Michigan Technological University

Undergraduate Research Symposium

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1. Nitric Oxide Releasing Composite Hydrogels for Tendon Repair via Matrix Metalloproteinase Controlled Pathways

Student Presenter: Kaylee Meyers, Biomedical Engineering
Faculty Advisor: Rupak Rajachar, Biomedical Engineering

Introduction:
Tendinopathy is typically the result of excessive overloading, which can affect normal tendon architecture and tenocyte morphology through the degradation of the extracellular matrix (ECM). Currently, acute and chronic tendinopathy injuries are treated with moderately effective reconstructive surgeries and anti-inflammatory steroids. In this work, we have assessed the ability of our novel NO releasing hydrogels to activate ECM-degrading enzymes known as matrix metalloproteinases (MMPs) so we can eventually control the biphasic regulatory relationship between NO and MMPs to promote more stable wound healing.

Materials and Methods:
In order to develop a tendon-specific model system, polyacrylamide (PAM) substrates of varying relative stiffness (20, 100, and 150kPa) were synthesized by dissolving acrylamide, an initiator, and various weight percent of a bis-acrylamide-crosslinker in deionized water. The gels were then polymerized by UV crosslinking under nitrogen. To provide a PAM surface that allows for tenocyte adhesion and growth, gels were directly coated with Type I collagen using chemical functionalization with a hetero-bifunctional crosslinker. Proliferation, viability, and morphology of tenocytes seeded on PAM matrices were assessed using fluorescent live/dead assays, DAPI, scleraxis, and phalloidin fluorescent staining, and cell shape factor quantification. Previously developed western blot and zymography protocols were used to evaluate the time dependent expression and activation of MMP-9 with tenocytes exposed to relatively low and high NO concentrations and seeded on varying PAM substrate stiffness. Threshold doses of NO in which MMPs were activated in response to varying substrate stiffness was also determined.

Results and Discussion:
In this work, we have synthesized a biocompatible, adhesive, injectable hydrogel composite that serves as a provisional matrix and delivery vehicle for NO. One of the physiologically relevant effects of NO is the activation and inhibition of MMPs that degrade network collagens and extracellular matrix (ECM) proteins. The regulation of MMPs and their inhibitors (TIMPs) is required to maintain ECM homeostasis as failure can result in damaged ECM, leading to tendinopathy. Overall, the goal of this study was to determine if matrix stiffness influenced the time dependent activation and expression of MMP-9 in response to controlled NO release. Results from this work will be used in future experiments to regulate the activity of MMPs and optimize the delivery of NO with our NO releasing polyethylene glycol (PEG)-fibrinogen adhesive-hydrogels to promote stable wound healing in in vivo tendon wound healing models.

2. Carbon Dioxide Sequestration at Michigan Tech Steam Plant

Student Presenter: Sam Root, Chemical Engineering
Faculty Advisor: Komar Kawatra, Chemical Engineering

Introduction:
Carbon dioxide, a byproduct of combustion reactions and industrial processes, is a greenhouse gas linked to climate change. Capture and sequestration of CO2 from emission sources is expected to slow the increasing concentration of atmospheric CO2. Current CO2 capture technology and sequestration methods are costly. Aiming to make sequestration of carbon dioxide a profitable venture, we have developed novel technology to capture CO2 using at lower cost, and sequester CO2 in a value added application.

Materials and Methods:
We have studied the capture of CO2 using sodium carbonate scrubbing solutions in a pilot scrubbing column. To do this, we have simulated flue gas by combining CO2 and compressed air. Real flue gas has impurities such as SO2 and NOx not accounted for in our simulated flue gas. To study CO2 capture from a real flue gas, an identical pilot scale scrubbing column was installed in the Michigan Tech steam plant. Aiming to increase the efficiency and decrease the capital cost of CO2 capture, we have added frothers to the scrubbing solution in order to increase the interfacial area available for CO2 transport. Upon regenerating the captured CO2, we have studied two sequestration methods. The purified CO2 has been used to neutralize red mud, a caustic byproduct of aluminum production. Doing so not only reduces the hazards of storing the waste material, but also shows potential to make extracting valuable minerals from it possible. Another sequestration method is electrochemical reduction to value-added products. By bubbling CO2 into a carefully selected aprotic electrolyte-solvent system, we are investigating converting CO2 to useful, non-volatile compounds, such as oxalic acid.

Results and Discussion:
To quantify CO2 capture effectiveness, the molar ratio of CO2 captured to carbonate absorbent used was compared between experiments conducted in the lab and in the

steam plant. On average, the single pass capture ratio is reduced by 25% when capturing real flue gas. This reduction comes from impurities complexing with the absorbent. The addition of frothers to the scrubbing solution greatly increases the interfacial area in the scrubbing column. Since the CO2 capture reaction rate is mass transport limited, we see the effectiveness of the scrubber increase drastically. Starting with a simulated flue gas of 16% CO2 an ordinary scrubbing solution reduces the CO2 content to 8%. By enhancing the scrubbing solution with a frother, the CO2 content can be reduced to 0.1%. This novel technique could reduce the footprint and capital cost of a CO2 capture system. By bubbling CO2 into red mud, its pH can be reduced from 13 to 10, simultaneously sequestering the carbon in a non-volatile form, and minimizing the caustic hazard of red mud. CO2 has been successfully converted into oxalic acid, however the efficiency must be increased in order for the process to be efficient.

3. Accelerated Boundary Integral Treecodes

Student Presenter: Satyen Dhamankar, Chemical Engineering
Faculty Advisor: Benjamin Ong, Mathematical Sciences

Introduction:
Dynamic properties of classical system are evaluated using regularized kernels. Algebraic regularization of kernels results in a modelling error that is undesirable, and reducing perturbation size results in restricted time-steps. A fast summation algorithm to reduce computational cost are used for these enumerations. Finding a recursive relationship between the derivatives for the fast summation and reducing computational expense further is the goal.

Materials and Methods:
Papers on implementing treecodes and observing functions using symbolic languages to see patterns between them.

Results and Discussion:
A recurrence relationship between the derivatives of the kernel exists and was found. The Taylor approximation (evaluated in fast summation) converged to the regularized kernels as number of terms in the Taylor expansion was increased. As perturbation size was decreased, force computation converges to force from non-regularized kernels. The treecode will be implemented in C++. A similar approach will be used for the two-parameter family of the Helmholtz kernel.

4. Rapid Evaluation of Wire Arc Additive Manufacturing of Aluminum-Scandium Alloys Using Desktop Open Source 3-D Printers

Student Presenter: Craig Ekstrum, Materials Science and Engineering
Faculty Advisor: Joshua Pearce, Materials Science and Engineering

Introduction:
Wire arc additive manufacturing (WAAM) has immense potential to reduce lead time and provide material savings for structural aerospace components. However, WAAM processed alloys will need to still achieve the high yield strength and low defect-inclusion standards of aerospace materials. One of the candidate aluminum (Al) alloy families for this process is 5000 series Al alloyed with scandium (Sc). This is due to Sc being the most efficient strengthener (by wt%) of Al alloys and improving weldability of Al alloys. This research seeks to investigate how microstructure, hardness, and defect distributions vary across multi-layer depositions of 5000 series Al-Sc alloys.

