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Michigan Technological University
UNDERGRADUATE RESEARCH EXPO

Welcome to the 2016 Undergraduate Research Expo!

The Undergraduate Research Expo highlights the amazing cutting-edge research being conducted on Michigan Tech's campus by some of our best and brightest undergraduate students.

The students showcasing their work today have spent a significant portion of the past year working alongside Michigan Tech faculty and graduate students to explore, discover and create new knowledge. They've spent long hours in the lab or out in the field designing experiments, gathering data, creating new models and testing hypotheses. They've applied their classroom knowledge in new and sometimes unexpected ways, and developed new skills that will propel them forward in their careers.

Each of the presenters has been mentored by a faculty member who took great care to guide them through the rigors and exhilaration of pioneering research projects. They've shared in arduous tasks, brainstormed, adjusted hypotheses and regrouped as their projects have taken shape. Through the process, they've built strong relationships that will last a lifetime. The students presenting today represent a wide array of scientific and engineering disciplines from across campus and highlight the diversity of research areas being explored.

I would like to take this opportunity to thank our partners and sponsors who have funded the work of many of the students that you will see on display today. In particular, I want to recognize the office of the Vice President for Research for funding the Summer Undergraduate Research Fellowship Program, as well as the Portage Health Foundation and the DeVlieg Foundation for funding the Undergraduate Research Internship Program.

I sincerely hope that you enjoy visiting with our students and learning about their research endeavors today. Challenge them with your questions and experience the passion that is Michigan Tech!

Sincerely,

Lorelle A. Meadows

Lorelle Meadows
Dean, Pavlis Honors College

Pavlis Honors College

Michigan Tech

Undergraduate Research Expo

The Pavlis Honors College would like to welcome you to the 2016 Undergraduate Research Expo!
The research presented here is sponsored by the Office of the Vice President of Research and the Provost, the Portage Health Foundation, the DeVlieg Foundation and the Summer Undergraduate Research Fellowship program.

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1. Novel Cloning Protocol for H3.3 Deletion Mutant Construction

Student Presenter(s): Kaley Annis and Tracy Mulka, Biochemistry and Molecular Biology
Faculty Advisor(s): Dr. Martin Thompson, Chemistry

Introduction:

H3.3 is one of the eight variants of human histone protein H3, and found to be mutated in about 70% of pediatric glioblastoma (PGB) patients at specific residues. In order to investigate how this specific mutation leads to cancer development, it is important to create the mutant and compare its activity to wildtype H3.3 in gene regulation. The purpose of this study is to apply a novel cloning method to prepare a H3.3 deletion mutant. This new method overcomes several disadvantages of traditional protocols, including shorter preparation time and larger recovery of DNA for transformation.

Materials and Methods:

For this study, a novel cloning method was employed in order to create H3.3 deletion mutant in which the first 45 amino acids from a 136 full-length protein were removed. Primers were designed to anneal sequences flanking the coding sequences of residues 1 through 45. The primers also contained 1) coding sequence for Xa factor which removes methionine before ligation and 2) Phosphorothioate modification at the location to protect from exonuclease cleavage. Inverse Polymerase chain reaction (PCR) with H3.3 wildtype plasmid template was conducted and the PCR reaction mix was treated with an endonuclease DpnI to remove template DNA and with T7 gene 6 exonuclease to create 5'-overhangs. The treated DNA was directly transformed into expression Escherichia coli strain JM109(DE3) via heat shock method.

Results and Discussion:

Inverse PCR resulted in ~ 5600 bp fragments as designed. After transformation and selection, plasmids were isolated and sequenced to confirm the deletion. SDS-PAGE showed an overexpression of H3.3 deletion mutant. This novel cloning method provided the following advantages over traditional cloning with restriction enzymes and ligase. By employing this new protocol, total cloning time was shortened and loss of DNA during gel purification was avoided. Introduction of protease cleavage sequences allowed the removal of methionine, which will interfere with downstream application. The purified deletion mutant will be ligated to peptides with the desired modification/mutation via native chemical ligation, and the resultant full-length H3.3 mutant used to examine the consequences of mutation in PGB development.

2. Linking Biocide Resistance to Antibiotic Resistance in Streams Contaminated with Fracking Fluids

Presenter(s): Andrew Baldwin, Bioinformatics and Andreas Koerner, Biochemistry
Faculty Advisor(s): Dr. Stephen Techtmann, Biological Sciences

Introduction:

Hydraulic fracturing (HF) is the process of injecting pressurized water and chemicals into a subterraneous rock, like shale, to create fractures that release natural gas or oil. The use of the process has grown, 702% in recent years. The fluids used in HF contain biocides that are used to control the growth of subsurface microbes during drilling. In a few cases, HF fluids have contaminated nearby streams. The goal of this project is to investigate the abundance of biocide-resistant strains in these streams as well as investigate if biocide resistance is linked to antibiotic resistance.

Methods and Materials:

The link between biocide and antibiotic resistance is possibly due to similarities in the mechanism of action between the biocides and antibiotics or the mechanism of removal between the biocides and antibiotics. We hypothesize that resistance to biocides will lead to resistance to antibiotics. Water from a stream impacted by hydraulic fracturing wastewater was plated on nutrient broth with either 100-ppm glutaraldehyde, 100 ppm DBNPA, or a combination of 100 ppm of both biocides. These are two popular biocides used in HF. Of the over one hundred strains that were isolated from this stream, 27 were chosen for further investigation. Sequencing of the 16S rRNA will be used to identify the taxonomy of the organism which will allow us to determine whether the organism has known resistance or if it was acquired after exposure. Over the next few weeks, the project will perform antibiotic resistance tests to identify antibiotic resistance in each organism along with minimum inhibitory concentrations for the biocides. Selected antibiotics include ones with similar mechanisms of action to the biocides and common antibiotics used in medical applications.

Results and Discussion:

Ninety-eight strains have been identified as resistant to Glutaraldehyde, seventy-eight have been observed as resistant to DBNPA, and sixty-one strains are resistant to both. Of these, 27 total strains have been selected for further studies. The majority of strains isolated from the contaminated stream exhibited some resistance to a biocide. The project will also be able to assess if resistance to multiple biocides increases the likelihood of being resistant to these antibiotics. Using the resistance data, we will be able to determine a possible link between gained biocide resistance and antibiotic resistance.

3. Colorimetric Detection of Amyloid Formation

Presenter(s): Stephanie Bean, Biochemistry and Molecular Biology
Faculty Advisor(s): Dr. Caryn L. Heldt, Chemical Engineering

Introduction:

Every 67 seconds someone in the United States develops Alzheimer's Disease (AD). AD is a neurodegenerative condition characterized by cognitive decline accompanied by memory loss. It is the only top ten cause of death in the United States which cannot be prevented, cured, or slowed. One of the proposed causes of AD is the formation of structures containing amyloid fibrils. Amyloid fibrils are insoluble fibrous protein aggregates sharing specific structural traits. Aside from AD, amyloid fibrils are associated with twenty other known human diseases which arise from eighteen naturally-occurring proteins or polypeptides which improperly fold to cause disease. Most of the current detection methods for AD are post-symptomatic. This means that irreversible damage to the nervous system has already occurred before an official diagnosis is made and therapy can begin.

Methods and Materials:

To improve abnormal protein accumulation detection and patient prognosis, gold nanoparticle aggregation, which has proven to be a viable detection method because of the colorimetric shift, can be used to detect the formation of amyloid fibrils during the early stages of their development.

Results and Discussion:

Our lab has demonstrated that insulin amyloid fibrils aggregate in the presence of gold nanoparticles resulting in a visible color shift in solution. Recent results from our lab also indicate that osmolytes, which are natural compounds that regulate osmotic pressure in marine life, may enhance the detection of these misfolded proteins by inducing hydrophobic reactions.

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4. A Lab-Scale Autonomous Haul Truck for Underground Mine Operations: Design and Development

Presenter(s): Loryn Becker and Ted Wierzba, Electrical Engineering Technology
Faculty Advisor(s): Seyyedmohsen Azizi and Aleksandr Sergeyev, School of Technology

Introduction:

The objective of this project is to facilitate the use of automation in an underground mining environment. In an active underground mine, there are several hazards a worker can face. The implementation of autonomous control of the mobile equipment used in these mining operations is one of the ways to cut down on reportable injuries or lost-time accidents. It can also result in less time wasted for the workers as well as an overall safer mining environment. With autonomous vehicles in underground mines, it is less likely for accidents to occur involving any mine employees.

Materials and Methods:

In order to implement autonomous control, several different types of sensors must be installed. The utilized sensors include multiple ultrasonic range detectors and an image processing unit. The sensors provide complementary data to an Arduino microcontroller for collision avoidance and tunnel navigation, respectively. Experiments will be conducted to test the performance and reliability of the developed autonomous underground mine truck.

Results and Discussion:

Outfitting the vehicle with the ultrasonic modules that were programmed with a collision detection algorithm, only proportional control yielded results that surpassed expectations. The truck was able to maneuver itself through half of the course by keeping an equal distance from each wall of the small-scale haul route. When the image processing unit is fully programmed, it is expected that the vehicle will finish the remainder of the route and be able to repeatedly run the course without collision. The results from the experimental data, which will be conducted in the future, will be analyzed and compared to the results from the manual mode of truck operation.

5. Microbial Community Response to Lake Ice Freezing

Presenter(s): Timothy Butler, Biology and Anna-Catharina Wilhelm, Biochemistry
Faculty Advisor(s): Dr. Stephen Techtmann, Biological Sciences

Introduction:

Very little is known about how microbial communities respond to dramatic changes in temperature as well as lake ice freezing. In many environments, microbial activity is dramatically decreased when temperatures decrease. We hypothesize that microbial abundance will decrease upon lake ice freezing. In progression toward understanding microbial communities and their response to ice cover and colder temperatures, this study hopes to investigate the link between changes in temperature and microbial abundance in hopes of better understanding the effects of lake ice freezing on the biogeochemical cycling.

Materials and Methods:

In this study microbial abundance was measured in samples collected from an aquatic system (The Keweenaw Waterway) on a daily basis from November to February. Environmental variables were measured at the same time as sampling in order to observe the effects of changes in temperature and ice cover on microbial communities. Abundance of total general Archaea and Bacteria, as well as Bacteria and Archaea involved in ammonia oxidation was determined using Quantitative Polymerase Chain Reaction (qPCR).

Results and Discussion:

While some environmental variables such as salinity remain very constant through the course of this study, other variables such as dissolved oxygen and pH changed throughout the course of sampling. Some of the variables exhibited variation on a day-to-day basis while others showed more gradual changes. Temperature gradually decreased from 10°C at the beginning of sampling until the formation of ice. After the formation of ice, the temperature stabilized between 0 – 0.1°C. These environmental changes will most likely impact microbial abundance in this system. This study hopes to shed light on how temperature affects microbial communities and in particular microbial abundance.

