**Analysis of Nutrient Loading and Algal Blooms in North Carolina Coastal Rivers and Estuaries**

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There has been limited exploration of factors responsible for a recent emergence of toxic algae blooms in Albemarle-Pamlico Sound estuaries, which prompts the need for an investigation that contributes to the APNEP (Albemarle-Pamlico National Estuary Partnership) water quality assessment. The factors characterized are trends in concentration and load of Total Nitrogen and Total Phosphorus as nutrients stimulating algae blooms, chlorophyll concentration and trends in discharge. Data were obtained from USGS NWIS database and EPA STORET database for the rivers and estuaries of interest; Chowan and Roanoke rivers flowing into Albemarle estuary, and Neuse and Tar river flowing into Pamlico estuary. The R statistical computing platform was used for this analysis employing packages like DataRetrieval, dplyr and EGRET (Exploration and Graphics for RivEr Trends) package for running WRTDS (Weighted
Regressions on Time, Discharge, and Season) model. Through semi-parametric regressions, WRTDS estimates the nutrient concentration value for days in the period of analysis with missing values, considering trends with time, discharge and season. Data visualizations through plots portrayed significant increase in trends of Total Nitrogen concentration and a similar increase in the concentration of chlorophyll downstream towards the estuaries through the years of analysis. Using concentration of chlorophyll as an estimate of algae levels, these results suggest that increasing nitrogen may be responsible for the increase in algal blooms. No significant trend in Total Phosphorus was observed. Further research will be conducted for a more concrete characterization model.

Poster Number: 271
**Incubation Experiments with Soil Samples from North Carolina Reveal Strong Microbial Siderophore Production: Common and Distinct Siderophore Structure**

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Iron is known as a micro-nutrient that can limit microbial and plant growth because of the low solubility of ferric iron (FeIII) at circumneutral pH. Siderophores are secondary metabolites that are released by many bacteria and fungi to access otherwise unavailable ferric iron sources. While many siderophores have been characterized from isolated cultures, very little is known about siderophore production and identities in complex soils. As a first step to identifying the relevance of iron limitation and siderophore production in soils, we performed incubations of soil samples collected across North Carolina for analysis of microbial secreted secondary metabolites. We determined the best method for isolating bacteria from the soil, used various media for optimal microbial growth, and measured siderophore production and metabolites in iron poor and iron rich media environments using liquid-chromatography tandem mass-spectrometry (LC-MS/MS). Our results show siderophores to be among the most concentrated secondary metabolites in all soil incubations, and we discuss the distribution of different siderophore classes in the various samples.

Poster Number: 279
**Life Cycle Assessment of Marine Microalgae-based Biofuels in U.S.**

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Growing attention to decreasing greenhouse gas emissions has increased the interest in microalgae-based biofuels as an alternative for conventional fuels. High potential yield, absorption of carbon dioxide and no competition with agriculture are some advantages; however, the production of these biofuels are not always environmentally beneficial depending on the technology choices in the production chain. Thus, systematic life cycle studies of these systems are needed to evaluate and compare them. Previous studies have assessed the environmental impacts of some combinations of technologies associated with
biofuel production, but we are still lacking a generally applicable approach for consistent environmental analysis. Therefore, the objective of this research is to implement and test a general-purpose life-cycle analysis-based quantitative framework and illustrate it by evaluating and comparing the environmental impacts of alternative production chains to produce biofuel from marine microalgae. The key processes included in the framework are cultivation, harvesting, dewatering, drying, extraction and conversion of lipids to liquid fuels. For each process, we developed a life-cycle assessment model in Python to quantify emissions of different pollutants and ten environmental impact factors. The results show that conversion, followed by extraction contributed the most to the following environmental impact: photochemical oxidation, cumulative energy, and ozone and resource depletion. When less energy intensive technologies for extraction and conversion are used, the greenhouse gas emissions improved, meanwhile other impacts, e.g. water depletion, worsened. This study highlights the variations in environmental implications of current technologies when used in different combinations for producing biofuels from marine microalgae.

**REU for Composites in Extreme Environments**

**Poster Number:** 19

**Polymer Nanocomposites for Potential Use as Medical Implants: Mechanical Strength and Degradation Behavior in Extreme Ph Environments**