Materials and Methods:
5000 series Al wire containing aluminum was manufactured by casting billets of alloy, extruding those billets into rod, and drawing the rod into 0.035” wire. To generate representative WAAM depositions, an open source WAAM printer was fabricated. The system comprised of a cartesian axis CNC frame with a welder affixed to the mandrel carriage, allowing for 3-dimensional weld depositions. This system was used to deposit successive layers of weld beads of the material on aluminum plate substrates to generate 3-dimensional volumes of Al-Sc alloy. 4047 Al multi-layer welds were also made for comparison. Hardness profiles, density, and microstructural imaging of multi-layer from substrates to the top of the depositions were measured to understand how mechanical properties, microstructure, and pore distribution change with multiple layer depositions. Vickers macro and micro hardness, Archimedes density, and optical microscopy of cross-sections of welds were implemented to study these weld characteristics.

Results and Discussion:
This research is ongoing. WAAM provides a unique heat treatment history to material that has already been deposited, with cyclical high-temperature cycling with each layer’s deposition. Additionally, the cooling rate experienced by each layer changes due to changes in heat flow path geometry and length. Characterizing the implications of this

thermal cycling is a central focus of this study. The findings from this study will be applicable to aerospace companies developing WAAM processes and alloys. Additionally, the demonstration of a low-cost open source WAAM printer will be important for lowering the barrier to entry for WAAM research in the academic community.

5. Processing of Porcine Internal Mammary Arteries for Human Bypass Graft Applications

Student Presenter: Kelsey LeMay, Biomedical Engineering
Faculty Advisor: Jeremy Goldman, Biomedical Engineering

Introduction:
The goal of this project is to create a human compatible bypass graft from porcine internal mammary artery. This will be achieved through selective decollagenization and decellularization of the artery. This graft would offer an alternative to using a patient's saphenous or internal mammary artery. Decellularization would minimize negative immune response from the foreign graft material and increase the shelf life. Through de-collagenization, the internal arterial surface will gain optimal blood contacting characteristics. With these processes, a natural vascular graft will be created with long shelf life and optimal mechanical properties to serve as a replacement vessel in urgent cases.

Materials and Methods:
There are two phases to processing the porcine artery, (1) decollagenization and (2) decellularization. Collagen is removed from the artery via perfusion of acetic acid at different pH and perfusion time. Thus far, repeated trials using different concentrations of acetic acid ranging from 0.1M to1M and times ranging from 10 minutes to 3 hours have been performed. For the perfusion treatment, the porcine arteries are placed in a chamber that is connected to a pump. Control samples are taken from each vessel prior to cannulation into the perfusion system. The arteries are completely submerged under fluid. Acetic acid of specified molarity is perfused through the lumen of the arteries for a specified amount of time. After treatment, the arteries are removed and snap frozen in liquid nitrogen for cryosectioning and histological staining. Samples are cross sectioned in a cryostat to a thickness of 8μm and placed on microscope slides. Histological samples are stained with Verhoeff–Van Gieson (VVG) to identify elastin and collagen

within the vascular layers. Lastly, each sample is imaged with a light microscope to view the effects of the acetic acid processing on the structural integrity of the artery.

Results and Discussion:
This research is currently ongoing. Once the optimal strategy for selectively removing the luminal collagens is determined, the grafts will be treated to remove cellular components. Multiple freeze/thaw cycles will be used to remove cellular components by disrupting cellular DNA. The coverage of DAPI signal (fluorescent DNA stain) in each specimen will be measured in ImageJ software. The effectiveness of removing cell DNA will be assessed again by DAPI staining and statistical comparisons among the different treatment conditions. After removing collagen and cellular components, the grafts will be tested using several methods. Mechanical testing, including tensile testing and burst pressure, will be compared statistically between grafts that received different treatments and an untreated control graft. An ELISA (enzyme-linked immunosorbent assay) will be used to quantify the amount of collagen retained in the grafts. A platelet activation test will also be used to test the collagen-depleted surface. In this test, non heparinized rat blood will be spread upon the surface of the graft to quantify the clotting responses. After the processing protocol is developed, and an optimal graft is created, we will implant them using a rat vascular engraftment model.

6. Fast Manifold Updates for Non-stationary Data Streams

Student Presenter: Anthony Marcich, Applied & Computational Mathematics
Faculty Advisor: Benjamin Ong, Mathematical Sciences

Introduction:
We use dimension reduction to process, visualize, and understand high dimensional data. Our work efficiently reduces the dimensionality of a large data stream while assuming its distribution can undergo drastic changes.

Materials and Methods:
Our work was implemented in NumPy, a numeric Python package. We maintained a Git repository to control version history of the software library we have been building.

Results and Discussion:
We initially built a method that would find low dimensional representations of data clusters using Principal Component Analysis (PCA) approximations. We then implemented algorithms that could cheaply update or downdate (remove data from) each approximation using Singular Value Decomposition (SVD) modifications. Through

testing we discovered it would be necessary to recenter each approximation about the cluster mean, which we formulated as another SVD modification. Further work may attempt using our results with multiscale analysis or finding a nonlinear low dimensional embedding to visualize data streams. We presented a poster of our results at SIAM Computational Science & Engineering 2019.

7. Controlled Breathing and Autonomic Cardiovascular Control

Student Presenter: Stephanie Jewell, Biomedical Engineering and Mechanical Engineering
Faculty Advisor: William Cooke, Kinesiology and Integrative Physiology

Introduction:
The autonomic nervous system provides insight into overall health and can be monitored through sympathetic and parasympathetic responses to stimuli. Heart rate and intervals between heart beats are influenced by respiratory rate; therefore, it is possible to influence autonomic activity by modulating respiratory frequency. Previous studies have suggested that respiratory frequency does or does not affect autonomic rhythms. Differences may be related to methodology, such as breathing either to auditory or visual cues. The purpose of this study was to document autonomic and cardiovascular effects of breathing to auditory versus visual cues.

Materials and Methods:
Twenty young, healthy adults (10 M, 10 F, 23±0.8 yr) participated. We recorded data from subjects laying in a semi-recumbent position. We recorded the electrocardiogram, beat-by beat arterial pressure (finger plethysmography), and muscle sympathetic nerve activity (peroneal nerve microneurography, MSNA). Subjects rested quietly for 5 minutes and breathed at their normal breathing frequency. Subjects were randomized between breathing with auditory and visual cues after baseline. For auditory cues, the subject breathed with a metronome at a frequency of 15 breaths/minute for 5 minutes. For visual cues, the subjects breathed with a periodic waveform on a computer display that prompted them to breathe at a frequency of 15 breaths/minute. Variables were assessed with repeated measures ANOVA. Data are expressed as means±SE. Heart rate variability was quantified by the percentage of R-R interval that varied by 50 ms or more (pNN50). MSNA was quantified by burst per 100 heart beats.

Results and Discussion:
The data show that controlled breathing using visual cues increases vagal cardiac activity compared with uncontrolled breathing and auditory cues (pNN50: uncontrolled 32±4.6; auditory 38±5.5; visual 41±5.6; $p<0.05$). Controlled breathing, using either auditory of visual cues, reduces MSNA compared with uncontrolled breathing (MSNA: uncontrolled 18±2.5; auditory 14±2.0; visual 13±2.0; $p<0.05$). Subjectively, 86% of subjects identified auditory cues being more stressful to follow than visual cues.
Our data suggest that investigators studying autonomic cardiovascular control might consider using visual rather than auditory cues. Vagal activity is higher with visual cues, and subjects perceive the stimulus to be easier to follow.