6. Neuromuscular Fatigue in Middle-Aged Obese Women

Presenter(s): Claire Eischer, Exercise Science
Faculty Adivsor(s): Dr. Tejin Yoon, Kinesiology and Integrative Physiology

Introduction:

More than one-third (34.9%) of adults are obese in the US. This is a problem because it limits physical functions and is a leading cause for mortality. The negative impact of obesity can be more serious in women because physical mobility limitations, large muscle function limitations, and gross motor function limitations, have shown to be more pronounced in women than in men. Despite the important functional implication of fatigue in middle-aged adults, and the significantly higher obesity rate in this age group, little is known about this population. The purpose of the study is to examine neuromuscular fatigue and recovery following dynamic fatiguing contractions in lean and obese middle-aged women.

Materials and Methods:

The participants will have the thigh muscle make-up (muscle architecture) examined through the use of ultrasound. After this, participants will complete a walking test, balance test, and a sit-to-stand test to examine basic physical functioning abilities. Participants will also perform 3 maximal voluntary contractions (MVCs) of the dominant leg for two different tests. The first test will examine maximal voluntary isometric contractions (MVIC) of knee extensors using Biodex dynamometer. The second test will examine maximal power through an isokinetic concentric MVC. After determining the MVCs, participants will then perform 5 sets of 30 repetitions of sub-maximal effort isokinetic lengthening contractions at 80% of MVIC loads, with 10 seconds given as a rest period between sets. Both MVC tests will be recorded at baseline, immediately following the fatiguing contraction tasks, and 5, 10, 15, 20, 30 min and 24, 48, and 72 h after task termination. Additionally, surface EMG will be used to record muscular activity of the knee extensors, including the rectus femoris, vastus lateralis and vastus medialis throughout all testing.

Results and Discussion:

The results of this study will be used to relate to functional limitations of the obese middle-aged population. Thereafter, results may be used to develop exercise programs related to improving muscular performance and subsequently improving performance of daily activities.

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7. A Better Approach to Tritylation of Alcohols

Presenter(s): James Gooding, Chemical Engineering
Faculty Advisor(s): Dr. Shiyue Fang, Chemistry

Introduction:

In organic synthesis trityl functions are used as protecting groups. They can be easily deprotected with weak acids allowing the alcohol to react in the next steps. Traditionally to get a trityl group to react with an alcohol, one would react trityl chloride with the alcohol under dry conditions with a base that is usually harmful and not environmentally friendly. All of these conditions are expensive in both time and money which lead to our aim of developing a new method for tritylation of alcohols under milder conditions with higher efficiency.

Methods and Materials:

In this new method, trityl alcohol is used in lieu of trityl chloride. Trityl alcohol is activated using trifluoroacetic anhydride. This creates a highly reactive carbocation, which is then reacted with an alcohol to give the product. A series of bases and solvents were screened initially. Current protocols for our methods call for the activation of trityl alcohol in dichloromethane (DCM) with three equivalents of trifluoroacetic anhydride at room temperature for one hour. The volatiles were then removed. To the residue, a solvent, base and the substrate alcohol were added. The reaction was allowed to proceed for 1 hour at 0 ˚C. Thin layer chromatography was used to monitor the progress of the reaction. The product was isolated by aqueous workup and purified with silica gel flash column chromatography. Characterization of the product was accomplished using 1H and 13C NMR, and mass spectrometry. Isolated yields were determined.

Results and Discussion:

We screened solvents such as dichloromethane (DCM), acetonitrile, dimethylformamide (DMF), and tetrahydrofuran (THF) and bases such as 2,6-lutidine, pyridine, diisopropylethylamine (DIEA), and 1,8-Diazabicycloundec-7-ene (DBU). Best results were obtained by using THF as a solvent and either 2,6-lutidine or DIEA as a base. Yields as high as 91% were obtained. A superior method for tritylation of alcohols was successfully developed. Advantages of this approach include (1) trityl alcohols are usually much cheaper. (2) Trityl alcohols are stable and can be conveniently handled in air. Importantly, there is no need of concern of decomposition of reagents to cause failure of expensive reactions. (3) The use of pyridine as solvent can be avoided. This gives chance to use low boiling point and less harmful solvents for the reaction. (4) The new method has higher reactivity, which makes the reaction much more efficient and results in higher yield of products. Importantly, the new method can be used for tritylation of certain hindered alcohols that could not be tritylated with any known methods.

8. Data Mining of Urban Farms in Detroit, Michigan

Presenter(s): Joe Grocholski, Geospatial Engineering
Faculty Advisor(s): Dr. Jessica McCarty, Michigan Tech Research Institute

Introduction:

According to the Food and Agriculture Organization of the United Nations, food insecurity affects around one in nine people on Earth. Even in developed countries like the United States, people face limited or uncertain access to necessary nutrition. Fortunately, some communities are combating food insecurity with urban farms. However, it is currently difficult and tedious work to monitor the conditions of these sites. The goal of this project is to research whether it is possible to use remotely-sensed data in combination with web scraping of social media to more effectively and efficiently monitor the soil conditions of urban farms.

Materials and Methods:

Detroit, Michigan's urban farms were selected as the initial site to monitor. The first step undertaken was to build a list of urban farms where social media or web scraping were expected. Using Google, websites were searched that listed names of community farms and gardens within the city of Detroit. Farms in the surrounding suburbs were not included. After compiling the list of farms, the next step was to find more information about each site and a search for each farm was made and its location (address, neighborhood, or street intersection) was recorded. For some of the farms, which have their own webpage or Facebook site, metadata was compiled, including their creation date, when they started growing food, and the variety of food grown. Once a general location of each farm was known, Google Earth was used to delineate boundaries and estimate areas. Open fields, raised beds, orchards, and greenhouses were identified. A Python script to parse through the entries of a crowd-sourced urban farming website (urbanfarming.org) and output a list of farms within 20 miles of Detroit was written.

Results and Discussion:

Fifty two farms were found by manually searching Google and Facebook. This is significantly less than the 609 farms that the urban farming database script identified. However, when searching for these farms using Twitter mining script, no significant useful metadata about the farms was extracted. Because Landsat data is free and has good temporal resolution, it would be an ideal satellite to use to monitor the farms. It has visible and infrared bands with 30 meter spatial resolution (the pixel size is 900 sq. m). This combination of bands is necessary to calculate a normalized difference vegetation index. The median farm sizes are 0.13 acres (526 sq. m) and 0.29 acres (1174 sq. m) for raised beds and open field sites, respectively. The analysis showed that the median size raised beds farms would occupy 0.6 pixel, and the median open fields would occupy 1.3 pixels. The limited spatial extent of the farms suggests that the spatial resolution of Landsat imagery is not sufficient for analyzing urban farm soil conditions. This task would be more viable if a remotely-sensed data source could provide frequent revisit times like Landsat but with a finer spatial resolution.

9. Vortex Cores and Their Link to Aneurysm Development

Presenter(s): Christopher Haferman, Biomedical Engineering and Mechanical Engineering
Faculty Advisor(s): Dr. Jingfeng Jiang, Biomedical Engineering

Introduction:

An aneurysm is an irregular bulge in a blood vessel. Aneurysms develop mostly as an intracranial aneurysm or an abdominal aortic aneurysm. An intracranial aneurysm is extremely dangerous because if it ruptures, it can cause massive damage to the brain. There is currently no certain way to determine if someone is going to develop an aneurysm. Studies have shown that there is a correlation between some factors such as wall shear stress, pressure, and aneurysm development. This study could potentially lead to a better way of predicting aneurysm development.

Materials and Methods:

In order to calculate the vortex cores in the vessel, a surface file was obtained. The geometrical errors on the surface file were then fixed using 3-matic software, so that it was anatomically correct. Then, using Vascular Modeling Toolkit (VMTK), the aneurysms on the blood vessel were removed. VMTK does this by calculating the centerline of the vessel and calculating where the aneurysm(s) are located. VMTK then removes the aneurysm(s) and recreates the theoretical original blood vessel based on the previous centerline calculation. This recreated vessel model represents what the blood vessel's structure was before the aneurysm(s) developed. Then, using ICEM CFD software, the surface structure was turned into a 3-dimensional volume mesh. The inside of the blood vessel was meshed using tetrahedrons; the wall of the vessel was meshed using rectangular prisms. This meshed model was then run through computational fluid dynamic (CFD) analysis. This analysis reported the necessary velocity values to calculate where vortex cores exist. These data outputs were run through VMTK; the lambda 2 method was used to calculate the vortex core in VMTK. This generated a visual representation of the vortex core which was qualitatively studied for anomalies.

Results and Discussion:

The results that were acquired from this study were extremely interesting. The data revealed that there was a vortex core that filled a majority of the reconstructed blood vessel. This shows that there is blood swirling throughout the entirety of the vessel; however, upon visual inspection, there were no obvious anomalies that could be related to the aneurysm's development. The types of anomaly that would have been accepted are holes in the vortex core structure, abnormal bulges in the structure, or sharp changes in the vortex core structure. Since there were no anomalies in the vortex core structure that could be studied, the focus of the study has changed slightly. Instead of looking for anomalies in the vortex core's structure, the critical point line of the structure will be calculated. The critical point line of a vortex core represents the center of where all the flow of a vortex core is located. The theory that will be tested is if this critical point line shows any possible reason for the aneurysm's development. The critical point line could, in theory, change direction near the wall and cause the aneurysm to develop.

10. Changes in Peat Carbon Storage With Altered Hydrology and Plant Species Composition

Presenter(s): Sarah Harttung, Applied Ecology and Environmental Science
Faculty Advisor(s): Dr. Evan Kane, School of Forest Resources and Environmental Science

Introduction:

Peatlands contain about 30% of the world's terrestrial soil carbon; the peatland carbon pool is approximately equal in size to that of all atmospheric carbon and is much greater than the land surface area of peatlands would suggest. However, the fate of this carbon pool in the face of anticipated climatic changes remains uncertain.

Materials and Methods:

Over a five-year period from 2010 to 2015, 24 blocks (1 m3 each) of peat were experimentally manipulated in a mesocosm at the US Forest Service Northern Research Station in Houghton, MI. Two water table (high and low) and three plant functional group (sedge, Ericaceae, sedge and Ericaceae (unmanipulated)) treatments were implemented. Bulk density samples from five depths were collected during the project's dismantling.

Results and Discussion:

Vegetation community significantly affected bulk density. From 10-20 cm and 20-30 cm, bulk density generally increased when sedges dominated and decreased when ericoids dominated. Water table (high or low) had a marginally significant effect on bulk density primarily when the water table was low. While it may be a big leap to apply the results of this mesocosm experiment to changing trends in global peatland carbon storage, it offers insight as to mechanisms of change.