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Polymers that are used as medical implants must be biocompatible with the body and must not suffer degradation in extreme pH environments found within the body. For example medical sutures must possess the flexural ability to move with the muscles of the body while lasting sufficient time so that the body can heal before they fully degrade. The use of polymer nanocomposites presents a particular opportunity to enhance the mechanical properties such as elastic modulus. Medical composites not only afford mechanical strength, but can improve the functionality of a material. The aim of this study is to use molecular dynamics simulations to investigate how the mechanical strength and the degradation of biocompatible polymers are impacted by the presence of carbon nanotubes (CNTs) as a function of pH. The focus is on P4HB (poly-4-hydroxybutyrate) and PLA (polylactic acid) embedded with 1 wt. % CNTs. To do this, both polymers were simulated in increasing acidic conditions and a temperature of 310.15K to mimic the internal conditions of the body. CNTs were added to models and compared to models of virgin polymer in the same conditions. The elastic modulus of both models were simulated in bulk quantities without internal body conditions. We will discuss how the elastic modulus is impacted compared to the virgin polymers along with the degradation rate as a function of pH.
Transverse Mechanical Behavior of Ultrathin Fiberglass Laminates with Carbon Nanotube Sheets

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In this project, multi-walled carbon nanotubes (MWCNTs) were incorporated into fiberglass/epoxy pre-preg composites. Prior research has shown that the transverse ultimate strength of unidirectional composites are often much lower than the pure resin matrix used in the plied composite. Cracking and fracturing in this transverse direction initiates the start of failure in plied composites as well. Prevention of the initiation of interlaminar fracture and transverse failure in plied composites has been researched, but the incorporation of millimeter long MWCNTs into thin-ply fiberglass laminates for improving transverse properties has not been studied. The focus of this study was to incorporate millimeter long, aligned MWCNTs into thin-ply unidirectional composites. By utilizing very thin pre-preg and incorporating multiple layers of MWCNT sheets between each ply, a relatively high CNT volume fraction will be achieved in the interlaminar region. Due to the MWCNTs being aligned perpendicular to the glass fiber orientation it was expected that significant differences in the composite transverse ultimate strength would be recorded. We have investigated the ultimate strength, stiffness and strain to failure along the transverse direction of the prepared laminates with varying numbers of MWCNT layers and compared these mechanical properties to baseline fiberglass samples without MWCNTs. There was an increase in the transverse mechanical properties which resulted from the CNTs bridging some of the initial pre-cracks that typically initiate a catastrophic failure.

Characterization of Freeze-thaw Cycling Induced Damage in Aircraft Composites Using Dielectric Properties

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Aircrafts experience freezing temperatures as they reach cruising altitudes, and higher temperatures when they are at ground level. This repetitive temperature cycling leads to the environmental degradation of fibre-reinforced polymer composites used in modern aircraft. Damage due to effects of such environmental cycling can be characterized by monitoring changes in dielectric properties as a result of chemical and physical changes in the states of bound and free water within the matrix of moisture-contaminated composites. The relative permittivity of the composite is a function of the amount of water and nature of its interaction with the polymer network. Water bonds with the polymer network with varying degrees of restriction to dipolar rotation in an electromagnetic field. The degree of restriction to dipolar rotation determines the amount of contribution to the relative permittivity of the moisture-contaminated composite. In this study, 4-ply Style 7781 glass fiber/epoxy laminate 25 x 65mm samples at 0.25% and 0.40% moisture concentration were exposed to freeze-thaw cycles between +7℃ and -7℃,
while dielectric properties were continuously monitored using a 10 GHz split post dielectric resonator coupled with a vector network analyzer. Results show an increase in relative permittivity with number of freeze-thaw cycles, indicating increases in free volume occupied by bulk water in micro-voids within the polymer network due to expansion of water when frozen. Water with preference for the free state is pulled into this new free volume causing a redistribution of free and bound water, and an increase in the free, higher permittivity bulk water present.

Poster Number: 150
**Self-healing And Self-sensing Structural Composites**

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Smart fiber-composites are being developed to autonomously sense and heal the inevitable and invisible internal delamination that occur during normal operation, and provide increased safety and longer service life. One prior self-healing strategy relies on the delivery of reactive liquids through fractured, internal microvasculature. While this approach has demonstrated successful delamination repair, the two-part chemistry employed requires sufficient *in situ* mixing to achieve polymerization and destructive testing to assess mechanical recovery. A new concept relies on embedded fiber optic waveguides (FOW) to not only provide light-based self-healing of a single photo-reactive agent, but also a self-sensing pathway to detect when delamination occurs and monitor structural recovery throughout the repair process. My research is focused on the optical characterization of embedded FOWs and how to effectively transmit light through a fractured fiber in order to polymerize a photo-reactive liquid released from internal vasculature. I will experimentally investigate polymerizing, high-frequency (UV/blue) light transmission by changing the distance between two cleaved ends of optical fibers under various input intensities. Based on optical theory, light transmission intensity is expected to decrease as fracture separation increases, and the extent of polymerized region to vary as the FOW fracture surface becomes non-planar. These assays will reveal the conditions necessary to achieve an *in situ* photo-reaction and monitor delamination recovery of such smart composites in a remotely-accessible, non-destructive manner.