8. 3D Bioprinting with Induced Pluripotent Stem Cells and GelMA

Student Presenter: Alicia Ball, Chemical Engineering
Faculty Advisor: Parisa Abadi, Mechanical Engineering-Engineering Mechanics

Introduction:
According to the American Heart Association, heart disease is the number one killing illness in the United States. With the ability to reconstruct tissue and produce cells, such as the cardiomyocyte cells found in the heart, we can counteract this disease. One way to do this comes through the method of bioprinting the cells. Bioprinting is recreating the 3-D structure of a tissue using a technique where a computer program slices up a construct into layers and rebuilds them using some sort of biomaterial that is extruded from a printer head. For this project, we researched the printability of bioinks, their mechanical characteristics, and the relationship between the two. When constructs are combined with cells, the process can be used to conduct research for regenerative therapy and other possible forms of treatment.

Materials and Methods:
Different concentrations of the bioinks were used in this project. For one type of bioink Gelatin-Methacryloyl (GelMA), a semi-synthetic hydrogel, was used. This hydrogel provides cells with an optimal bio-environment and is easily photo-crosslinked which provides stability to our substrate. Preparation of 10% weight by volume (w/v) GelMA was done inside a fume hood in the laboratory. GelMA was weighed out and dissolved into a vial containing the desired volume of Phosphate Buffer Solution (PBS) and 5% (w/v) Lithium phenyl-2,4,6-trimethylbenzoylphosphinate (LAP), the photo-initiator compound. The vial and its contents was heated to 60˚C by use of a hot plate and stir

bar. While still warm, the GelMA was transferred into a 10mL syringe and then capped. The syringe was then placed onto a bed of ice to cool the solution down to room temperature. The CAD program, SolidWorks, was used to create the desired shape of our construct, and produce a g-code to carry out the printing process. The 3D bioprinter, an Allevi BioBot, was then turned on, calibrated, the syringe attached, and printing began. During printing, the use of a UV light was integrated into the g-code to begin cross-linking with the photo-initiator, which gave the structure better stability after printing. After printing was completed, the construct was kept for further research and use.

Results and Discussion:
Initial studies included testing preparation methods for bioinks and their mechanical properties. For GelMA bioinks, we concluded that slow heating, combined with an appropriate ratio of photo-initiator, produced ink with the best printability. This is because of the direct relationship that was found between the printability of bioinks and their mechanical characteristics. Bioprinting contains many degrees of freedom; including needle diameters, viscosity of the bioink, flow rate (printing speed), and the amount of pressure used to extrude the ink. Out of these, viscosity of the ink proves to be the most crucial because, if it is not within the correct range for bioprinting, then the print will be deformed, yielding a mutated construct as the result. Besides being important for the shape of the print, cell viability is also dependent on viscosity of the ink. Therefore, finding the optimum property is critical for the cells health, as well as the project's results and future research. Currently, we have found that 10% (w/v) GelMA bioink has showed promising results and will be used in the future to conduct further bioprinting studies.

9. Mechanical Properties & Applications of Recycled Polycarbonate Fused Particle Fabrication-based 3- D Printing

Student Presenters: Matt Reich, Nagendra Tanikella, and Aubrey Woern,
Materials Science and Engineering
Faculty Advisor: Joshua M. Pearce, Michigan Tech Open Sustainability Technology Lab

Introduction:
Past work has shown that fused particle fabrication (FPF) / fused granular fabrication (FGF) has potential for increasing the use of recycled polymers in 3-D printing.

Recycled polymer pellets are less expensive than commercially sold 3-D printer filaments, and can used to create parts at a fraction of the cost. The method by which the pellets are melted and extruded allows for a very high volumetric flow rate, and therefore also greatly decreases print time for larger parts. This study extends this potential to high performance (high mechanical strength and heat resistant) polymers using polycarbonate (PC).

Materials and Methods:
Recycled PC regrind of approximately 25 mm2 was 3-D printed with an open source Gigabot X were analyzed. A power and nozzle velocity matrix was used to optimize the print speed, and a print test was used to maximize the output for a two-temperature stage extruder for PC. ASTM type 4 tensile tests as well as ASTM approved compression tests were used to determine the mechanical properties of the recycled PC and were compared with filament printing and the bulk virgin material.

Results and Discussion:
The results showed the tensile and compressive properties of the recycled PC particles were comparable to that of the commercial filament, although less elastic under compression. Three case study applications were investigated: i) using PC as a rapid molding technology for lower melting point thermoplastics, ii) printed parts for high temperature applications and iii) printed parts for high strength applications. It is concluded that the PC particles printed with the Gigabot X can produce high strength and heat resistant parts.

10. Aggregation of Gold Nanoparticles and Virus Complexes with Osmolytes

Student Presenter: Ellie Lucier, Chemical Engineering
Faculty Advisor: Caryn Heldt, Bioengineering

Introduction:
Detection of viruses is difficult because they are some of the smallest microorganisms in the world. One method to detecting viruses is the use of citrate capped gold nanoparticles (AuNPs). When in the presence of osmolyte, viruses and AuNP complexes will aggregate due to hydrophobic interactions, increasing the hydrodynamic diameter of the AuNPs. Size changes can be detected using methods of dynamic light scattering (DLS) and a red shift in ultraviolet visual spectroscopy (UV-Vis). The research

conducted consists of multiple trails using both 15 nm and 40 nm AuNPs to detect the behavior of aggregation with two model viruses.

Materials and Methods:
AuNPs were synthesized by reducing gold (III) chloride trihydrate using trisodium citrate. The size of the synthesized AuNP was confirmed using DLS and UV-Vis. Next, the virus was purified via dialysis with 1000 kDa dialysis tubing in 4.3 mM pH 7.2 phosphate buffer (PB). Size exclusion chromatography was completed in a 6000 Da desalting column to further purify the virus. Once purified, a 1:10 dilution was performed to obtain 5 different concentrations of virus. Additionally, 1 nM and 1 μM bovine serum albumin (BSA) and 4.3 mM PB alone were used as controls to show virus/AuNPs were only aggregated by osmolyte. AuNPs were used at a concentration of 3.5 nM in nanopure water. 500 μL of 3.5 nM AuNPs were combined with 500 μL of each concentration of virus and each control sample, were left to coat by rotating for 20 hours. Once coated, a benchmark measurement was taken before aggregation with osmolytes and salt. To aggregate, the coated samples were spun down, supernatant was pipetted off and the samples were then resuspended in 1 mL of 1 M glycine, mannitol, or sodium chloride. Finally, the aggregated samples were measured using UV-Vis and DLS.

Results and Discussion:
Two viruses were used during experimentation to test the detection ability of AuNPs. It was hypothesized that a 1:1 ratio of AuNP diameter to virus diameter would provide the best results because it would be easier for similarly sized particles to interact with each other's geometries. 8 log to 4 log porcine parvo virus (PPV) MTT50/mL – having a diameter of 16-26 nm – and 40 nm AuNP complexes showed some aggregation when in the presence of 1 M glycine. These samples had a limit of detection at 4 log PPV MTT50/mL. Meanwhile the same range of detectable PPV with 15 nm AuNP complexes showed conclusive aggregation when 1 M mannitol was added. 7 log to 3 log bovine viral diarrhea virus (BVDV) MTT50/mL – having a diameter of 40-60 nm – and 15 nm AuNP complexes showed results with 1 M mannitol as well. These samples had a limit of detection at 3 log BVDV MTT50/mL. Current experiments are being conducted with BVDV and 40 nm AuNPs. It is hypothesized that results will be similar to those of PPV and 15 nm AuNPs; both experiments having a 1:1 ratio of diameters.