11. The Effects of Ice Cover on Fish Exposure to Methyl Mercury (MeHg)

Presenter(s): Ashley Hendricks, Environmental Engineering
Faculty Advisor(s): Dr. Noel Urban, Civil and Environmental Engineering

Introduction:

Methyl Mercury (MeHg) is an anthropogenically-emitted toxin that can be found in any lake across the United States; atmospheric deposition generally is the primary source of MeHg to these lakes. Fish from northern lakes have been found to exhibit higher MeHg concentrations than fish in the south, whereas in the south, lakes receive more mercury input from atmospheric deposition than northern lakes. One major difference between the south and north, and also a plausible factor to explain the higher concentrations, is seasonal ice cover.

Materials and Methods:

To test the hypothesis that seasonal ice cover causes increased MeHg in lakes, a mathematical model, which is patterned after the EPA model, SERAFM, of Knights et al., is developed using MATLAB to simulate MeHg cycling and to include seasonality. Other than ice cover, seasonality includes changes in temperature, phytoplankton, dissolved organic carbon (DOC), solar radiation, and hydrology. The model considers three mercury species (MeHg, elemental mercury, and divalent mercury), and three compartments in a lake (epilimnion, hypolimnion, and the sediments). The initial model was for a lake with seasonal ice cover; however, to determine the effects of ice cover, the model was altered in order to examine five postulated mechanisms whereby ice affects MeHg cycling. The scenarios include seasonality changes of atmospheric deposition, precipitation, lake mixing, sunlight received in the water column, air-to-water exchange of mercury, and temperature changes due to ice melting or forming. The model was also analyzed for sensitivity to changes in parameters.

Results and Discussion:

The model predictions matched seasonal temperature and concentrations of DOC and phytoplankton. The model also indicates that there is a seasonality to Hg species concentrations. The most sensitive parameters in the model were found to be the temperature adjustment coefficient, MeHg upland runoff coefficient, and MeHg dry deposition velocity to vegetation. The results from the scenario testing suggests that ice cover increases MeHg concentrations in lakes. The increase is driven mainly by the amount of solar radiation that penetrates into the water column. In contrast, other scenarios showed that seasonal changes in lake mixing and atmospheric deposition would, if not offset by the sunlight penetration, decrease MeHg concentrations in lakes during winter.

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12. Size-dependency of Thiolated Chitosan Gold Nanorods on Photothermal Properties and Cellular Uptake

Presenter(s): Michelle Hoard, Chemical Engineering
Faculty Advisor(s): Ching-An Peng, Chemical Engineering

Introduction:

It has been suggested that gold nanorods (GNR) have great potential in cancer therapy because of their ability to deliver drugs directly to cancer cells and offer photothermal therapy. Photothermal absorption is the physical ability of the material to convert near-infrared (NIR) laser light into heat. The generation of heat from the GNRs could be used to ablate malignant cells including cancer stem-like cells (CSC). CSCs are thought to be resistant to most traditional cancer therapies, including chemotherapy and radiation. Hence, it was desired to see how the size and aspect ratio of GNRs will affect both their ability to penetrate the cell membrane through endocytosis and their photothermal properties.

Materials and Methods:

GNRs were synthesized using a seed mediated growth method and a seedless growth method to produce GNRs with a length of 71 ± 13 nm and 42 ± 10 nm, respectively. In a ligand exchange, thiolated chitosan was used to replace the cytotoxic CTAB bilayer surrounding the GNRs. The CGNRs were labeled with Rhodamine B before cell treatment and then added to A549 lung cancer cells.

Results and Discussion:

It was found that the seed mediated (71 nm) GNRs absorbed in the NIR region at 715 nm and the seedless growth (42 nm) GNRs absorbed at 880 nm. From bright field images, it was observed that the 42 nm CGNRs had better cellular uptake into the A549 cells. Hence, the CGNRs produced from the seedless growth method absorbed at a higher wavelength and showed better cellular uptake.

13. Reversibility of Warming Responses of Sugar Maple Root and Soil Respiration to the Cessation of Experimental Warming

Presenter(s): Peter Hoch, Forestry & Wildlife Ecology
Faculty Advisor(s): Dr. Andrew Burton, School of Forest Resources and Environmental Science

Introduction:

Warmer temperatures have the potential to increase both the root respiration and organic matter decomposition components of soil respiration. The resultant increase in CO2 flux to the atmosphere could create a positive feedback loop, leading to even greater warming. A previous study found that experimental soil warming caused root respiration to increase, but that partial temperature acclimation did occur, limiting the increase in CO2 efflux. Bulk soil respiration and soil nitrogen mineralization both increased, indicating greater organic matter decomposition was occurring. This study investigated the reversibility of those results during the first year after cessation of the experimental warming.

Methods and Materials:

The soil in a mature, sugar maple-dominated northern hardwood forest was experimentally warmed by 4 to 5 degrees Celsius for four and a half years during the growing season, from September 2010 until October 2014. Warming was applied to twelve 30 m x 30 m experimental plots using infrared heating lamps. During the growing season of 2015, when warming no longer occurred, fine-root (< 1 mm) respiration, soil respiration and net nitrogen mineralization were measured monthly, to determine if responses occurring under warming persisted or reversed.

Results and Discussion:

Specific root respiration rates were less in the formerly warmed plots at the beginning of the growing season, consistent with the partial temperature acclimation that had occurred in response to soil warming. Over the growing season this acclimation reversed to pre-treatment conditions, leading to no differences between roots from formerly warmed and non-warmed plots. Soils that were previously being warmed had lower rates of soil respiration and lower rates of nitrogen mineralization, indicating that labile organic matter had been depleted during the four plus years of warming. These results suggest that temperature acclimation of roots was a plastic, rapidly reversible response to warming. However, depletion of soil organic matter in response to climatic warming is a real possibility that could have longer term impacts on soil C pools and nutrient cycling.

14. The Role of Implicit Memory Processes in Age-Related Declines in Motor Learning

Presenter(s): Olivia Ingram, Biological Sciences
Faculty Advisor(s): Dr. Kevin Trewartha, Kinesiology and Integrative Physiology

Introduction:

Motor learning is supported by a fast process that allows for rapid improvements in performance and a slow process that allows more gradual improvements. Although researchers have speculated that the slow process may be related to implicit memory resources, this hypothesis has not received direct support. Recent research has shown that aging is associated with impairments in the slow process for motor learning. The current project investigated the nature of the implicit memory process underlying the slow process. This study is significant because it focuses on the largely uninvestigated relationship between implicit memory performance and motor learning in aging.

Materials and Methods:

In the current study, a group of undergraduate students from Michigan Technological University were recruited to provide a healthy younger adult control group as part of a larger project investigating age-related changes in the implicit memory processes underlying motor learning. Participants performed a motor learning task in which they reached to visual targets while grasping a handle attached to a robot that generates unusual movement-dependent forces at the handle (KINARM, BKIN Technologies). Although the load initially perturbs hand movement, people gradually adapt by producing forces that counteract the load. Performance on this motor learning task is used to provide an estimate of the fast and slow learning processes. In addition to the motor task, participants were asked to perform a cognitive battery that included an implicit memory task (the pursuit rotor task) that is known to rely on implicit procedural learning mechanisms. The cognitive battery also included three explicit memory tasks including a verbal paired associates task, a spatial working memory task, and a spatial paired-associates working memory task. These tasks will be used to evaluate any age group differences in cognitive abilities.

Results and Discussion:

The main goal of the current experiment was to investigate the nature of the implicit memory resources that underlie the slow process for motor learning. The ultimate goal of this project is to determine if age-related changes in procedural memory can account for previously observed declines in the slow process for motor learning in aging. The slow process can be estimated from the magnitude of the after effects that participants experience after learning to counteract the forces imposed by the robot when reaching to visual targets. Correlations between procedural learning scores on the pursuit rotor task and the magnitude of the after effects on the motor task were calculated to test the hypothesis that implicit, procedural learning resources underlie the slow process for motor learning. The current observations provide a healthy younger adult baseline against which we will compare healthy older adults to test the prediction that age-related procedural memory impairments explain age-related declines in the slow process for motor learning. Ultimately, this larger project will provide valuable information about the nature of age-related changes in motor behavior that can inform the design of interventions aimed at improving functional independence in later adulthood.

15. Extrinsic and Intrinsic Motivation in Team and Individual Athletes

Presenter(s): Lisa König, Psychology
Faculty Advisor(s): Dr. Shane Mueller

Introduction:

Motivation is an essential factor to perform highly and can determine whether an athlete continues or drops out of their sport. Research has been conducted to find differences of extrinsic and intrinsic motivation, for example between gender (Vallerand et al. 1995, 1998). Gillet et al. (2008) found that individual athletes display a higher level of autonomy, but the difference of extrinsic and intrinsic motivation between team and individual athletes was not significant.

Materials and Methods:

For the experiment, 69 student athletes from Michigan Tech were assessed using the Sport Motivation Scale (SMS) by Vallerand (1995) and a crossword puzzle task to examine differences in motivation. The hypothesis stated that individual and team athletes would have different levels of extrinsic and intrinsic motivation which would influence the number of correct answers from the crossword puzzle task. A second experiment was conducted to assess the perceived levels of motivation in athletes, asking the general population and using the judgement of fictional scenarios.

Results and Discussion:

The results showed that participants who showed high intrinsic motivation also showed high extrinsic motivation. Furthermore, individual athletes, on average, had greater motivation in general than team athletes. This might occur because they are obligated to prepare and be responsible for themselves, which makes them motivated and determined to make the outcome of their performance perfect, because they can’t rely on others.

16. Omeprazole Interaction with Luminal Domain of H+/K+ ATPase System as Investigated at Electronic Structure Level

Presenter(s): Emily Lilla, Pharmaceutical Chemistry and Cheminformatics
Faculty Advisor(s): Dr. Loredana Valenzano, Chemistry

Introduction:

Omeprazole (Prilosec®) and its (S)-isomer, esomeprazole (Nexium®), are medications for gastroesophageal reflux disease (GERD), and serve as proton pump inhibitors (PPI). They inhibit the enzymes CYP2C19 and CYP3A4 and prevent the final step of acid production and basal and stimulated acid secretion. Omeprazole must be converted into the active drug in the stomach acid, making it a sulphenamide. The molecule then undergoes covalent bonding on cysteine 813 and 822 in the luminal domain of the H+/K+ ATPase system in gastric parietal cells.

Materials and Methods:

To investigate the interaction of omeprazole and esomeprazole with the biological substrate at an electronic level, we used Density Functional Theory (DFT) to determine the equilibrium geometries for each molecule using different levels of theory. PBE and B3LYP functionals were employed. Atoms were described within the linear combination of atomic orbitals (LCAO) approach as implemented in the Gaussian09 program. The influence of different levels of basis sets (6-31G, 6-311G, and 6-311G(d,p)) was addressed. Calculations were performed both in vacuum and in H2O, to simulate biological conditions.