Poster Number: 175
**Damage Detection on Composite Plates Using Fiber Bragg Grating and Piezoelectric Ultrasonic Sensors**

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The safety of high performance structures such as advanced naval ships can be increased through structural health monitoring systems implemented on the structure. A critical component of these systems are sensors. Piezoelectric transducers (PZTs) can both emit and receive ultrasound waves on structures. Fiber Gragg grating (FBG) sensors can act as a receiver with a PZT actuator. While PZTs have a higher sensitivity for receiving ultrasound waves, they have low durability. This makes them impractical for long term structural health monitoring systems. FBG sensors have high durability and multiplexibility, which means they can be combined in a less complicated setup. This poster examines the functionality of a hybrid PZT to FBG system, where a PZT creates the signal and an FBG sensor receives it. These results were compared to a more common PZT to PZT system. For each sensor interaction, the data was run through several Matlab codes to determine the size of the received signal and its arrival time. Variations in the shape and timing of the received signal indicated the presence of damage or notable differences in the composite itself. The plates were tested both with and without damage. This made it easier to determine what differences in the signal were caused by damage as opposed to the plate directional properties. The goal is to eventually create a long-lasting system that can detect and locate damage in composite plates. A system of this nature can improve structural health monitoring systems for many composite structures, including aircraft and ships.

**Poster Number:** 192

**Predicting and Controlling Interfacial Failure Modes of Indium Tin Oxide Thin-film Polymer Systems for Flexible Applications**

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The objective of this work is to predict and control the interfacial behavior of nano-sized indium tin oxide (ITO) films that are layered on polymer substrates. These nano-layered systems can be used for innovative applications such as solar cells, flat panel displays, and organic LEDs. The use of these film systems have been hindered by mechanical failure modes such as interfacial cracking between the film and the substrate, tensile channel cracking of the film, and compression-induced rupture. I used a finite element analysis to understand how the system behaves in tension, compression, and bending for different layer thicknesses and polymer substrate material combinations. These results indicate that increasing the film thickness renders the film more prone to cracking than a thinner film and that polymers with significantly lower moduli than that of the film can add flexibility to the system and inhibit film cracking and interfacial delamination. The interfacial property mismatches between the film and the substrate can be used to control failure in ITO-substrate film systems for different loading regimes and applications which can provide guidelines for designing failure resistant thin film flexible systems.

**Science of Software in CSC**

**Poster Number:** 35

**Did You Check Stack Overflow: An Empirical Study of What Programmers Ask When Learning a New Language**
Programmers are expected to write code in multiple languages, and various tools exist to facilitate the language acquisition process. The current methods, however, fail to make use of a potentially valuable resource: the existing knowledge of the programmer. In order to understand if programmers make use of their previous experience while learning a new language, we analyze the types of questions that they ask along the way. In this study, we examine a popular computing Q&A site, Stack Overflow, to look for trends in the types of questions asked by current coders. Our findings determine that a programmer’s existing knowledge is a key factor in how they learn a new language.

Poster Number: 68

Are Gender Biases Backed by Work Competency?

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Biases in open source software development platforms are documented to exist. Such biases have an impact on how contributions to projects are evaluated due to gender being criteria for acceptance. But what if the biases are actually backed by differences in the quality of work done? If there is a demographic difference in work quality then biases in the open source community have a different meaning other than being based on gender alone, and thus new approaches to removing such biases should be found. To find work quality differences between genders I use tools and databases, involving open-source software development, for measuring competency of men and women. After applying competency metrics to the genders I have concluded that men and women have both similarities and differences in their competency depending on the nature of the work done.

Poster Number: 101

Improving Gender Diversity in Open-source Software Communities

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As open-source software communities have become more aware of how social biases and discrimination negatively affect their culture, many have established policies regulating their contributors’ social interactions without considering the efficacy of such measures. If these communities lack an empirical awareness of their policies’ impact, they may find themselves adopting dogmatic practices that serve only to increase overhead maintenance costs. We conducted a gender diversity analysis of popular open-source projects and discovered that communities who adopt a code of conduct tend to see marginal—yet consistent—increases in the proportion of women contributing. Taking these observations into account, the open-source community should consider the social changes effected by their policies and seek further opportunities to maximize the developments that they desire.

Poster Number: 155

“Give Me Some (office) Space!”: Creating a Comfortable Workspace Through Biometrics

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The goal of our project is to properly process and relate the biometric and survey results of an 8-week study on ABB employees. The final objective of this project is to create a predictive model that measures a number of states an employee may experience and apply that prediction to improving the workspace. The unique pairing of biometric to survey data with analysis of various comfort states is what differentiates this project from other studies. Our part in this project was to figure out how to best relate these datasets to each other and identify the low quality data that needed to be cut. To do this we utilized Python for formatting the data, R for visualizing it, and a number of statistical models to find significant relationships between datasets. We identified low quality survey data along with bad sensor data, and also successfully used a variety of time frames and quality levels to relate the two datasets, while setting a path for further analytic work.