11. Effect of heat and chemical treatment on performance of supercapacitors using activated carbon

Student Presenter: Max Akhmetov, Materials Science and Engineering
Faculty Advisor: Yun Hang Hu, Materials Science and Engineering

Introduction:

Supercapacitors are getting increasingly popular in various industries including energy harvesting and automotive industries. Researching new potential ways to increase the performance of supercapacitors allows us to find more efficient ways to store and channel energy. This research focuses on various processing techniques of activated carbon and their effects on the material's performance as part of a supercapacitor. Activated carbon, due to its high surface area-to-volume ratio stores relatively high amount of charge, and because of its low cost, is a great candidate for a material used in building supercapacitors. The processing methods include heat treatment and chemical treatment with nitric acid for varying time intervals.

Materials and Methods:

2.5 mg of carbon black and 20.5 mg of activated carbon were ground in multiple steps. The powder was dry-ground for 30 mins, then ethanol was added to the powder and it was wet-ground for 2 hours. Lastly, a drop of PTFE (Polytetrafluoroethylene) was added and the mixture was ground for another hour until all the ethanol evaporated. The resulting paste was then collected into a small ball and rolled out into a 1 cm wide membrane using a rolling press. The membrane was then cut into 2 to 4 pieces and placed on the nickel electrodes with known mass. The electrodes were then put under a power press and under high pressure, the activated carbon membrane adhered to the electrodes. The electrons were then left in the oven for at least 24 hours to eliminate any remaining moisture in the electrodes. The electrodes were then tested inside the galvanostat using CorrWare software and varying currents to see how the material preforms in terms of discharge time and charge conservation during each discharge. This test took around 1.5-2 hours. The activated carbon underwent certain treatment before it was used in making the electrodes. Besides the control samples, the following conditions were applied to activated carbon: heat treatment at 400 °C for 2, 4 and 6 hours, and chemical treatment using nitric acid for 2, 4 and 6 hours.

Results and Discussion:

It was expected that heat treating the powder would increase the porosity of the material, therefore increasing the rate of charge flow. After the data was gathered and analyzed, there was no significant difference between the control samples and the heat-treated samples. The average discharge rates for control samples are 73.1, 64.5,

50.6, 19.1 and 8.6 s for 0.5 A, 1 A, 2 A, 5 A and 10 A currents respectively. The discharge time obtained for the heat-treated samples were 80.5, 67.7, 45.6, 4.5 and 10 s. It is seen that there is no significant difference between the heat treated and control samples. It is worth noting, however, that each treated data-set consisted only of 2 samples, which is not enough to prove definite lack of effect of the treatment.
The samples that were chemically treated, displayed a deviation from the control samples. Every current except for 10 A exhibited an increase in discharge time of around 40 seconds. At this point, due to the time-consuming process of making and assembling the electrodes, only two conditions (heat treated for 6 hours and chemically treated for 6 hours) have been tested. There are 4 more conditions that need testing (samples that were chemically treated and heat-treated for 2 and 4 hours). Each condition should be tested at least 7 times (the same number of trials as the control), which will take a very long time. If the results are consistent when all conditions are tested, the potential implications include using the supercapacitors of this nature in electric cars or solar power storage units.

12. Synthetic 3-deaza-3-alkyl-adenosines as minor groove alkylation mimics in studies on DNA replication processivity

Student Presenter: Gilliane Kenyon, Medical Laboratory Sciences
Faculty Advisor: Marina Tanasova, Chemistry

Introduction:
Among all naturally occurring nucleic acid modifications, alkylation at the N3-site of adenine exhibits an important role in determining the replicability of genomic information. Previously, our lab designed a strategy for synthesizing 3-deaza-3-alkyl-adenosine derivatives which were incorporated into oligonucleotides and studied for DNA duplex thermal stability.

Materials and Methods:
Using the same adenosine phosphoramidites, synthetic DNA strands and primers were generated to assess the influence of the 3-alkyl minor groove alkylation on DNA replication processivity. The resultant DNA strands carrying our 3-alkyl modifications were annealed to form duplexes and further tested using primer extension assays with human DNA polymerases.

Results and Discussion:
Our results indicate that the type of 3-alkyl modification plays a significant role in processivity, and furthermore, that different types of polymerases will process the DNA to produce different end products.

13. Moose Browsing Effects on Soil Nutrient Availability in the Boreal Forests of Isle Royale National Park

Student Presenter: Chelsey Bach, Forestry
Faculty Advisor: Evan Kane, School of Forest Resources and Environmental Science

Introduction:
Currently, the most extensive disturbance to boreal forest on Isle Royale National Park is derived from browse pressure by moose. This increased browse pressure likely alters the carbon sink-strength of boreal soils. Examination of moose disturbances is particularly timely, as the moose population and browsing has continued to grow, which will affect the abundance of vegetation and inputs to the soil. This study will look at the long-term impact of moose browse on soil nutrients, organic matter, and soil physical properties. These comparisons can then inform land managers on consequences of increasing moose populations.

Materials and Methods:
Sampling was conducted at the five exclosures across Isle Royale National Park. Three sample plots were randomly placed within the exclosure and in the adjacent control plot, with each plot coordinates recorded on a GPS. At each plot, a 50 cm by 50 cm descriptive soil pit was dug to a depth of 40 cm. The depths of each genetic soil horizon were recorded. For each horizon, a bulk sample of around 500 grams was taken along with a bulk density sample (using corers). The organic layer was measured by removing the organic material and measuring the depth to mineral soil.
Both physical and chemical analysis of the samples were completed in the Michigan Tech SFRES's soil science lab. The bulk soil horizon, bulk density, and organic samples were processed using the standard lab procedures. The dried horizon samples were then sieved (#10) to remove and sort through rocks, woody materials, roots, and char. Each sieved sample was then split into subsamples to measure percent nitrogen and carbon along with exchangeable base cations (CA, K, Mg, Al, and Na).

Results and Discussion:
Across all five moose exclosure sites, there were significant changes in chemical and physical properties. This was anticipated since the sites encompass three different soil orders of taxonomy. This variation across the five exclosures also contributed to the different treatment responses seen. The biggest effects seen was the significant increase of bulk density of both organic layers and top mineral soil horizons in the browsed areas compared to the exclosures. It was found that long-term browsing resulted in a decline of percent nitrogen in more weathered soils, but there was not a significant difference in the younger soils. The total carbon and nitrogen stocks were also found not significantly affected by browse. The base cations showed the exclosures having significantly higher potassium and sodium in the first mineral soil. When comparing across all soil horizons, it was found that potassium and magnesium were significantly higher in the exclosures than the browsed areas. We anticipate continuing to analyze the data to look at the influence of the variability between sites. Implications of the research indicate reducing moose populations to lower the long-term impacts on boreal soils.

14. Optimizing the Chemical Additive in Wet Spray System for Dust Suppression in the Mineral Industry

Student Presenter: Caroline Inaury, Chemical Engineering
Faculty Advisor: Lei Pan, Chemical Engineering

Introduction:
In the mining and mineral industry, the run-of-mine (ROM) ores go through size reduction and separation processes to extract valuable minerals which produce crystalline silica dusts during the operation. Crystalline silica has been classified as a human lung carcinogen, and breathing crystalline silica dust can cause silicosis [1, 2]. According to The Mine Safety and Health Administration (MSHA), the standard limit of the permissible exposure limit (PEL) of crystalline silica (quartz) in dust is 2mg/m3 [3, 4]. However, during their dust sampling process in 2003-2007, it indicated that many mineral processing operations have exceeded the limit. One of most commonly used methods for dust suppression at the mineral processing operations is a wet spray system. In using this method, water is sprayed over dust clouds so that dust particles are collected by water droplets and settled to the ground. However, using water alone does not give an optimal performance in lower the concentration of silica dusts.

Therefore, wetting agents or surfactant are introduced in wet spray system applications [5, 6]. These surfactants can effectively lower the surface tension of water droplets, resulting in smaller water droplets, larger surface areas as well as the lower contact angles of wetting liquids on dust particle surfaces.