Results and Discussion:

PBE/6-311G(d,p) results obtained both in vacuum and aqueous environment on the relative stability of the two isomers have revealed an excellent agreement with available experimental results showing $\Delta E = 2$ kJ/mol, with esomeprazole being the more stable isomer. These results are the starting point for addressing the interaction between omeprazole and the biological active site.

17. Preliminary Investigations of Aqueous-phase Ultraviolet with Hydrogen Peroxide Advanced Oxidation Process for the Removal of 1,4-Dioxane using Simplified Pseudo-Steady State Model

Presenter(s): Shaye Maetzold, Environmental Engineering
Faculty Advisor(s): Dr. Daisuke Minakata, Great Lakes Research Center

Introduction:

Advanced Oxidation Processes (AOPs) that produce highly reactive hydroxyl radicals are used in water treatment to destroy organic contaminants in water [1]. A combination of ultraviolet light with hydrogen peroxide (UV/H2O2) AOP has been employed in wastewater reclamation processes. 1,4-Dioxane is an organic compound used as an industrial stabilizer, classified as a probable carcinogen, and is not completely removed from wastewater using conventional treatment methods [2]. We developed a simplified pseudo-steady state (Sim-PSS) model for UV/H2O2 to evaluate the impact of water quality parameters for preliminary assessment of the use of UV/H2O2 for direct potable reuse.

Materials and Methods:

First, we calculated the quenching rate for the reaction of hydroxyl radicals with 1,4-Dioxane in the absence/presence of alkalinity and background organic matter to evaluate the impact of the other water quality parameters to UV/H2O2. Then, we ran the Sim-PSS model to calculate the energy efficiency per removal of order (EE/O) for the removal of 1,4-Dioxane in a completely mixed batch reactor. The total volume of the reactor was 6 m¬¬3. The solution pH was 7.1 with an initial concentration of 0.19 mg/L of 1,4-Dioxane, a value half of the current Occupational Safety and Health Administration's (OSHA) (US EPA 2015) permissible exposure limit. We compared the impact of alkalinity as a concentration of CaCO3 and background organic matter as a concentration of dissolved organic carbon (DOC) to the EE/O. We varied the H2O2 doses to evaluate the changes in the EE/O and H2O2 residual concentrations and determined the optimal H2O2 dosage.

Results and Discussion:

Deionized water (DI) with a sole concentration of 1,4-Dioxane yielded the lowest necessary H2O2 dosage and the least EE/O values. Adding alkalinity as CaCO3 and DOC increased the EE/O values and demanded a dosage 1-3 mg/L higher than the DI water. Alkalinity (i.e., bicarbonate ion at pH 7.1) and DOC react with hydroxyl radicals. As a result, this required higher concentrations of the H2O2 dose to produce more hydroxyl radicals to destroy 1,4-Dioxane. Addition of alkalinity had little effect on the effluent concentrations of 1,4-Dioxane, but the addition of DOC led to effluent concentrations that were approximately 77% of the initial concentration.

Limitations of the current Sim-PSS model include the assumption of constant concentrations of all species that are equal to the initial concentration during the process, and the assumption of constant pH during the process. Nevertheless, the Sim-PSS provides prediction of the pseudo-first order reaction rate constants obtained from the dynamic simulation and experimental observations in literature [3]. We plan to perform batch experiments and investigate the intermediate transformation products that are produced from the initial reaction of hydroxyl radicals with 1,4-Dioxane.

18. Open Source Recycling of Waste PET Plastic into 3D Printer Filament

Presenter(s): Lewis Marshall, Materials Science and Engineering
Faculty Advisor(s): Dr. Joshua Pearce, Materials Science and Engineering

Introduction:

Water bottles around the world are used daily to provide fresh drinking water to sustain human life. However, after all of the effort which goes into creating these bottles, they are usually discarded, with this issue being especially prevalent in developed countries. By developing a method for recycling these bottles into 3D printer filament, waste-pickers in underdeveloped countries can set up their own business making filament, open--source makers can create cheap filament, and the environmental impact will be lessened.

Materials and Methods:

Plastic reprocessing can impart thermal, mechanical and chemical stresses onto the material. PET in particular experiences hydrolytic, mechanical, and oxidative degradation resulting in decreased mechanical properties. To convert from a waste bottle to 3D printer filament requires shredding first, wherein bottles are broken into tiny pieces through the use of a granulator. After this step, these pieces must be dried in a vacuum oven. For this method, approximately 4 hours at temperatures of ~80°C was found to be suitable. This drying process ensures that all water has been removed from the plastic before it is subjected to the 242°C processing temperature in the extruder. If the water is not removed, hydrolytic degradation occurs, causing the PET chains to shorten, and results in loss of mechanical strength. Once the molten plastic passes through the end of the extruder, it is necessary to swiftly cool it to ensure that crystallization is minimized. If crystallization occurs, the plastic becomes brittle and is unable to be spooled, due to cracking. During extrusion, a high feed rate must be maintained to the hopper, so that a consistent diameter of 1.75mm filament can be produced.

Results and Discussion:

The major finding of this research is the processing temperatures for extrusion and for PET drying. Temperatures in excess of 260°C will cause degradation and a significant loss of viscosity, making spooling a pointless and impossible task. Once the temperature was reduced to the 235°C range, it was very apparent that the PET flakes were unable to melt into one another at such a low temperature. 242°C then is expected to be the temperature which provides the minimum amount of heating required for reprocessing. To further improve this method, a more powerful vacuum oven could be used, which would allow a higher vacuum and a heating plan which allows for increased temperatures as more water is evaporated from the flakes. If the process could also take place in an inert atmosphere, it would also help to prevent oxidative chain scissioning. This project has revealed the need for a powerful open -source shredder or granulator, which will facilitate easier reprocessing of waste plastic. Such a device is currently in development by the Open -Source Hardware Enterprise at Michigan Tech.

19. The Effect of Changes in Fitness and Fatness on Aortic Pulsatility

Presenter(s): Hannah Marti, Biomedical Engineering
Graduate Student Co-Author: Travis Wakeham, Biological Sciences
Faculty Advisor(s): Dr. John Durocher, Biological Sciences

Introduction:

Cardiovascular disease (CVD) is the leading cause of death in the United States. Obesity is associated with increased aortic stiffness, an independent risk factor for CVD. An emerging non-traditional risk factor for CVD, aortic pulsatile load, is thought to be an important contributor to aortic stiffness. Lifestyle interventions are able to effectively reduce risk factors associated with CVD; however, there is debate among researchers if reducing body fat or increasing fitness is more important. Therefore, we examined three lifestyle interventions' ability to reduce body fat, increase fitness, and lessen pulsatile load.

Materials and Methods:

Ten obese participants were randomized into one of three groups: aerobic exercise (n=3), combined (75% aerobic, 25% resistance) exercise (n=4), or hypocaloric diet (n=3) for a period of 12 weeks. Participants' body fat, fitness, and aortic pulsatile load were assessed before and after each intervention. Detailed body fat analyses were completed at UP Health System – Portage via dual energy X-ray absorptiometry (DXA) and computed tomography (CT) imaging. Aerobic fitness was determined by peak oxygen consumption (i.e. VO2peak) during a graded exercise test on a treadmill and muscle strength was assessed through resistance training exercises (i.e. bicep curl, leg extension). Aortic pulsatile load was measured as the product of aortic pulse pressure (as assessed via applanation tonometry) and heart rate. Data within each group were analyzed using paired t-tests. Pearson correlations were performed for changes in pulsatile load vs. changes in other major dependent variables.

Results and Discussion:

Combined training significantly ($P<0.05$) reduced body fat and trunk fat as assessed by DXA scans. There were also non-significant decreases in visceral fat for all groups. VO2peak, bicep curl and leg extension increased only in the combined training group ($P<0.02$ for all). Likewise, aortic pulsatile load only increased in the combined training group ($\Delta 249 \pm 68$ a.u., $P<0.05$). Our combined training results suggest that although there are clear benefits in regard to loss of body fat and increases in strength, even small volumes of resistance training may contribute to the risk for CVD in obese individuals. Changes in visceral fat and changes in aortic pulsatile load from week 0 to week 12 were significantly correlated ($r=0.71$, $n=10$, $P<0.03$), while changes in VO2peak and changes in pulsatile load were not significant. Although changes in visceral fat across groups did not reach significance in our small sample size, the changes in the aerobic group (Δ-13.1 cm2) appear to be much greater than the combined training (Δ-2.7 cm2) and hypocaloric diet (Δ-4.8 cm2) groups. These findings, in conjunction with previous studies, suggest that independent low-intensity aerobic training may be the best way to simultaneously reduce visceral fat and pulsatile load.

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20. Effects of Hyperthermic Denaturation of Collagen Fibers on Tissue's Mechanical Characteristics Resulting from Ablation

Presenter(s): Ross Michaels, Biomedical Engineering
Faculty Advisor(s): Dr. Jingfeng Jiang, Biomedical Engineering

Introduction:

The most abundant protein in the extracellular matrix is the fibrous protein collagen. Collagen is the protein that gives a tissue its structure. It has been shown that collagen's chemical structure is first disrupted and then destroyed at high temperatures. This leads to dramatic elevation of mechanical stiffness due to microstructural change of collagen fibers. This leads us to ask the question that will be the basis of this research.

Materials and Methods:

Data Collection: Heating of both collagen gels and ex vivo tissues will be conducted through temperature-controlled double water-bath. Following the set hydrogels and ex vivo liver tissues being divided into groups, they will then receive different heat treatments. One group, being a controlled sample, will not be subjected to any excessive heating and will be placed in a 37°C isothermic bath to mimic human body temperatures. The remaining groups will be subjected to a range of temperatures and treatment increments, typical of an ablation procedure, via a thermal bath. Following heating the samples, the final hydrogel and ex vivo tissue temperature will be tested and recorded. Data analyses of both tests as described below will reveal the changes in viscoelastic property due to heating. Parameters of viscoelastic properties will be represented using a Kevin-Vigot Fractional Derivative model.

Analysis: The analysis of this data will be attempting to define a "thermal dose" which will standardize the amount of thermal energy introduced by the varying temperatures and times and checking this experimental data against differential and thermodynamic equations.

Results and Discussion:

So far both the creation of collagen hydrogels and the processing of the porcine liver tissue have been standardized. Both have been tested in compression tests generating stress-strain relationships for the samples to be used as a control. Along with the generic ramp test, creep, stress relaxation, and cyclic loading tests on the liver tissue were conducted. Some of the results of these tests are included below. The effects of crosslinking on the mechanical properties prior to using the hydrogels for denaturation studies was explored. There was a statistically significant increase in the elastic modulus of the hydrogels when exposed to a higher concentration of crosslinking solution. Creep and stress relaxation test results from the porcine liver tissue have also been obtained. These results along with the results obtained from the cyclic loading test will serve as control data for the denaturation study. Moving forward, the ongoing work being done includes producing protocols for the thermal bath heating method and then conducting mechanical testing on the denatured tissue and hydrogels.