Poster Number: 176

Using Software Engineering Team Projects to Understand Team Collaboration

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The goal of this project is to understand the processes that students use when working on teams and the effectiveness of team collaborations in an undergraduate software engineering course. Team building skills are often difficult to integrate into software engineering classes and this project aims to identify best practices in student collaboration that could be incorporated into other courses of the computer
science curriculum. We studied the six-week team project that was part of a redesigned offering of CSC326 from Spring 2018. Using source code repositories from CSC326 we created a database to mine student team interactions through pull requests, issues and commits. Using pull requests, issues and commits we took for patterns and practices of team collaboration and the relationship with student grades. For example, looking at the time between the creation and close of a pull request estimates how long team members might have spent on inspection of the changed code, where a short period of time may suggest a perfunctory check leading to lower quality code. By developing a greater understanding of successful student collaboration we can introduce collaboration skills earlier and create assignments that support using those skills, which are vital for capstone projects, industrial job opportunities, and graduate work.

Poster Number: 200

**Empirical Analysis of Feature Toggle Practices in the Software Industry**

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Feature toggling has become an increasingly common practice used by software companies to facilitate continuous deployment by allowing developers to integrate unfinished features into the code base without impacting user behavior. A systematic analysis of feature toggle usage in the software industry can benefit software developers by creating a common knowledge base of feature toggle practices to assist developers in the adoption of feature toggles. The goal of this research project is to aid software practitioners in the management of feature toggles and the design of feature toggle systems through an empirical analysis of industry practices. The feature toggle management practices and system designs of 32 companies were studied by performing a qualitative analysis of Internet artifacts. An initial study of Internet artifacts about feature toggles yielded 14 practices and 6 system design decisions; artifacts about feature toggle use at specific companies were analyzed to determine the use of each practice and design decision for that company. The artifact review revealed 23 different feature toggle systems used by 35 companies, with 4 companies using unknown feature toggle systems. While companies were more open to sharing information about feature toggle systems, management practice were less commonly listed, with only 7 practices mentioned to be used by at least 5 companies. References for 29 companies have been collected and a follow-up survey has been prepared to collect additional information. The negative technical debt imposed by feature toggle usage can be lessened by the knowledge of current industry practices.

Poster Number: 259

**Dazed: Measuring the Effects on Cognitive Load for Public Versus Private Technical Interview Settings**

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A popular technique in the Computer Science industry for evaluating a potential candidate’s competence for a job is having the interviewee solve coding problems on a whiteboard. One major concern with this interview style is that solving problems in front of interviewers causes unwanted stress and increased cognitive load on the interviewee. These factors could lead to discriminatory hiring practices by unfairly filtering out candidates who do not do well in these settings. In this study, we use eye tracking software to collect participant eye metrics, which can be used to measure cognitive load and stress. Previous research has established that working on the whiteboard caused higher cognitive load and more pressure when compared to working the problem on paper. For this study, we compare participants who perform tasks in two different settings: on a whiteboard in a private room versus on a whiteboard in a public setting. We asked 8 undergraduate participants to perform a task while wearing eye tracking glasses in each of the mock interview settings. Each task was the same level of difficulty, determined by an online site. Our preliminary results offers insight into how current technical interview practices affect interviewee performance. Specifically, we find initial evidence that candidates exhibit higher cognitive load and stress in a public setting; In contrast, not only do candidates feel more at ease in private settings, they often can also solve the problem in a shorter period of time.

Poster Number: 281

**Optimizing Cart & De to Compare Mre & Sa**

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When it comes to software analytics, predicting outcomes from historical datasets is one of the most important tasks. The interesting part is that sometimes they really don’t need much of a computing resource. Using an evolutionary algorithm (like DE) on an already existing learner (like CART), can also provide good performance. My task was to run the CART with DE tuning to acquire good predicting results (MRE and SA are used as my performance metrics). From there, I was tasked to use the decision tree based learners that tuned by differential evolution and analyze them to find good parameters combination for prediction.

**Socially Relevant Computing and Analytics in CSC**

Poster Number: 1

**Non-linear Storytelling in Location-based Gaming**

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The NCSU Visual Narrative Initiative is building off of their Urban Panorama project to create a set of educational location-based mobile games which allow players to learn about historic Raleigh through content continuously generated from a dataset of information-tagged pictures of historic locations in Raleigh. The game which we have worked on specifically is a branching story-based game, which has little precedent for being merged with location-based gaming due to the only recent popularization of the
latter, the difficulty of monetizing story-based apps, and the general difficulty of writing branching narratives. Our task was threefold: generating story content, putting that story content into a game made in the same engine being used to develop the other games in the set, and merging that content with location-based functionality. Using Twine to create the story content and Unity as the engine for developing the game itself, as well as Cradle, a Unity asset library for importing documents created in Twine, and Mapbox, a “location data platform” used for our GPS needs, we have been able to create a prototype of the game which will later be built with the framework we began developing this summer. This game, once developed, will act as a free and fun tool for players to learn about the history of Raleigh through direct engagement with unique narratives procedurally generated from archival data, and the goal is that the process can eventually be exported to other cities, allowing them to develop their own historical games.