Materials and Methods:
Various Surfactants are evaluated by measuring adhesion force between dust particles and water droplets in air using a force apparatus developed by my mentor's group [7]. A schematic representation of this force apparatus that will be employed to determine both adhesion force and separation distance between water droplet and dust particles. A dust particle is attached onto the tip of a cantilever by means of an optical glue. The particle is initially brought close to the apex of a water droplet that sits on a hydrophobic surface to a separation distance of 100 μm, and it is followed by bringing the water droplet close to the dust particle by a piezoelectric actuator until the solid particle is snapped into the surface of the water droplet. A force sensor is used to determine the deflection of cantilever springs at a 100 kHz frequency while measuring the separation distance by means of the interferometry technique. Measurements will be conducted using various wetting agents, such as anionic, cationic and non-ionic surfactants, and other commercially available wetting agents (e.g. Triton X-100). In the secondary phase of this project, the capture efficiency of dust particles using water spray is evaluated using a laboratory-scale dust capture system. A closed dust chamber is built in Chemical Engineering Building Lab Room 209 to evaluate the efficiency of dust particle removal with and without wetting agents. The dust will be created by dispersing ultrafine particles in a closed environmental chamber, and a water spray system is employed to suppress dust. The efficiency of dust control by water spray is evaluated by collecting dust particles on a filter and the amount of particles retained on the filter are weighed and determined.

Results and Discussion:
The use of surfactants enables an improved collection of dust particles by water droplets by destabilizing the Gibbs free energy associated with wetting of dust particles by surfactant liquids.

15. Empowering Youth to Be a Voice in Neighborhood Change Through Geospatial Technologies

Student Presenter: Rose Hildebrandt, Psychology

Faculty Advisor: Don Lafreniere, Social Sciences

Introduction:

Scholars have historically been using a mix of qualitative and quantitative methods to study children's use and perception of community space. Leading research has asked youth participants to use a suite of sensors and provide qualitative data such as photography, GPS, child-led tours, and travel diaries to develop models of the relationship between children and their environments. The geospatial analysis done with this research has historically been conducted solely by the researcher. Youth are collecting spatial data but not benefitting from analysis, nor have they learned how to use the data to develop their own questions or drive policy decisions.

Materials and Methods:

We incorporated geospatial technologies into a youth-led neighborhood environmental audit in the Villages of Calumet and Laurium, while also allowing the youth to take a leading role in the audit development, data collection, and analysis. A combination of sketch mapping, focus groups, and collaborative tours were used to gain an in-depth understanding of how youth view and interact with their neighborhood spaces. These activities provided baseline data for researchers to understand how the youth see and interpret different types and quality of urban spaces and served as an entry point for youth to evaluate it themselves before conducting the environmental audit. Collaborative tours were then used to familiarize the youth with data collection as well as standardize collection methods between youth. Youth then collected data using Collector for ArcGIS and analyzed the data themselves using ArcGIS. Using their data, the youth created three web-based GIS applications using ESRI's Webapp Builder. These maps focused on administrative, community, and visitor purposes, each with different functions. Youth presented these maps and their findings at a community meeting and held an interactive session where they helped members of the public navigate the data.

Results and Discussion:

We proposed that we could incorporate GIS and geospatial technologies into a youth-led neighborhood environmental audit to increase spatial awareness among youth and heighten our understandings of how youth use their neighborhood spaces. By directly involving youth in the entire process of environmental audit design, data collection, analysis, and dissemination, not only were youth able to increase their spatial awareness and learn how to use geospatial technologies, they were able to answer their own questions and become involved in their community by lending a youth perspective to neighborhood planning and policy decisions.

16. Decentering and Arterial Stiffness in Young Adults

Student Presenter: Sarah LewAllen, Medical Laboratory Science and Exercise Science
Faculty Advisor: John Durocher, Biological Sciences

Introduction:
Decentering, a mindfulness-related quality, involves an individual's inherent ability to recognize thoughts as simply psychological stimuli and accept a distant perspective. This includes understanding that thoughts and emotions are transient, rather than permanent associations of the individual. Previous studies have concluded that improvements in anxiety following an MBSR protocol were related to an increased ability to decenter. However, it is currently unknown how the ability to decenter might influence arterial stiffness. Therefore, the purpose of this study was to determine if a higher ability to decenter would be associated with lower arterial stiffness.

Materials and Methods:
Twelve individuals (25±9 years) volunteered to participate in this study. All participants had a BMI less than 30 kg/m2, and reported no history of smoking, taking cardiovascular medication, or having diabetes. Subjects were instructed not to consume alcohol, caffeine, or exercise for 12 hours before, and to abstain from food 3 hours before testing. Three supine blood pressures were recorded to calculate an average to calibrate the SphygmoCor system. We performed applanation tonometry to measure pulse wave analysis (PWA) at the radial artery and carotid-femoral pulse wave velocity (cfPWV) at the respective arteries to determine arterial stiffness. Participants also completed an 11-item decentering questionnaire to objectify their ability to disconnect from their emotions. Data were analyzed using IBM SPSS statistical software for bivariate Pearson correlations. We further performed a median analysis on the ability to decenter, and then unpaired t-tests for the low vs. high decentering groups. Differences were considered significantly different when $P<0.05$.

Results and Discussion:
A higher ability to decenter was associated with lower mean arterial blood pressure ($r=-0.736$; $P=0.010$), lower wake-time ambulatory systolic arterial blood pressure ($r=-0.800$; $P=0.005$), and lower cfPWV ($r=-0.579$; $P<0.05$). Participants with a low ability to decenter (n=6) had significantly higher cfPWV (5.9±0.9 m/s) than those with a high ability to decenter (4.9±0.6 m/s; n=6). Our results in a small sample size indicate that

the ability to decenter may be associated with lower cardiovascular risk factors such as mean arterial blood pressure, ambulatory systolic pressure, and cfPWV. Previous studies with very large sample sizes indicate that a 1 m/s reduction in cfPWV may help to reduce the risk for cardiovascular mortality by 15%. Our preliminary results are promising in regard to how the ability to decenter may reduce cardiovascular risk.

17. Grade estimation using dynamic anisotropy interpolation

Student Presenter: Ben Neely, Geological Engineering
Faculty Advisor: Snehamoy Chatterjee, Geological and Mining Engineering

Introduction:
In the mining sector, mineral resource estimation is an assessment of the quantity, quality, shape, and grade distribution of a mineral deposit. While estimation can be a very useful tool, some geologic situations may prohibit its use. Grade estimation for deposits that are undulated or folded has proved to be challenging, especially for gold deposits which are usually characterized by a skewed grade distribution where a small number of higher grade samples can cause an overestimation from the low grade around it. While there are options to reduce the variation in feedback from the search parameters of block model estimation, one of the best ways to go about this specific issue is with dynamic anisotropy interpolation.

Materials and Methods:
The solution was using dynamic anisotropy interpolation to correctly estimate the ore bodies. This method included a multitude of parts, most of which were done in the Surpac software package using block model estimation. The first step in the process was to create a trend surface in Surpac which reflected the variations in dip and dip direction in the mineral deposit. The trend surface was created using a function in the program to calculate points in between the upper and lower surfaces surrounding the ore body. Using the surfaces command with DTM file functions, creating trend outlines was the next step. This used a digital terrain model (DTM) to create a string file from the trend surface. The output of this was a string file that represented each DTM triangle as a polygon with dip and dip direction which were subsequently, d1 and d2. Once this was done, appropriate block model attributes were added to store values for dip and dip direction. The previous attributes were then selected. To proceed with the estimation of each block, the ellipsoid reflected the values in the attributes for each block. This

process was repeated for all data sets given. Finally, validation techniques such as swath plotting and Surpac validation functions will be used to interpret the final data.