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21. Culturally Appropriate Methodology for EPA-Developed Tribal Specific Fish Consumption Survey Projects

Presenter(s): Melissa Michaelson, Anthropology
Faculty Advisor(s): Dr. Kari Henquinet, Social Sciences

Introduction:

Tribes in the Great Lakes Basin consume large amounts of fish due to subsistence and traditional cultural practices. High fish consumption rates lead to disproportionate exposure to pollutants and a greater risk of health impacts. The EPA works with tribes in the development of tribal-specific fish consumption rates to improve water quality standards and ensure appropriate protection of human health. This research explores ways of blending scientifically-sound survey methods with cultural appropriateness for more accurate results.

Materials and Methods:

This research was supervised by an EPA Region 5 employee and a member of the Lac du Flambeau Tribe. The methodology, cultural considerations and results of ten tribal-specific fish consumption survey projects that took place between 1994 and 2015 were analyzed. Members of the Fish Consumption Survey Working Group from the Keweenaw Bay Indian Community were interviewed for their suggestions on culturally-appropriate survey methods and EPA Region 10 employees who are currently working with tribes on heritage consumption rates were consulted. A literature review of the most current research on tribal fish consumption survey projects was compiled and resulted in the development of a template to assist tribes interested in developing a fish consumption project in collaboration with EPA.

Results and Discussion:

It is important that all interested parties have an equal share in the the process of making decisions on survey methodology and best practices for tribal fish consumption survey projects. In order to sufficiently protect human health and align with tribal goals, the project should be reviewed by a number of tribal committees for approval and feedback before implementation. Tribes should understand the differences between a contemporary and heritage fish consumption rate, how they apply to their project goals and suggested methodology for collecting data. The use of ethnographic methods is suggested when working with tribes since they require trust building for the most accurate results.

22. Influence of Passages and Differentiation on Dielectrophoretic Properties of Human Mesenchymal Stem Cells

Presenter(s): Anna Nelson, Chemical Engineering
Faculty Advisor(s): Dr. Adrienne Minerick, Chemical Engineering

Introduction:

Human mesenchymal stem cells (hMSCs) are immature cells which can be found in human bone marrow. They have three key components that allow them to be practical in medical applications: the ability to differentiate, self-renew, and repair tissue. hMSCs have beneficial medical applications in treating bone defects, cartilage lesions, spinal cord injuries, and can even treat degenerative diseases such as diabetes mellitus and Parkinson's symptoms. Current methods of stem cell purification are expensive and invasive. This study is investigating a cheaper, more time effective alternative to cell sorting known as dielectrophoresis (DEP). Dielectrophoresis is the polarization of cells, based upon their dielectric properties, due to electric field gradients. This work expands preliminary experiments that measure hMSCs dielectric properties as a function of solution conditions.

Materials and Methods:

hMSCs become polarized when subjected to DEP. The cells either exhibit a negative or positive DEP response (nDEP or pDEP) based on the repulsion or attraction to areas with a high electric field gradient. The frequency at which the cells move from nDEP to pDEP is known as the crossover frequency (COF). It is predicted (with support from previous research) that each type of differentiated cell type will have a differing dielectric spectra allowing DEP to be a feasible sorting method for undifferentiated hMSCs. Currently, optimization of analysis methods is being conducted with undifferentiated hMSCs at different passages. The hMSCs are loaded into a microdevice that is connected to a function generator, then subjected to static frequencies ranging from 0.2 MHz to 3.0 MHz. Video microscopy recordings (2 fps, 16X) of the resulting DEP motion are recorded, then analyzed using image processing software (Image J) to determine nDEP, pDEP ranges, and COF for each set of parameters.

Results and Discussion:

Preliminary results show that all of the cells demonstrate nDEP at frequencies under 0.2 MHz and pDEP at frequencies over 3.0 MHz. This means that the targeted range for determining the COFs is 0.2 MHz to 3.0 MHz. To determine whether DEP can feasibly sort hMSCs, undifferentiated hMSC response data will be compared to adipocyte response data. Once the crossover frequency is determined, dielectric parameters can be calculated. Further data collection will be conducted with adipogenic-differentiated human mesenchymal stem cells (adipocytes). In the future, these properties may allow for the design of a microdevice to effectively sort hMSCs into pure cultures of their differentiated progeny.

23. Mapping the Past to Inform the Future: GIS and 3D Modeling for Watershed Management

Presenter(s): Emily Oppliger, Civil Engineering
Faculty Advisor(s): Don Lafreniere, Social Sciences and Alex Mayer, Civil and Environmental Engineering

Introduction:

Throughout history, a relationship between urban infrastructure and watershed environments has evolved. Urban watersheds are constantly changing due to human interaction and development. Streams, rivers and inland lakes are continuously physically and chemically altered due to commercial development. By pulling back the curtain of historical data of an urban watershed, the changes in physical properties are recognized and analyzed to define the effects. This research provides essential insight into the history of the Huron Creek watershed landscape through 3D modeling. These models represent a framework for understanding how we will need to approach the important mission of watershed stewardship.

Materials and Methods:

Archival collection for this project was conducted through the Michigan Technological University (MTU) Archives and the United States Geological Survey (USGS). After researching the Huron Creek watershed in the MTU archives by collecting historical news articles, maps, and survey drawings, the background of this specific landscape became defined. The qualitative data was important to understand the background of the area and what aspects affect the watershed's change over time. USGS Topographic maps played the biggest role in this project to create Digital Elevation Models (DEM) of the historic landscape. The historic topographic USGS maps collected are imported and Georeferenced (aligned) and projected over the geospatial data or modern day imagery. Every contour line on the maps was attributed to a corresponding elevation value to create a DEM. These DEMs were used to precisely locate the watershed boundary for each historical year. Once the watershed boundaries were perfected, the DEM files were imported to 3D software as 3D models.

Results and Discussion:

The integration of spatial and temporary data, and the analysis of data over time gives a unique contribution to create a geospatial model of the past urban creek over time. These models provide a virtual learning tool that reveals the true history of an urban watershed landscape. Historic landscape re-creation provides value to heritage, watershed management, tourism, and environmental protection.
The mining companies within its boundaries and the commercial development in Houghton immensely impacted the Huron Creek. These impacts on the watershed boundary can be recognized through the 3D models. Between every model year a change occurred; sometimes very small and others very large. The importance is to understand and recognize our impacts on the environmental landscape through 3D re-creation.

24. Intergrowth Texture of Fe-Si Intermetallic Compounds in a Fulgurite from Central Lower Michigan

Presenter(s): Ruth Oppliger, Geological Engineering
Faculty Advisor(s): Dr. Christopher Stefano, AE Seaman Mineral Museum

Introduction:

A fulgurite is a natural glass that is formed when lightning strikes sand, soil, or rock. During the formation process, it is estimated that temperatures can exceed 2000 K. Extreme temperature combined with organic matter in the soil may result in highly reducing conditions. These extreme conditions effectively smelt the soil, producing unmixed iron silicides among other compounds. This research project studied a 14 cm diameter fulgurite that was formed in sandy, glacial till in 2014 near Houghton Lake, MI.

Materials and Methods:

Spherical grains of iron silicides were separated from the natural glass and studied using the Scanning Electron Microscope. Back-Scattered Electron images of these spheres showed a unique texture that is hypothesized to result from a slow cooling and crystallization process with in the fulgurite.

Results and Discussion:

This project is exploring the geochemical processes during fulgurite formation by attempting to understand the conditions responsible for the observed texture.

25. Characterization of the Effect of Test Temperature on the Strength of Al-Sc-Zr Alloys

Presenter(s): Emily Petersen, Materials Science & Engineering
Faculty Advisor(s): Dr. Paul Sanders, Materials Science and Engineering

Introduction:

Aluminum's desirable strength-to-weight performance has lent to investigation by the greater materials science community into new alloying elements and strengthening effects, particularly in systems at elevated temperatures. Several mechanisms can be employed in aluminum systems that restrict deformation. Precipitation hardening is a heat treatment technique intended to increase yield strength of ductile materials such as aluminum. In this investigation, hardness and compression testing have been performed on Al-Sc-Zr specimens heat treated at 200, 250, 300 and 350°C as the first steps in developing a profile that characterizes materials strength in relation to test temperature.

Materials and Methods:

Eight Al-Sc-Zr specimens were heat treated at 200, 250, 300 and 350°C where two samples were treated for each temperature. Vickers hardness testing was performed at five points along each sample using 1kg load. An optical microscope at 10x magnification was used to observe all samples with the exception of the two samples heat treated at 350°C which was observed at 5x magnification. The diagonals were recorded and averaged in order to determine Vickers hardness values. Compression testing was done on one sample of each temperature group. The samples heat treated at 200, 250 and 350°C were preloaded with 350lbs and tested at 2% strain. The sample treated at 300°C was preloaded with 100lbs and tested at 10% strain.

Results and Discussion:

Most aluminum alloys are restricted to low temperature usage due to dissolution or precipitate coarsening; however, together with scandium and zirconium, coherent Al3 (Sc, Zr) precipitates form. The introduction of zirconium reduces lattice mismatch, resulting in a lower coarsening rate. Hardness results indicate reasonable resistance to plastic deformation, a promising sign of successful precipitate formation at each test temperature. Compression testing is intended to yield increased dislocation density which will be analyzed through transmission electron microscopy in the coming weeks.

26. 3D Printing Prosthetic Hands for Children in the Developing World

Presenter(s): Jill Poliskey, Materials Science and Engineering
Faculty Advisor(s): Dr. Joshua Pearce, Materials Science and Engineering

Introduction:

People who are missing their fingers or arms below the elbow can benefit from 3D printed devices developed by e-NABLE. They are especially helpful for children who do not normally have the option of traditional prosthetic devices due to cost or time. The basic e-NABLE design is customized and can be 3D printed on location. The e-NABLE project works fantastically for most children in need. However, some locations, like those of our project partner in Nicaragua, pay incredibly high import tariffs on 3D printing filament, which makes this method uneconomical and leaves the poorest of the children in need.

Materials and Methods:

This project encompasses testing different inexpensive accessible filaments to be used in underdeveloped countries for 3D printing. Enabling the Future will be using these filaments to 3D print prosthetic hands for children. The project involves optimizing parameters for 3D printing with different commercially-available polymer materials, including nylon weed whacker line, and testing these samples to see if their properties are suitable for prosthetic hands. The first step is to figure out how to print with these different materials, which implies finding the correct temperature, rate of extrusion, layer height, etc. which are different from the settings for the standard 3D printing filament, i.e. PLA and ABS. The next step is to test these prints for different properties like tensile strength. The final step is to make test prints of the prosthetic hands Enabling the Future uses for specific people, and give the organization the information collected to print them with the different materials. This will help to open many opportunities for 3D printing in places like Nicaragua.