Poster Number: 4

Typos- Learning to Avoid Syntax Errors Through Transcribing Functional Code
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Learning to code in computer science is very difficult, as high dropout rates from introductory courses show. However, there has been limited research into improving computer science retention. A significant issue early Computer Science students face is syntax errors. Our project, TYPOS, is a new training method for improving retention of students in the introductory courses and reducing these errors. Our methodology involves having students manually copy examples of working and relevant-to-the-class code, using a web-based tool- TYPOS. This tool allows teachers to make these training exercises, allows students to use them with automatic error checking, and allows us to measure activity and success while doing so. We will perform experiments comparing those who used it for various periods of time against those who did not. We expect that for TYPOS to be beneficial, students who used the system should perform similarly or better than students who did not. If this proves to be the case, TYPOS will provide a place to build on for designing better introductory Computer Science courses in the future, as well as helping train students to avoid syntax errors.

Poster Number: 17

Using Time Series Models to Forecast Uncertain Supply in Nonprofit Hunger Relief Organizations
Author: Lahari Revuri Computer Science NC State University

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Hunger relief organizations assist individuals who lack consistent access to affordable, healthy food through the distribution of food and other essentials. Nonprofit supply chains rely heavily upon an ever-changing group of donors that irregularly provide donations in variable amounts, all of which hinders the ability of these agencies to distribute food in an efficient manner. Prior literature has implemented time
series models to forecast uncertain supply in food banks, but it has not used the optimal number of minimum observations necessary to make full use of the models. Using 11 years of data from a domestic food bank, I investigate the nature of the food donation environment by characterizing its key features, such as food types, food sources, and their changes over time. Several time series models are fitted to the data and evaluated on forecast accuracy for comparison. Additionally, possibilities for machine learning techniques to forecast donation data are discussed.

Poster Number: 64

**Writing Effective Programming Questions for Automated Grading Using Bloom’s Taxonomy**

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Large introductory programming courses are experiencing an increase in class sizes, as they often see the enrollment of hundreds of students. Automated grading has become crucial in supporting courses of this size by assisting instructors in reducing grading time and course costs. However, there is an issue that sometimes novice programmers are frustrated by autograded systems as they don’t provide enough feedback for complex questions. We have designed a study that will examine if gradually increasing question complexity, based on Bloom’s Taxonomy, for auto-graded exercises will lead novice programmers in non-CS majors to learn more effectively and efficiently. Additionally, we will survey students to measure student perception on automated grading as well as their self-efficacy regarding their programming skills. Examining perception is important because providing a positive student experience is critical for cultivating an effective learning environment. Question difficulties will be rated in regards to the revised Bloom’s Taxonomy. To measure effective learning, we will analyze student exam scores after the completion of a lab that consists of automatically graded programming exercises. To measure efficient learning, we plan to analyze the time spent on each exercise, number of attempts made before submitting an exercise, and the following exam score. We conjecture that scaling the question complexities from lower to higher orders of thinking will produce the most effective and efficient student learning. We expect to see that this modified progression of exercises will result in higher student self-efficacy and more positive opinion of the exercises and the automated grading itself.

Poster Number: 135

**How Players Develop Mental Models of Puzzle Games**

*Author: Ryan Alexander* Computer Science NC State University

*Mentors and/or Co-Authors:*

_Chris Martens_ College of Engineering NC State University

While playing puzzle games, players develop an understanding of the game’s mechanics and concepts. But how exactly do players develop and revise these mental models of puzzle games while playing them? Most people can recognize a satisfying puzzle or level of a puzzle game, but few have endeavored to quantitatively determine what makes these satisfying. We have developed a set of levels with unique
mechanics that can be reordered to see how this may affect the mental models of different players. By measuring players’ understanding and enjoyment of puzzle levels against a scale that we have crafted, we are able to see how an accurately developed mental model correlates with a general enjoyment of the game. The results of this research have the potential to further cognitive research as it relates to video games, as well as provide the groundwork for developing procedurally generated puzzle games.