Results and Discussion:
Research is ongoing, but will be complete soon. The intended outcome will assist in analyzing and estimating the ore bodies which pose a problem due to their folded nature. By doing so, the future of the operations will be more strategic and focused. This will hopefully increase the production and efficiency of the operations in future mines by giving them a better view the ore bodies they wish to possibly extract.

18. Small Scale Composition Analysis for Lignocellulosic Biomass Characterization

Student Presenter: William Otto, Chemical Engineering
Faculty Advisor: Rebecca Ong, Chemical Engineering

Introduction:
To combat increasing global demands for energy, researchers have been investigating conversion of biomass into fuels and chemicals as an alternative, sustainable source. Proper identification of biomass structure and compositions in various feedstocks is needed to fully extract available sugars and maximize biological conversions. This project scales down a standard composition analysis method used to characterize lignocellulosic biomass for comparison against the traditional method. The ~8 g of material required in the traditional method is reduced to ~ 1 g and ceramic filters are substituted with microfiber filters. Additionally, this method employs a parallel extraction process that significantly increases throughput.

Materials and Methods:
Switchgrass, miscanthus, poplar and corn stover were selected as feedstocks for evaluation. Pre-dried biomass (250 mg) was loaded in triplicate in solid phase extraction tubes. The biomass was extracted three times with 2 mL of 70 °C water followed by three extractions with 2 mL of 70 °C ethanol. Extracted biomass was removed and dried overnight at 85 °C. Triplicate pre-extracted biomass (20 mg) were placed in 8 mL vials for a stage two hydrolysis to break down acid soluble lignin. During stage one, 72 w/w% sulfuric acid was added to the vials before being placed in a 30 °C heating mantle for 60 ± 5 min with mixing every 5 minutes. Once completed, samples were diluted with DI water to achieve 4 w/w% sulfuric acid and placed in a 101°C heating mantle for 60 min

with no mixing. The material was then passed through pre-ashed glass microfiber filters in a vacuum filtration apparatus. Filtrate was analyzed for structural carbohydrates using an Aminex HPX-87H columns. After drying filters and residue for 8 hrs at 80 °C, each filter mass was recorded. Insoluble (Klason) lignin was calculated by taking the difference of the filter mass before filtration and after drying.

Results and Discussion:
The collected data will be analyzed for content of total extractives, structural carbohydrates, and Klason lignin. This data will allow us to directly compare with results from the conventional method and assess the viability of small-scale composition analysis. Using microfiber filters decrease filtration time by three fold and eliminated time spent cleaning ceramic crucibles. Reducing the amount of required feedstock for biomass characterization minimizes unnecessary waste, resources and costs while providing comparable results to the conventional method. This opens the possibility to evaluate feedstocks that are limited in quantity such as transgenic samples.

19. Magneto-Rheological Fluids Create Human-Like gait in Ankle-Foot Prostheses

Student Presenter: Eric Houck, Mechanical Engineering
Faculty Advisor: Mo Rastgaar, Mechanical Engineering-Engineering Mechanics

Introduction:
Lower leg amputees are known to develop secondary physical conditions due to a gait imbalance resulting from the inability of a prosthesis to mimic natural gait characteristics. A prosthesis able to perform with a more human-like gait will be more effective in preventing these secondary physical conditions. Magneto-Rheological Fluid, (MRF) which has emerged as a successful medium for adaptive automobile suspensions, shows potential to provide these characteristics in a prosthesis.

Materials and Methods:
MRF is a suspension of micron-sized iron particles in a carrier fluid of ethylene glycol; that when subject to a magnetic field, increases in viscosity. This study focuses on the modulatory behavior of MRF and its potential to produce desired damping characteristics in an ankle-foot prosthesis. A hollow disk of rubber-like resin, sitting around the universal joint connecting the pylon of the lower limb and foot prostheses, was 3D printed and filled with MRF before being subject to magnetic fields of varying

strength, produced by a pair of electromagnets. The lower limb pylon, not attached to a human subject, was struck with an impact hammer and its oscillation recorded using an accelerometer for each magnetic field intensity. The angular stiffness and damping were calculated from these measurements, relating them back to the magnetic field intensity.

Results and Discussion:
As the magnetic field intensity incident on the MRF disk increased, the angular damping of the modeled ankle joint increased while its angular stiffness increased. This significant modulation of the dynamic characteristics of MRF shows that MRF is a viable and implementable approach to reducing gait imbalances in lower-leg amputees.

20. The Effects of Aging on the Ability to Make Optimal Corrective Actions During Reaching Movements

Student Presenter: Allison Waara, Exercise Science
Faculty Advisor: Kevin Trewartha, Cognitive and Learning Sciences

Introduction:
Rapid motor corrections allow us to make evasive actions to avoid knocking over objects in a cluttered workspace when reaching, and to navigate around other people in a crowded room. The objective of this research is to identify the cognitive mechanisms that contribute to our ability to make rapid evasive actions in response to sensory feedback during ongoing movements, and to establish how these mechanisms are impacted by aging.

Materials and Methods:
In the current study, we used a robotic device (Kinarm, BKin Technologies) to apply unpredictable visual “cursor shifts” while participants reached for visual targets and tried to avoid haptic obstacles. The obstacles were positioned to the right and left of a straight path from the start position to a target; upon contact with the participant’s cursor obstacles applied a repulsive force to simulate a collision with a real obstacle. On each trial the cursor briefly disappeared behind a rectangular occluder positioned in front of the start position, and emerged either unperturbed, or shifted by a small, medium, or large distance to the left or right of the original path. The medium-shift placed the cursor in a collision course with one of the obstacles, and required a corrective movement to avoid making contact. For the no-shift and small-shift trials, and the large-shift trials

corrective movements were not necessary to guide the cursor between or around the outside of the obstacles, respectively.

Results and Discussion:
We tested the prediction that older adults (60-85 years old) would perform less optimal corrections more frequently than younger adults (18-35 years old). Finally, we probed for individual differences in the efficiency with which older adults made rapid corrective actions by administering a battery of perceptuomotor and cognitive tasks. This battery allowed us to identify factors that best predict impairments in performance on the obstacle avoidance task in later adulthood.

21. Development of high reflective index, magnetically actuatable, silicone gel substrate for traction force microscopy (TFM)

Student Presenter: Shaina Royer, Biomedical Engineering
Faculty Advisor: Sangyoon Han, Biomedical Engineering

Introduction:
Traction Force Microscopy (TFM) is a soft gel-based, experimental and computational technique to measure the mechanical forces exerted by cells. TFM uses gel deformation created by cells' pulling force to reconstruct the most-likely force field. To quantify the gel deformation, the soft substrate is coated with fluorescent beads, imaging of which during cells' presence and absence on/from the gel enables is used for computationally tracking individual beads. The goal of this study is to assess the determining chemical/mechanical factors that guarantees the bead coating of the gel with highest possible bead density for highest spatial resolution of the traction.