Results and Discussions:

This research found that printing with nylons like weed whacker string and commercial fishing line do produce high strength prints that could be used for 3D printed prosthetics. However, these materials cannot be printed outside of a fume hood due to possibly harmful gases emitted from the melted filament. Usable 3D printed prosthetic hands were printed using this material following the correct precautions. Our e-NABLE project partner in Nicaragua needed knowledge of how to work a 3D printer and a 3D printer that performs well in Nicaraguan conditions to start producing hands. To achieve this, our partner came to Michigan Tech for a week to build a RepRap Athena 3D printer and learn the technicalities of a 3D printer. In addition, he was given a 3D printer build kit and instructions on how to teach others how to use it. Since then, he has been printing custom prosthetic hands for children in need in Nicaragua and has teamed up with a university there to spread the knowledge of 3D printing. Doing so will hopefully enable people in the future to print their way out of poverty by printing a greater number of practical, usable objects.

27. Investigation of the Effects of Breast Tissue Heterogeneity On Shear Wave Propagation Speed Estimation

Presenter(s): Cal Riutta, Biomedical Engineering
Faculty Advisor(s): Dr. Jingfeng Jiang, Biomedical Engineering

Introduction:

Breast cancer is among the leading causes of death for women in the United States. Research has found that early detection reduces the mortality rates of this disease. There are several early detection methods, each containing pros and cons. This project focuses on ultrasound based Shear Wave Elastography (SWE), which has shown promise as an imaging alternative; however, it still faces a lack of confidence from the clinical community. This project seeks to address some of those concerns and explore SWE potential by analyzing how the image quality is affected by tissue heterogeneity.

Materials and Methods:

An assessment of the influence of tissue heterogeneity on image generation quality can be accomplished via SWE simulation based on a series of open source software packages. To begin, three models of increasing complexity and tissue heterogeneity are required. Next, an ultrasound pushing pulse can be generated and applied to the models. The resulting shear wave can be tracked via ultrasound RF data. The stored wave front arrival time vs. lateral distance data allows the shear wave speed to be estimated. Recall that sound waves travel faster through stiffer material. The calculated variations in shear wave speed provide a representation of the tissue stiffness. There can be interfering factors with this process that decrease the image quality or accuracy, potentially including increasing tissue heterogeneity. The results of the image data based on the three models must be compared to each other to determine if increasing tissue heterogeneity results in a more inaccurate image.

Results and Discussion:

Currently, two models of varying tissue complexity have been generated. Shear wave speed estimation in these models has been accomplished through the use of finite element analysis. The corresponding results were what would be expected when compared to results in the literature. This demonstrates that the simulation platform can perform SWE. Based on the relatively smaller propagation distance the wave traveled before major wave front distortion in the more heterogeneous model, one can find that tissue heterogeneity may indeed be a factor strongly affecting SWE image results due to interference with the shear wave as it propagates through the tissue. This project will continue to simulate SWE on a virtual breast model and assess the measurement quality. In the future, more parameters (e.g. transducer parameter) will be considered to show the effects on the final measurements.

28. Biodegradation of Zinc Stent Material with Oxide Films of Varying Characteristics

Presenter(s): Sara Schellbach, Materials Science and Engineering
Faculty Advisor(s): Dr. Jarolsaw Drelich, Materials Science and Engineering

Introduction:

Current endovascular stents, typically made of stainless steel or cobalt-chromium alloys, are not degradable and are left in the body for many years once implanted, thus increasing the risk of chronic inflammation and late stage thrombosis. Bioabsorbable materials, dissolving inside the body after 6-9 months, could serve as an alternative material. MTU researchers discovered improved corrosion resistance and ductility in zinc alloys over previously tested magnesium and iron alloys. The zinc alloys displayed biocompatibility in past studies, however with non-uniform degradation. A controlled degradation rate for appropriate bioabsorbability of the implants requires an engineered microstructure and surface oxide film.

Materials and Methods:

This work specifically investigates the influence of electropolishing and anodization of zinc material on oxidation film thicknesses and biocorrosion protective characteristics. The biodegradation rate is studied through both *in vitro* and *in vivo* methods. The samples consist of a 0.25 mm diameter pure zinc wire and five samples, 1 mm in length, are required for each of the *in vitro* and *in vivo* methods: one control sample, one electropolished sample and three anodized samples (varying concentrations of anodization solution). A Smithells solution is used for the electropolishing method whereas a 0.1M, 0.3M and 0.5M oxalic acid solution is used for the anodization method.

Results and Discussion:

Visually, the electropolished sample displayed the most uniform corrosion whereas 0.1M oxalic acid treated sample displayed the most non-uniform corrosion. Imaging of the cross sections with the scanning electron microscope (SEM) will better verify the linearity of corrosion on the various samples. At this point in the project, cross-sections of the wires explanted after 2 months of *in vivo* testing are being prepared for SEM imaging and further samples will be explanted after a testing period of 3 months. Once the cross sections have been imaged, an analysis of the corrosion uniformity and total area affected by the corrosion will be evaluated. Obtaining this information from the results will allow a comparison of corrosion between the various wire surface treatments, as well as a comparison of the severity of corrosion after 2 and 3 months.

29. Numerical Solutions of Variable-Size Design Space Benchmark Optimization Problems

Presenter(s): Abbey Senczyszyn, Mechanical Engineering
Faculty Advisor(s): Dr. Ossama Abdelkhalik, Mechanical Engineering–Engineering Mechanics

Introduction:

Variable-size design space optimization refers to the optimization of problems of variable number of variables. This type of problem is found in systems architectures optimization. Benchmark functions were recently developed for variable-size design space optimization problems. These are modifications on standard benchmark optimization functions such that the dimension of the problem is a variable itself. The purpose of this research work is to search for the optimal solutions for these variable-size benchmark functions using enumerate search.

Materials and Methods:

Seven functions previously defined by Jamil and Yang were modified in order to make them of variable size. These functions are: Ackely, Cosine Mixture, Egg Holder, Giunta, Qing, Quintic, and Schwefel functions. A code was developed for each function in Matlab to evaluate the function at all points in a predefined grid. The input values for each variable and the resulting function value were recorded at each iteration. After the data was generated for each function, a second Matlab code was developed to process and plot the results. In order graphically represent the data, each function is plotted versus two of the variables while holding the other variables constants. The optimal solution for each function is shown. The Matlab code also reports other minimum values within a 1% range of the global minimum, which were recorded and summarized in a table format.

Results and DIscussion:

The plots developed graphically represent the function surface for each benchmark problem, and provide a means for quick and easy analysis of the maximum and minimum solution values. Similar to other benchmark functions, these results will be used to test novel optimization algorithms that are being developed by other members of this research team at MTU. Benchmark functions provide an important check and guideline in testing and validating new algorithms.

30. A Quantum Computational Study on the Effects of the Interaction between Magnesium Oxide Nanotubes and Active Pharmaceutical Ingredients on the Quality of Drinking Water

Presenter(s): Angela Small, Physics
Faculty Advisor(s): Dr. Loredana Valenzano, Chemistry

Introduction:

The presence of molecules from active pharmaceutical ingredients (APIs) in drinking water and soil is currently a major environmental and medical concern. Materials and structures able to trap, separate, or inhibit the action of such APIs, in form of membranes for example, must be studied to mitigate this problem. The objective of this project is to address the nature of the interaction between metal oxide-based materials and the most common API molecules found in water such as acetaminophen, codeine, and ethinyl estradiol.

Materials and Methods:

Binding energies between the molecules and MgO(001) nanotubes are determined via single point calculations which are then used to find the zero point energy through a parabolic fit. The magnesium oxide nanotubes consist of forty atoms and have a diameter of approximately 7.0 Å. The molecules are arranged with respect to the nanotube according to different geometrical configurations in the proximity of the base of the tube. This project will employ state-of-the-art electronic structure computational approaches based on density functional theory (DFT), which will allow for the understanding of the physicochemical properties of the interaction of acetaminophen, codeine, and ethinyl estradiol with the mentioned metal oxide species.

Results and Discussion:

After a preliminary investigation of the relative stability of molecular monomers in a water solvated environment, the interaction with MgO(001) nanotubes is addressed. Results from this investigation show that water always stabilizes the structures by roughly 30 kJ/mol.

31. Assessing the Effects of Manipulating Spatial Working Memory Load on Motor Learning

Presenter(s): Tessa Sprague, Exercise Science
Faculty Advisor(s): Dr. Kevin Trewartha, Kinesiology and Integrative Physiology

Introduction:

Learning a new motor skill involves both a fast, and a slow process that allows for rapid, and then more gradual improvements in performance, respectively. Recent research has shown that the fast process can be linked to explicit working memory resources, whereas the slow process may be related to implicit memory. It has also been shown that age-related declines in working memory are associated with impairments in the fast process for motor learning. The current project was focused on further specifying the nature of the memory processes underlying age-related declines in the fast process.

Materials and Methods:

For the current project we recruited undergraduate students to serve as a younger adult control group. These preliminary data provide a baseline against which a subsequent group of healthy older adults will be compared. To assess motor learning participants were asked to perform a well-known sensorimotor adaptation task. Participants made out and back movements to four visual targets arranged around the periphery of a home position while grasping a handle attached to a robot that generates unusual movement-dependent forces at the handle (KINARM, BKIN Technologies). Although the load initially perturbs hand movement, people gradually adapt by producing forces that counteract the load. In the current study participants were randomly assigned to a high or low working memory load condition. In the high load condition the order in which the targets were presented was randomized, whereas in the low load condition the targets appeared in a repeating four-target sequence. Participants also performed a cognitive battery including a verbal paired-associate memory task, a spatial working memory task, a spatial paired-associate working memory task, and an implicit memory task. This battery allowed us to independently evaluate the relationship between spatial, and associative working memory resources with the fast process for motor learning.

Results and Discussion:

The first aim of the current project was to determine if participants would benefit from explicit spatial information when learning a new motor skill. One group of younger adults learned the motor skill while reaching to targets presented in a random order, whereas a second group reached for targets in a repeating four-target sequence. These two groups were compared to test the hypothesis that explicit spatial information about the targets facilitates the ability to learn the motor task.
The second aim of the current project was to investigate whether the fast process for motor learning is more associated with spatial or associative working memory. Correlations between each cognitive test and the rate of motor learning were calculated to test the hypothesis that the fast process is more related to spatial than associative working memory. Combined, the current data establish a baseline of the effect of explicit spatial information on the rate of motor learning, and the correlations between spatial and associative memory resources and the fast process for motor learning. These baseline measures will be used as a comparison for groups of healthy older adults that will be recruited in the second phase of this project to test age-related hypotheses.