Poster Number: 153
**Developing a Framework for Analyzing Choices in Gaming and Their Effects on the Player**
Author:
*Alex Gray* Computer Science NC State University

*Mentors and/or Co-Authors:*
*Arnav Jhala* College of Engineering NC State University

Video games as a medium for storytelling are different from their pre-digital predecessors because of their ability to facilitate interaction between the audience, or player, and their story. This interaction most often occurs through choices presented by the game to the player, which affect the game world to varying degrees and in different ways depending on which option is taken. However, there exists no systematic framework for analyzing these choices as narrative devices capable of eliciting specific responses, intentional and unintentional, from an audience. The one significant work which has attempted to address this issue builds a vocabulary which could be used by a future framework but does not outline one itself. This was our task: to use the language developed in this earlier paper to help our mentor and his colleagues implement and refine the first attempt at such a method. We assisted in identifying aspects of their proposed framework which lacked clarity, contained unnecessary complications, or was otherwise problematic. Additionally, we worked towards establishing a system by which this framework could be exported so others could perform choice analyses and contribute them to a corpus, which we began to build with analyses done by us and our colleagues. The aim of this research is to produce a framework which can be used to allow for deeper reflection on the design of choices and the effects of that design on players, with the hope that such reflection will produce more compelling video game narratives in the future.

Poster Number: 172
**An Educational Game Simulating Linked Lists for CS Education**
Author:
*Kevin Prehn* Computer Science Elmhurst College

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*Veronica Catete* College of Engineering NC State University
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*Tiffany Barnes* College of Engineering NC State University

Educational games have been shown to be an engaging, interactive tool for teaching a wide range of topics. These games often present a concept through virtual manipulatives, allowing students to develop a mental model of a system through interaction and observation. There have not been many CS education games using virtual manipulatives. We present an educational game designed to help players learn Linked Lists, a data structure which CS students often struggle with. The game’s virtual
manipulatives and game mechanics have a direct mapping to the entities and operations of Linked Lists. We evaluated the game with middle schoolers at a summer camp to determine whether the game helped players develop a mental model and if that model can be applied to new problems through analogical reasoning. Students who played the game found it challenging yet enjoyable, felt more familiar with Linked Lists terminology, and most were able to identify which game entities were Linked List virtual manipulatives. However, there was limited success with students applying the mental model to similar problems. To our knowledge, this is one of the first CS education games which involve virtual manipulatives for students to build a mental model of Linked Lists.

Poster Number: 182
A Computational Tool for Creativity: State-driven Visualizer
Author:
Kamai Guillory Computer Science NC State University
Megha Ganatra Human Biology NC State University

Mentors and/or Co-Authors:
Chris Martens College of Engineering NC State University

When building abstract models of the world to describe phenomena or common behaviors observed in the world, State Machines provide valuable text related to the current state of the world/model. With this text however it leaves the user of the model with only a thought of how, the rules/conditions, predicates/states, and transitions manifest in a physical sense. In other words, not just thinking but seeing the state of the world allows the users to have a greater understanding of the system as a whole. With that in mind, I have aimed to turn the text of a State Machine into a picture of the world. My project builds a bridge between Cep tre, a rule-based language, and WordsEye™ an application that translates text (nouns and adjectives) into 3D viewing models. My prototype allows the user to go through examples of virtual worlds and social mechanics, in a visual format. Each rule, predicate, and transition has a meaning which is then translated into an image. Seeing is believing!

Poster Number: 188
Big Owen's Data Dash: A Study on Implicit Learning in a CS Game
Author:
Anam Navied Computer Science NC State University
Shuhua Yin Statistics NC State University
Caroline Mann Statistics NC State University

Mentors and/or Co-Authors:
Veronica Catete College of Engineering NC State University

As computer science education becomes more ubiquitous, the use of serious games allow students to be immersed in an engaging environment where they can explore and understand the underlying concept. Previous research has primarily focused on assessing learning from the game solely through out-of-game assessments, but there is an need for a mapping between implicit in-game behaviors and explicit learning gains. We developed a game to teach students about Linked Lists - a key data structures concept - as well as its operational and conceptual aspects. Domain experts identified the moves and strategies within the game that were indicative of student's implicit learning of the concept or a lack of it thereof and we used log data to detect these. A pilot study was conducted with middle school students who played our game
and then completed pre and post assessments to test their explicit learning gains. The corpus of data is currently being analyzed to measure possible correlations between the observed implicit learning behaviors and explicit learning gains that were shown in the post-assessments. For each level a partially ordered plan is coded and students’ attempts towards completing these steps are studied to better understand implicit learning patterns and common misconceptions. Findings will show to what extent students are able to apply an implicit understanding of the concept in an abstract situation.

Poster Number: 196
The Relationship Between Solution Length and Accuracy in Logical Proofs
Author:
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Mentors and/or Co-Authors:
Behrooz Mostafavi College of Engineering NC State University
For several semesters, instructors and researchers have been trying to improve and optimize the quality of students' learning from online intelligent tutors. One such tutor is the Deep Thought logic tutor employed by NC State's CSC226 Discrete Mathematics course. Over the course of my research, I have been analyzing student data from two semesters of CSC226, where students worked through 7 levels of logical proof problems of the Deep Thought tutor. I separated the student results into k-means clusters based on 3 metrics. Those metrics were accuracy (the ratio of correct rule applications that the student made to the number of total rule applications), solution length (the number of steps it took the student to solve the problem), and elapsed time (the amount of time it took the student to solve the problem). For each metric, there are 3 clusters which signify either high, medium, or low performance on the part of the student. I came to form a hypothesis that there may be a correlation between which cluster for length that a student falls in, and which ranking for accuracy that they fall in. Through my data analysis however, I have found that student solutions on average seem to fall into the medium accuracy cluster more often than the high or low clusters, regardless of what length cluster (short length, medium length, or long length) their solutions fall into.