Materials and Methods:
TFM gel was fabricated with mixing base and crosslinker of a silicone gel. Mixing ratio between the two determines the stiffness of the gel. The mixed gel was spin-coated on a cover-glass and cured on a hotplate. Vapor-phase or liquid-phase deposition was used to coat the gel with a monolayer of silane to which carboxyl coated beads can attach. Two kinds of silanes, (3-Aminopropyl)trimethoxysilane (APTMS) vs.(3-Aminopropyl)triethoxysilane (APTES) were tested for the bead coating. The fluorescence beads in 1-Ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC) solution were sonicated to evenly disperse the beads and to break up any potential clumps. Sonication times of 3-15 minutes were tested for regular bead coating. After the

sonication, the mixture was immediately poured over the gel substrates to covalently attach beads to the silicone surface. Atomic force microscopy (AFM) was used to find the elastic modulus of the gel. A spherical tip was used to avoid cutting the gel. To test if the gel is magnetically actuatable, the magnetic beads were coated on the gel at a ratio of 1:100 magnetic to fluorescent beads, using the same silane chemistry and tested with a permanent magnet with known magnetic field.

Results and Discussion:
In terms of liquid vs. vapor phase silanization, liquid deposition yielded more consistent high bead density compared to vapor phase deposition. Between APTMS vs. APTES, APTES coating has produced consistently clean and transparent deposition result whereas APTMS-coating sometimes made the gel turn a cloudy white regardless of phase of the silane. For sonication time, 15 minutes resulted in the least clumping while short (e.g. 3 min) of sonication led to lots of bead clumps. Overall, liquid phase deposition with APTES with 15 minutes of sonication has yielded the highest bead density, 1.14 bead per um^2. For magnetic TFM gel, application of magnetic field has induced slight displacement of the magnetic bead (to be quantified). The elastic modulus, measured with AFM, has shown an average of 4.824 kPa for a gel mixed with 1:1 ratio between the base and the crosslinker, and 24.36 kPa for the gel mixed at 1:2 ratio. In-vivo experiments with the cells have shown elevated traction force and spread area upon attachment to the stiff substrates (24 kPa) than when cells were on a soft substrate (5 kPa). Taken together, my work has established the optimal procedure for high-resolution TFM gel fabrication and promise for magnetic actuation.

22. Long Term Biocompatibility of Zn and Zn Alloys in Murine Arterial Model

Student Presenter: Elisha Earley, Biological Sciences
Faculty Advisor: Jeremy Goldman, Biomedical Engineering

Introduction:
Restenosis of stented arteries is exacerbated by the permanent presence of the stent. Extensive efforts have begun over the past decade to materialize the concept of fully bioresorbable stents. Polymer-based materials have proven inadequate in human studies [1]. Our group introduced zinc and zinc alloys as candidate stent materials with improved corrosion performance relative to other metallic materials. Small quantities of alloying elements have been incorporated to improve zinc’s mechanical properties.

Whereas most studies focus on the in vitro degradation and cytotoxicity of zinc and zinc alloys, our group has developed an implant model in a rat artery that simulates a stent strut [2].

Materials and Methods:

Extruded zinc/zinc alloy wires were implanted into the abdominal aorta of Sprague Dawley rats by puncturing the wire through the arterial wall, advancing the wire along lumen, and puncturing the wire out at the opposite end. The rats were euthanized at either 6 or 11 month time points and the abdominal aortas were collected. Plasma, liver, heart, and kidney were collected at 6 months. Arterial cross sectioning of the samples was undertaken at 8-10 μm thickness using a Thermo-Scientific HM 550 P cryostat. Hematoxylin and Eosin (H&E) as well as Verhoeff/van Gieson (VVG) staining was performed on the artery/implant cross sections in order to characterize the neointimal response. Neointimal area was calculated for the zinc and zinc alloys at both time points by outlining the neointimal region using MetaMorph Offline Version 6.3r7 software. The neointima was identified as tissue surrounding the implant on the luminal side of the first elastic fiber, which is readily recognized in VVG staining. Accumulation of ionic zinc in the plasma, liver, heart and kidney was determined using an abcam flourometric zinc quantification kit (ab176725).

Results and Discussion:

A stable neointima formed around the zinc implant as a result of limited hyperplasia and low to moderate inflammation, as shown in the representative image below, indicative of the biocompatibility of the zinc/zinc alloys. The neointimal area at 6 and 11 months for pure Zn and ZnMg and ZnLi alloys can be seen in Figure 1. The neointimal area significantly increased from 6 to 11 months for ZnLi ($p<0.005$) but not for Zn or ZnMg. This small increase could be caused by an unresolved chronic low to moderate inflammatory response. High variability in the neointimal area that was found for ZnMg could be caused by nonuniform corrosion rates, which results in correspondingly varied inflammatory responses. Preliminary data shows a significant increase in free zinc ion concentration ($p<0.05$) in plasma between control ($n=4$) and 6 month zinc implant time points ($n=8$). There is minimal progression from 6 to 11 months of neointimal area and apical thickness for pure zinc. A significant increase of plasma ionic zinc was observed at 6 months at a magnitude that is of minimal physiologic relevance (0.156 vs. 0.314 mg/mL for controls vs. 6 months). Overall, the biocompatibility of long-term zinc arterial implants look promising for application as degradable stent materials.

23. Exploring the Social Determinants of Health and Disease Outbreak Patterns in Children in Early Twentieth Century Calumet, MI

Student Presenter: Timothy Stone, Sustainability Sciences and Society
Faculty Advisor: Don Lafreniere, Social Sciences

Introduction:
Historical health studies of children provide significant advantages over their contemporary counterparts, specifically with their ability to study at the scale of the individual child. This project utilizes the Copper Country Historical Spatial Data Infrastructure (CCHSDI) to couple 30 years of school attendance and vaccination data to a full recreation of the social (SE) and built environments (BE) of Calumet and Laurium. We examine the role of BE variables such as residential crowding and proximity to industrial activity and SE variables such as family composition and parent's education to uncover who was most susceptible to contracting common communicable diseases.

Materials and Methods:
This project started with the acquisition and transcription of nearly 30 000 records from the 18 public schools in Calumet during the early 20th Century. The student information was then geocoded, utilizing the Sanborn Fire Insurance maps, City Directory records, and Census records compiled within the Copper Country Historical Spatial Data Infrastructure (CCHSDI). Geocoding is the process by which textual data, a child's health data in this case, is paired with a location on a map using their address. Using historical geocoders is a new avenue in the realm of historical spatial demographic research and allowed us to place children into a 3D model of the actual home they lived in at the time the record was produced. Records which did not fall within the range of the historical geocoder were manually mapped using their contemporary spatialized census records and city directories linked within the CCHSDI. Records were then linked to their corresponding Census records using LinkageWiz. Spatial analysis then linked BE and SE variables to individual children, their siblings, and classmates. A socio-economic (SES) index allowed us to contextualize SE variables such as the parent's education and family situation as well as identifying immigration status and approximate living environment.

Results and Discussion:

Analysis is ongoing, but initial observations provide a clue for possible findings. Automatic geocoding produces a match-rate of over 80% across most schools, suggesting that the historical geocoding approach is an improvement over traditional method. Manual review indicates that three primary reasons lead to false positives or no-matches: (1) there were multiple streets with the given name in the town at the time, (2) the child's given address was improperly transcribed, and (3) the map of the given year did not cover the child's location. Initial linkage results show match rates around 65%, meaning that in-depth analysis will be possible with this proportion of records. Initial results suggest that residential crowding and a child's proximity to land used for mining purposes are both expected to have a direct effect on their ability to ward off infectious diseases. Other suspected relationships expected to affect one's susceptibility include the socio-economic status of the child's family, the population density, and the immigration status of the family and child. These findings illustrate the need to look beyond the arbitrary areal unit to individual georeferenced cases to find distinct patterns and trends over time.