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32. Controlled Variable Release of Nitric Oxide Using SNAP-PDMS

Presenter(s): Hugh Stanton, Biomedical Engineering
Faculty Advisor(s): Dr. Feng Zhao, Biomedical Engineering

Introduction:

Nitric Oxide (NO) is one of the most important molecules in the body. It can reduce inflammation and showcases antithrombogenic properties. It can also affect stem cell differentiation and proliferation. This makes it an ideal candidate for future use in tissue-engineered vascular grafts. However, cells have vastly different responses to NO depending on release levels. For example, If the level of NO release is too high, the cells will begin to die. Therefore, a controlled release of NO is required for future work *invivo*.

Materials and Methods:

To begin, 1.6g of polydimethylsiloxane (PDMS) is placed in 4 mL of toluene. 0.3g of (3-aminopropyl) trimethoxysilane (3A3M) are dissolved in 2 mL of toluene. The PDMS and 3A3M are combined and the resulting solution vortexed. A stock solution of dibutyl tin dilaurate using 15 mg in 5 mL toluene is created. 2 mL are placed in the PDMS/3A3M and immediately vortexed. The solution is placed on a stir plate and left overnight to crosslink. The next day 20mg of thiolactone are placed in 2 mL of toluene and then mixed with the cross-linked PDMS and left overnight. Tert-butyl nitrite was cleaned using 30 mM cyclam. 2 mL of clean tert-butyl nitrite were then added. RTV-3140 was mixed with toluene at an equal mass to volume ratio as the SNAP-PDMS. After 60 minutes casting of the SNAP-PDMS began. 4 casts were done at 100%, 75%/25%, 50%/50%, and 25%/75% SNAP-PDMS to RTV-3140. 200 uL of either solution was pipetted out at 15 minute intervals a total of 4 times. Afterwards casts were left in the dark to cure overnight. 10 mm diameter samples are obtained and analyzed using a Sievers 280i Nitric Oxide Analyzer.

Results and Discussion:

Quantitative analysis of the data is still ongoing. It is expected to see NO release to trend higher with increasing SNAP-PDMS to RTV-3140 levels. Samples are also weighed to determine whether the NO release varies more with surface area or mass. Once specific release levels can be controlled for, cells may be cultured atop SNAP-PDMS for determination of specific physiological responses.

33. Prevascularization of a Highly Aligned Nanofibrous Extracellular Matrix Scaffold

Presenter(s): Mitchell Tahtinen, Biomedical Engineering and Statistics
Faculty Advisor(s): Dr. Feng Zhao, Biomedical Engineering

Introduction:

Tissue engineering today has been facing the challenge of developing a tissue construct that contains a vascular network throughout. Without an adequate vascular network, tissues fail due to the diffusion limit of oxygen, which is about 200 μm. Many methods have been attempted to overcome this issue, but each have limitations. The method used in this study is a completely biological approach that would overcome many of the limitations of other methods. A co-culture of human mesenchymal stem cells and human umbilical vein endothelial cells were seeded on an aligned natural scaffold that highly mimics *in vivo* properties.

Materials and Methods:

A decellularized, aligned, fibroblast sheet that was developed by our lab was used as a natural scaffold. Human mesenchymal stem cells (hMSCs) were seeded on the decellularized scaffold at a density of 10,000 cells/cm2 and cultured for 7 days in complete media under hypoxic conditions (2% O2). Human umbilical vein endothelial cells (HUVECs) were then seeded on top of the scaffold at a density of 20,000 cells/cm2 and continuously cultured under normal oxygen conditions (20% O2) for up to 7 days. Immunofluorescent staining was done at days 1, 3, 5, and 7 to visualize the nuclei and vascularization using a DAPI solution and CD31 antibody, respectively. Staining was observed using fluorescent microscopy and quantified using imageJ software.

Results and Discussion:

A vascular network is essential for the long-term survival of tissue engineered constructs. Previous studies have found that a co-culture of hMSCs and HUVECs can obtain a significant vascular network, which is one of the reasons for using those cell types in this study. By day 3 of this study, vascularization was observed with this co-culture on the decellularized scaffold. However, it wasn't until days 5 and 7 that a significant vascular network was observed. BrdU staining was also done to confirm the vasculature formation and positive staining for both vascularization and proliferation was seen at day 7. Therefore, by using a co-culture of hMSCs and HUVECs, we were able to obtain significant vascularization on a decellularized fibroblast scaffold.

34. Avian Community Responses to Stand Age in Northern Aspen Forests

Presenter(s): Gina M. Testa, Wildlife Ecology & Management
Faculty Advisor(s): Dr. David Flaspohler, School of Forest Resources and Environmental Science

Introduction:

As part of an interdisciplinary study of the socio-ecological effects of bioenergy development in northeastern Wisconsin, we examined the response of avian communities to aspen (Populus spp.) stands of differing age, a possible feedstock for biomass power plants in the region.

Materials and Methods:

As part of an interdisciplinary study of the socio-ecological effects of bioenergy development in northeastern Wisconsin, we examined the response of avian communities to aspen (Populus spp.) stands of differing age, a possible feedstock for biomass power plants in the region.

Results and Discussion:

Avian community assemblages were strongly associated with each stand age class between young (<15 yrs), middle (20-45 yrs) and old stands (45 yrs+). Species richness varied among stand age, with young, middle, and old-aged stands having an average richness of 33.5 (SE ± 0.33), 28 (± 0.22) and 26 (± 0.49), respectively. Avian abundance was highest in the young stands and lowest in the middle-aged stands. The Nonmetric Multidimensional Scaling ordination resulted in a two-dimensional solution with a final stress of 6.12.

High relative abundance and species richness suggests that young aspen stands are important habitat for migratory birds, but it does not discount the importance of old-aged aspen stands. The Nonmetric Multidimensional Scaling ordination revealed that avian community assemblages were strongly associated with each stand age class, suggesting that the elimination of a given age class, or an extreme alteration in stand age distribution across the landscape due to shortened rotation lengths may have an effect on avian communities across the landscape."

35. Design, Construction and Testing of Rugged Non Planar CNT Transducers to Match Audio Amps and Improve Efficiency

Presenter(s): Stephania Vaglica, Mechanical Engineering
Faculty Advisor(s): Dr. Andrew Barnard, Mechanical Engineering–Engineering Mechanics

Introduction:

Carbon nanotubes are hexagonal latticed tubes of carbon that have diameters one ten thousandth of the thickness of human hair. These graphite allotropes of carbon have a range of different applications and properties, particularly thermoacoustic conductivity. Because of their unique thermoacoustic properties, a lightweight loudspeaker can be designed by creating an aligned film of carbon nanotubes. The nanotube film has extremely low surface mass density and can create cascade failure when approaching the maximum power density. The greatest asset of using carbon nanotubes in speakers is their lightweight property. The purpose is to create a unidirectional transducer that has the resistance and efficiency of an 4 Ω loud speaker.

Materials and Methods:

Materials needed to fit the criteria of the following properties: high temperature rating, immense electrical insulation, low acoustical absorption, low creep, low thermal expansion, and fall within geometric parameters. Three materials could potentially act as surrogate materials: Boron Nitride (BN), Teflon (PTFE), and MACOR. After ordering material, a mechanism for spinning the CNT onto the cylinder had to be constructed. In order to determine the size of the cylinder, and optimization code was created in MATLAB. This code would optimize the speaker for any desired resistance (in Ohms) and any cylinder diameter. The code would then output the required number of electrodes, height, and other design variables to the user. The speaker dimensions were optimized, and different electrode configuations were researched. It was found that copper tape was good for close contact, and flexible enough to be cut to the required electrode size. The prototypes were then built and tested.

Results and Discussion:

It was then concluded that Teflon (PTFE) was the best material as it has high electrical conductivity, was inexpensive, and could be ordered to any size. The speaker itself was found to be 3 Ohms at a low power input. At high power, the speaker was found to have an impedance of 5-6 ohms, which is well within the target limit. The current models of the planar speakers have a resistance of 150 Ohms which makes it difficult to input a lot of power. It was found that these speakers could be optimized to have a resistance of 4-8 Ohms. The speaker itself was unidirectional around the cylinder of the speaker and could emit sound in all directions. Further research of these omnidirectional speakers are currently being researched and developed as well. Spherical speakers are the next step and if achieved, the spherical speakers could potentially be used as omnidirectional sources used in architectural acoustics.

36. Legacy Disturbance Effects in a Lake Littoral Zone: Effects of Stamp Sands on the Structure of Macrophyte Communities in the Keweenaw Waterway of MI

Presenter(s): Ryan Van Goethem, Biology
Faculty Advisor(s): Amy Marcarelli, Biological Sciences

Introduction:

Large-scale disturbances can cause legacy effects on community structure and invasibility in lake littoral zones. The Keweenaw Waterway was subject to multiple large-scale disturbances including altered hydrology, dredging of shipping channels, and copper mining from 1855-1968 in which, 34 million metric tons of heavy metal-rich residues (hereafter stamp sands) were deposited into the waterway. Aquatic macrophyte communities, the underwater forests, may be impacted by stamp sand deposition via heavy metal toxicity and altered sediment characteristics. If so, macrophyte communities may be more readily invaded by non-native Myriophyllum spicatum and hybrid M. spicatum x sibricum, first identified in the waterway in 2012.

Materials and Methods:

In July - August 2015, a field study was conducted to test the hypotheses that 1) stamp sands alter the composition of macrophyte communities due to sediment characteristics and copper toxicity, and 2) Myriophyllum species distribution will be different between non-stamp sand and stamp sand sites due to invasibility of sites. Macrophyte distributions were determined by prior surveys and 15 stamp sand and 15 non-stamp sand sites were randomly chosen within areas where macrophytes were observed. Macrophyte species were collected using a twist rake for biomass and watermilfoil specimens were collected for genetic analysis when present. Sediment samples were obtained using a corer and analyzed for heavy metals and sediment characteristics. Water samples were collected for water chemistry and general limnological characteristics (e.g., water clarity, depth, temperature) were recorded on site.

Results and Discussion:

It was observed that stamp sand deposits were mostly devoid of macrophytes during the pre-surveys; however, total macrophyte biomass, diversity, species richness, and coefficients of conservatism did not significantly differ between site types when macrophytes were present. At the taxonomic level though, differences were apparent. Vallisneria americana was the most common macrophyte observed and 1/2 as dense at stamp sand sites. Potamogeton richardsonii and Potamogeton gramineus were 5.3 and 6.4 times denser at non-stamp sand sites. Non-native M. spicatum was only found at stamp sand sites, while hybrid M. spicatum x M. sibricum was found at both site types, but was 7.2 times denser at non-stamp sand sites. These results suggest that legacy disturbance may impact littoral macrophyte communities by altering states of species composition and promoting the invasion of non-native species. Current work is underway to determine the relative roles of sediment chemistry, heavy metals, and texture on these dynamics. Understanding these mechanisms of disturbance will improve the understanding of macrophyte communities for possible reclamation of aquatic littoral zones and the management of non-native Myriophyllum species in the Keweenaw waterway.