Poster Number: 203
Towards an Understanding of Student Behavior in an Online Critical Reading Software
Author:
Nathaniel Larson Computer Science Whitman College

Mentors and/or Co-Authors:
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Yiqiao Xu College of Engineering NC State University

The educational software Actively Learn aims to strengthen students’ critical reading skills in several ways, including: (1) breaking complex texts into smaller sections, (2) allowing teachers to embed questions and notes into text, (3) facilitating discussion between classmates, and (4) providing feedback to teachers on student reading patterns. We believe that data from the software system will provide a rich picture of how students read documents, what aspects of them they find important or worthy of comment, and their level of comprehension. However, these data are contained in a large, opaque, and previously unstudied database. In this study, we examined and pre-processed the database, conducted
preliminary analysis to uncover trends related to student reading, and identified some of the questions that can be addressed by the dataset. This early work lays the foundation for future research into how students read and interact within the Actively Learn system.

Poster Number: 204
Eye Tracking in a Digital Hanabi Game
Author: Eve Gottwald Computer Science Mills College

Mentors and/or Co-Authors:
Chris Martens College of Engineering NC State University

Over the past few years, there has been accelerated development in the topic of artificial intelligence. Central to this area of computer science is the idea that AI agents will rapidly gain more intelligent, human-like, reasoning abilities as work in this field continues. With the advancement of technologies such as 3D motion sensors, gaze tracking devices, speech-recognition, and more, the world of digital game-play has also progressed rapidly in the last decade. However, there has yet to be significant research in applying these technologies to the AI’s we create to play against or alongside humans—another field in which computer science has a long history. By integrating these two important aspects of computer science, we can get closer to simulating in an AI agent, the ability of reading a person’s nonverbal cues such as body language; a tool of communication that humans use entirely subconsciously. To begin this integration, my project is to attach Tobii Eye-Tracking technology to an AI created to play the cooperative card game of Hanabi. With the gaze-tracking data, the AI will be able to make decisions based not only on game logic, but also on what cards a player is looking at, what parts of the game board is being focused on, and other nuances of the human-gaze during gameplay. This experiment could potentially serve as a gateway into far more intelligent, and personal human-computer interactions, starting with a new species of game-playing artificial intelligence.

Poster Number: 216
Ai-driven Procedural Generation in Detective Games Using Ostari
Author: Henry Mohr Computer Science Haverford College

Mentors and/or Co-Authors:
Chris Martens College of Engineering NC State University

Detective games are video games in which the player investigates a crime, gathers evidence, and eventually determines who committed the central crime. Often, such games are based on detective stories in the mold of Arthur Conan Doyle and Agatha Christie. One difficulty with game adaptations of detective stories is that replayability can be limited, since the game becomes trivial if the player knows the answer. We create a game, playable in a web browser, in which the player is a detective who must investigate a murder on a cruise ship. The game uses procedural generation and AI agents to create murders so that the outcome is not fixed, while keeping the mystery solvable by the player. This means that players experience different detective stories on different playthroughs, depending not only on player actions but also on the procedural generation and the actions of AI characters. The game is written primarily in Ostari, a programming language framework developed by Markus Eger for defining games in which players have differing beliefs about the state of the world. It takes advantage of Ostari’s belief and
action system (which is based on Alexandru Baltag's action language for Dynamic Epistemic Logic) to handle the discovery of evidence that narrows down the suspects until the murderer is determined. It also uses Python for some of the procedural generation, and for the browser interface. If we are successful, we will substantially improve the replayability of detective games.

Poster Number: 217

**Labeling and Predicting the Prognoses of Sepsis Patients**

*Author:*  
**Aurora Zhang** Mathematics Pomona College

*Mentors and/or Co-Authors:*  
**Min Chi** College of Engineering NC State University

Septic shock, a condition that results from infection entering the bloodstream, is a lethal complication resulting in hundreds of thousands of deaths per year in the U.S. alone. Recent research in machine learning and healthcare has proposed new methods in deep learning to predict the progression of septic shock in a timely and accurate manner. The validity of these algorithms, however, must be verified on real-world data from electronic health records (EHR), which can be sparse, incomplete, and in the case of septic shock, contain insufficient diagnostic information. For this project, I investigated features of the Mayo Clinic database, which contains detailed patient level, visit level, and event level time series data for over 350,000 unique hospital visits over the span of seven years. I performed several pre-processing tasks: (1) generating accurate shock labels for event-level data based on expert-determined rules, (2) verifying those labels against ICD-9 diagnostic information, and (3) creating appropriate samples from shock and non-shock visits to be used in future training and testing for machine learning models. In addition, I examined the correlations between shock diagnoses and patient features, including age, gender, race, length of hospital stay, and risk of readmission, and I evaluated their implications for the prognoses of infected patients.
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# Student Listing by Program

## ASSIST - Nanosystems ERC for Advanced Self-Powered Systems of Integrated Sensors & Technologies

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## Basic and Environmental Soil Science Training (BESST)

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## BeeMORE: Bees and Microbes in Organized Research Experiences

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### FREEDM Center

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REU for Composites in Extreme Environments

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**Science of Software in CSC**

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**Socially Relevant Computing and Analytics in CSC**

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<td>Zhang</td>
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</table>
Symposium Summary

Total Participants: 319
(Lead Student Presenters: 284 / Co-Presenters: 35)
Representing 80 National and International Institutions and NC State University

Summary of Presentations by Program
ASSIST - Nanosystems ERC for Advanced Self-Powered Systems of Integrated Sensors and Technologies = 18
Basic and Environmental Soil Science Training (BESST) = 10
BeeMORE: Bees and Microbes in Organized Research Experiences = 8
Biotechnology Summer UG Research Experience (BIT SURE) = 15
CASL REU (Nuclear Engineering) = 1
Comparative Medicine (CMI) Summer Interdisciplinary Research Initiative (CMI SIRI) = 10
Food Science Summer Scholars = 8
FREEDM Center = 10
Global Engagement in Academic Research (GEAR) = 37
IMSD Intensive Research & Training Program (IMSD) = 2
Integrative Molecular Plant Systems (IMPS) = 8
Interface of Computations and Experiments - Chemistry = 13
Kelman Scholars – Plant Pathology = 12
MAE REU in Composites = 2
McNair Scholars = 5
MEAS – Wake Tech Program = 5
NC State Independent Researcher = 49
NextGen Data Science Fellowship Program = 7
NSF EFRI-REM Mentoring Catalyst Initiative = 1
OUR Grant Recipient = 20
Research Internship Summer Experience (RISE) in Civil & Environmental Engineering = 24
REU for Composites in Extreme Environments = 6
Science of Software in CSC = 8
Socially Relevant Computing and Analytics in CSC = 14

Summary by College
College of Agriculture & Life Sciences 34
College of Education 1
College of Engineering 103
College of Humanities & Social Sciences 8
College of Natural Resources 4
College of Sciences 91
College of Textiles 3
Poole College of Management 1
Unaffiliated with a College 39

**Summary by Classification**

Freshman = 4
Sophomore = 49
Junior = 121
Senior = 145

**Summary of Student Home Institutions**

Alamance Community College
Appalachian State University
Arizona State University
Athens High School
Beijing Institute of Technology
Benedict College
Berea College
Brown University
Bucknell University
California Polytechnic State University, San Luis Obispo
California State University, Sacramento
Carnegie Mellon University
Carthage College
Catawba College
Cornell University
East Carolina University
Elmhurst College
Elmira College
Enloe High School
Erskine College
Green Hope High School
Grinnell College
Haverford College
Hendrix College
Humboldt State University
Indian Institute of Technology (BHU), Varanasi, India
Iowa State University
Ithaca College
Jilin University
Lynchburg College/University of Lynchburg
Meredith College
Miami University
Michigan State University
Middle Georgia State University
Millersville University
Mills College
Nanjing Normal University
NC Central University
NC State University
New College of Florida
New Mexico State University
Northeastern University
Northern Kentucky University
Open University of Sri Lanka
Penn State University
Pomona College
Rice University
Rochester Institute of Technology
Sanderson High School
Shaw University
South Carolina State University
South Dakota School of Mines and Technology
St. Augustine’s University
St. Edwards University
Stockton University
Susquehanna University
Tennessee Technological University
The Chinese University of Hong Kong (Shenzhen)
Tuskegee University
UCLA
UNC-Chapel Hill
UNC-Pembroke
University at Buffalo
University of Arkansas
University of Central Florida
University of Colorado-Boulder
University of Connecticut
University of Delaware
University of Florida
University of Maryland
University of Maryland Baltimore County
University of Massachusetts Amherst
University of Minnesota
University of Pennsylvania
University of Puerto Rico at Rio Piedras
University of Science and Technology of China
University of Vermont
Wake Technical Community College
Washington and Lee University
Washington State University
Washington University in St. Louis
Whitman College
Winthrop University
Zhejiang University

Please note that portions of these data sets are self-reported by students during the registration process and therefore may have variance.