37. The Effects of Increased Anthropogenic Nitrogen on Plant Characteristics and Herbivory

Presenter(s): Virginia van Vianen, Biological Sciences
Faculty Advisor(s): Dr. Erika Hersch-Green, Biological Sciences

Introduction:

Plant productivity is often limited by soil nitrogen (N) availability, and N fertilization usually results in increased productivity. Globally, human activities have dramatically increased soil N availability, yet almost nothing is known about how increases in soil N availability affect plants indirectly through altering their interactions with other species. Insect herbivores consume plant tissues and most often have negative fitness consequences for plants, although herbivory can also have null or even positive effects on plant fitness. We examined how changes in N availability influenced resistance to herbivory and characteristics related to reproductive fitness in four different plant species.

Materials and Methods:

We grew 45 replicates of four different native wildflowers species in the summer of 2015, where a third of each species received one of three nitrogen treatments (2, 60, and 600 ppm, 180 total plants). To estimate plant fitness and growth the research group measured bud, flower, and fruit number, and flower size biweekly and collected pollen and nectar samples from flowers when feasible. At the conclusion of the experiment, 1-3 seed pods were collected, and the total number of seeds per plant was estimated. Plants were harvested and dried to obtain dry above-ground biomass measurements.
To estimate plant resistance, leaves from each treatment were placed into petri dishes either alone (no choice trials) or with leaves from all three N treatments (choice trials) along with an insect herbivore. Herbivores were allowed to feed for 48 hours and then leaf samples were scanned to determine total area consumed. Insect herbivory damage was estimated by bagging half of the plants of each species by N treatment and placing two insects inside the bags, allowing them to feed for 48 hours and visually estimating total leaf area consumed. In all experiments, a generalist insect herbivore, Spodoptera exigua was used.

Results and Discussion:

At the completion of this project, three major conclusions were drawn. First, increased soil nitrogen availability leads to increased damage susceptibility. This was demonstrated in all three herbivory experiments. In the no choice petri dish trials, only one species showed increased susceptibility with increased N, and in the bag trials, only two species showed this. However, in the choice petri dish trials, all four species showed increasing damage with increased nitrogen. It was also found that increased soil nitrogen availability was associated with increase in various fitness traits for all four species. Greater seeds, fruits, and aboveground biomass were all associated with increased nitrogen in different species. In one species where nectar was measured, increased N was also associated with higher nectar amounts and concentrations. The other major finding was that herbivory damage had mixed effects on fitness traits. In two species herbivory was not associated with any fitness metric; in one species herbivory was associated with lower seed production and aboveground biomass; and in one species, herbivory was associated with higher seed production.

38. Muscular Contributions and Coordination During Upper-Body Tasks

Presenter(s): Ashley VanSumeren, Exercise Science and Biomedical Engineering
Faculty Advisor(s): Dr. Steven Elmer, Kinesiology and Integrative Physiology

Introduction:

Muscles in the upper-body are important when performing many functional tasks, including manual labor, sport activities, and manual wheelchair locomotion. While upper-body tasks involve recruitment of arm, shoulder and trunk muscles, muscles in the lower body may also be important. Previous authors have reported that the lower body muscles contribute substantially to standing arm-cycling performance by elite sailors, as well as double-poling performance by cross-country skiers. These results suggest that the lower body plays a critical role during upper body tasks. The purpose of this study was to identify the contribution of arm, trunk, and leg musculature to submaximal and maximal arm cycle performance.

Materials and Methods:

Five healthy Michigan Tech students (3 males and 2 females) performed three seated arm cycling conditions. For the 'normal' condition, participants performed arm cycling, using their arms and trunk and legs for stabilization. For the 'restricted legs' condition, participants performed arm cycling using their arms and trunk, while the legs were restricted. For the 'restricted trunk and legs' condition, participants performed arm cycling using only their arms, while trunk and legs were restricted. Part 1: For each experimental condition, participants performed a maximal arm cycling trials (~4 seconds) to determine maximum neuromuscular power. Part 2: To be completed. Participants will also perform a submaximal arm cycling test until voluntary exhaustion to determine upper-body peak oxygen consumption (VO2peak), along with heart rate, ventilation, energy cost, and rating of perceived exertion. A repeated measures ANOVA was used to compare differences in maximal power across the three experimental conditions, and will be also used to compare differences in VO2max, once those data are collected.

Results and Discussion:

Results from Part 1 indicate that when the legs were restricted maximum power decreased by 22 ± 6% (556 ± 201 vs. 423 ± 134 Watts, $p < 0.01$). In addition, when the trunk and legs were restricted, power decreased by 26 ± 6% (556 ±201 vs. 402 ± 130 Watts, $p < 0.01$). Note that results obtained from Part 2 of the study will provide additional insight as to how the muscles of the arm, trunk, and legs impact upper-body VO2peak. These results suggest that the muscles of the trunk, and the lower body especially, play a critical role during maximal arm cycling. Results from this study support and extend upon previous studies that evaluated the contribution of the lower body to standing arm-cycling and cross-country skiing. This information can be applied to sport training, clinicians who prescribe upper body exercise to improve health in clinical populations (e.g., COPD, advanced age, cardiac rehab), and wheelchair locomotion.

39. Optimization of Adhesive Polymer in Wound Healing Hydrogels

Presenter(s): Randall Wilharm, Chemistry
Faculty Advisor(s): Dr. Bruce Lee, Biomedical Engineering

Introduction:

Many current methods of wound healing involve inorganic bindings that add no mechanical support to the wound. Those that do are permanent and must either be removed, or remain with the patient. Current adhesives have difficulty binding to the wet interior of the body. Hydrogels integrated with an adhesive based on marine muscles have the potential to solve all of these problems. These muscles produce a protein (DOPA) that contains a catechol (diphenyl) functional group, which is the basis for the adhesive polymer of the hydrogels. This project focused on the production and optimization of the adhesive polymer.

Materials and Methods:

The polymer has three parts: a hydrophilic polyethylene glycol derivative backbone, a hydrophobic polyester bridge (polycaprolactone derivative) for structural support, and an adhesive catechol (dopamine). This project included the synthesis of two preliminary compounds, polycaprolactone diglycine (PCL diGly) and 4-armed polyethylene glycol glutaric anhydride (PEG Glu), to them be combined with dopamine to synthesize the final adhesive polymer. There were two types of criteria this project focused on to measure the success of a synthesis: purity of product and yield of product. The purity was tested using NMR and UV-Vis spectroscopy. Additionally, mechanical tests were employed on hydrogels using the adhesive polymer. The yield was tested using percent yield of the synthesis in conjunction with NMR and UV-Vis data. UV-Vis data was used to find the dopamine concentration in the final polymer by comparing the absorbance by concentration (mg/mL) to a standard curve of pure dopamine.

Results and Discussion:

Improving the purity of the polymer is important so that correct polymerization may occur when integrating into hydrogels, as well as obtaining the highest amount of adhesion. In this project, purity not only relates to the amount of contaminants, but also the ratio of each component (1 PEG: 1 PCL: 2 dopamine). Preliminary batches showed low coupling of the dopamine and high coupling of the PCL. This problem was addressed and fixed by adjusting reaction conditions and component synthesis. Improving the yield of the synthesis, although not as vital as purity, is important when creating larger batches of hydrogels. Average yields were increased from around 50% to over 90% through the course of this project.

40. Vision Based 3D Pose Estimation and Homography for Unmanned Aerial Systems

Presenter(s): Chris Wilkerson and Nopparuj Saipong, Computer and Electrical Engineering
Faculty Advisor(s): Dr. Timothy Havens, Electrical Engineering

Introduction:

Unmanned Aerial Systems (UAS) are replacing humans in applications ranging from infrastructure mapping to military convoys. Traditional GPS-based systems are limited by the small size of many common commercially-available Unmanned Aerial Vehicles (UAV). This work aims to develop fast and robust algorithms for real-time localization of the UAV using a small mounted camera.

Materials and Methods:

There are two main algorithms that were used during these tests. The first algorithm estimates the platform localization using an affine transformation. The second algorithm performs real-time platform tracking using perspective-n-points (pnp) techniques. These algorithms are implemented using the open source OpenCV library. Models and basic mounted camera platforms were used to simulate the UAV platform and demonstrate the functionality of the algorithms

Results and Discussion:

The research is still ongoing so at this time there are no end-all findings. If the research goes as predicted, this could be applied to many areas such as government, surveying, autonomous exploration, etc. The ability to accurately depict the location of the UAV along with the platform in 3D space is anticipated.

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41. Development of Reagents for Chikungunya Virus Vaccine-Related Research

Presenter(s): Justin C. Workman, Biological Sciences Pre-Professional
Faculty Advisor(s): Dr. Ebenezer Tumban, Biological Sciences

Introduction:

Research on the Chikungunya virus (CHIKV) is growing due to an urgency for the discovery of a vaccine. The virus originated in the Eastern Hemisphere and is known to cause musculoskeletal pain. Genetically displaying an epitope of CHIKV (E2EP3) on coat proteins, via insertion at two different locations, is important to the discovery of virus-like particles (VLPs) decorated in a fashion that initiates a strong immune response against the infection. In order to create VLPs, assemblage of recombinant E2EP3-QB proteins must occur in a specific manner. This research includes the observed expression of proteins associated with CHIKV.

Materials and Methods:

A Real Time Polymerase Chain Reaction RT-PCR was used to amplify the CHIKV DNA. The presence of DNA was observed by electrophoresis in a 1% agarose gel. The DNA was extracted, and then digested using proper restriction enzymes. The digested CHIKV DNA insert was ligated to a digested vector to create a plasmid. Next, a heat shock transformation technique was used to clone the DNA in bacterial C41 competent cells. Cultures were grown on solid Luria Bertani (LB) growth media containing Kanamycin antibiotics. Cultures were then grown in a liquid LB growth media, also containing Kanamycin, and induced with IPTG for protein expression. Once protein expression was confirmed on SDS page gels, the culture growth and induction was repeated in different volumes for the creation of VLPs. Purification of VLPs involved a precise method of cell lysis, pelleting by centrifuge, and re-suspension of pellets with various solutions. Samples of the lysis and supernatants were collected for each construct in order to observe the expression of proteins once again on SDS page gels.

Results and Discussion:

Insertions of E2EP3 at each of the two locations on the coat protein did not affect the expression of coat proteins. Expression was observed after cloning the DNA on SDS page gels. However, insertion at the N-terminus affected the assembly of the recombinant E2EP3-QB coat proteins into VLPs. The proteins were determined to be non-soluble in solution during the purification of VLPs. The effect of E2EP3 insertion at the AB-loop is currently being assessed. E2EP3 cannot be displayed by N-terminal genetic insertion on the surface of VLPs.