24. Post Processing of 3-D Printed Parts for Use in Vacuum Systems

Student Presenter: Pierce Mayville, Materials Science and Engineering
Faculty Advisor: Joshua M Pearce, Materials Science and Engineering

Introduction:
Access to vacuum systems has been limited because they are expensive, scientific research instruments. One promising method of reducing costs and thereby improving access would be to digitally manufacture vacuum systems from plastic. Vacuum systems have historically not utilized polymer parts due to their outgassing properties except for use in gaskets. Further problems are encountered when attempting to use 3-D printed polymers as there is porosity between the printed layers.

Materials and Methods:
To overcome these challenges this study tests various post processing treatments to make 3-D printed polypropylene capable of holding a vacuum. Polypropylene was selected for testing as it had been found to have the best outgassing properties in a related study. These treatments included the application of a commercial vacuum sealant, solvents, and heat treatments.

Results and Discussion:

Utilizing a heat gun to seal the 3-D printed surface exposed to vacuum was found to be the most effect post processing. This process allowed the 3-D printed part to max out the roughing pump used for testing. 3-D printed vacuum parts would allow for a significant reduction in the cost of vacuum systems such as those used in ALD.

25. Changes in urban wildlife behavior due to human-induced stresses

Student Presenter: Tanner Barnes, Wildlife Ecology and Management
Faculty Advisor: Kristin Brzeski, School of Forest Resources and Environmental Science

Introduction:
Certain wildlife can exploit urban landscapes better than others by adapting their behavior around anthropogenic stresses. For example, wildlife winter behavior is important to study to determine how human-induced stress may lead to higher winter mortality or changes in behavior compared to rural conspecifics. Michigan's Upper Peninsula is one of the most widespread forested areas in the Midwest, however, it is still important to study how species interact when they encounter urban locations on the highly connected forested landscape.

Materials and Methods:
To assess how an urban location impacts species distribution and activity behavior, we deployed five camera traps in green spaces throughout the city of Houghton, Michigan, and deployed five cameras equal distances apart in nearby rural Pilgrim Community Forest. Cameras were deployed in the field between November 2018 and March 2019 for a total of 1,005 trap nights.

Results and Discussion:
Preliminary results show higher species accumulation in the urban environment than the rural environment, so it is clear wildlife still uses the urban environment when rural habitat is wildly available. Further statistical analysis will be done to quantify species behavior between the two landscapes. Results from this study will help to determine how wildlife adjust their behavior to deal with human-induced stress and how this affects wildlife populations in an urban area.

SESSION B: 3-5 PM

	Presenter	Department	Title
1	Alexander Oliver	Biomedical Engineering	Characterizing the Long Term Inflammatory Response to Zinc Stent Materials
2	Kiaya Caspers	Biomedical Engineering and Material Science and Engineering	Impact of Fibrin Microparticle Crosslinking Density on Physical and Rheological Properties of Composite Polyethylene Glycol-Fibrin Microparticle Hydrogels for use in Tendon Repair
3	Conner Hawry	Physics, Applied and Computational Mathematics	Synthesis of Small Diameter BNNTs for Biomedical Application
4	Emily Byrne	Applied Ecology and Environmental Science	Physiological Effects of α-Amanitin in Various Mycophagous Drosophila Species
5	Joshua Langlois	Electrical Engineering	Signal Processing for Carbon Nano Tube Speakers
6	Christopher Wallenfang	Materials Science and Engineering	Recycled Waste Polypropylene and Glass Composite for 3-D Printing Applications
7	Ceily Fessel Doan	Environmental Engineering	Comparison of Nannochloropsis and Chlorella vulgaris Algae to Energy Efficiency in the Rio Grande Watershed
8	Michael Hromada	Biochemistry and Molecular Biology (Chemistry)	Hemolysin X (HelyX): A New Bioactive Compound with Therapeutic Potential
9	Zack Hjorth	Physics	Synthesis of Boron Nitride Nanosheets for Use in Two-dimensional Devices

10	Lauren Cohen	Applied Ecology and Environmental Sciences	Impacts of a Gradient of Silvicultural Harvests and Site Preparation Treatments on Presence of Eastern Red-Backed Salamander (Plethodon cinereus) in Northern Hardwoods
11	Bella Nutini	Exercise Science	Determinants of breastfeeding among younger mothers in Michigan's U.P.: A secondary analysis
12	Lauren Spahn	Chemical Engineering	Statistical Optimization of Lignin Precipitation from Hardwood Black Liquor
13	Deanna Springgay	Biochemistry and Molecular Biology - Chemistry	Creating a New Family of Polycarboxybetaine Copolymers
14	Brennan Vogl	Biomedical Engineering	Monitoring Migration of Cancer Cells Pre-Treated with Fructose Analogs
15	Jacob LeBarre	Chemical Engineering	Improvement of virus purification methods using cation exchange chromatography
16	Alexa Destrampe	Exercise Science	Impact of Community and Institutional Factors on Breastfeeding Practices in the U.P.
17	Michelle Burge	Exercise Science	Motor learning as a sensitive behavioral marker of early Alzheimer's disease
18	Logan McMillan	Chemical Engineering	Blood-typing and Hematocrit Testing Using Point of Care Methods on Medical Microdevices
19	Jessica Brown	Computer Science	Fuzzy C-Means Algorithm Applied for Fraud Detection
20	Zachary A. Kondrad	Mechanical Engineering	Low emissions /High Efficiency Three Way Catalyst in a Micro-Pilot Diesel Natural Gas Dual Fuel Combustion Engine
21	Samuel Jacobs	Chemical Engineering	Ultrafiltration of Colloidal Silica: Reduction of Concentration Polarization by Turbulence
22	Marissa Gallmeyer	Chemical Engineering	Extraction of Waxes and Lipids from Sorghum Using Green and Renewable Solvents
23	Michael Anthony Schroeder	Chemical Engineering	Viral Partitioning in Aqueous Two Phase System with Osmolytes
24	Sam Willard	Biochemistry and Molecular Biology (Chem) & Cheminformatics	Curcumin Binding Modulates SOD1 Stability: A Computational Study
25	Meredith Grusnick	Chemical Engineering	Maize Growth in Lignin-Rich Fermentation Residue Enhanced Upper Peninsula Soils
26	Austin Goudge	Biomedical/Mechanical Engineering	Medical Imaging Derived 3D Computational Torso Model: A Future Platform for Ultrasound Simulation

27	Abby Sutherland	Exercise Science	Development of an age-predicted maximum heart rate equation for upper-body exercise
28	Jack Wilson	Sustainability Science and Society	Understanding the Possibilities: Local Farmers Share Opportunities for Sustainable Local Food Systems Development
29	Anne Fife	Biological Sciences-Pre Professional	Prenatal and Demographic Influences on Breastfeeding in the U.P.
30	Sue Yon Kim	Biomedical Engineering	Novel Particle Image Velocimetry Method for Traction Force Microscopy Application
31	Sarah Wayward	Biomedical Engineering	Understanding physiological relevance of differences in NO production in clinical samples for wound healing
32	Thomas Basala	Biological Sciences - SBL5 (Pre-Health Professions)	Ambulatory Blood Pressure Patterns and Arterial Stiffness in Adults: A Pilot Study
33	Elizabeth Polega	Biomedical Engineering	Antibacterial properties of mussel-inspired polydopamine coatings prepared by simple two-step shaking-assisted method
34	Brenna Rosso	Biochemistry and Molecular Biology	Assessing the Expression and Purification of Arg-Tagged MS2 Coat Protein by Cation Exchange Chromatography
35	Daniel Woodall	Mechanical Engineering	Conductive PDMS Composites
36	Sarah Goble | John Ruf | Cole Peppin	Economics, Mechanical Engineering, Chemical Engineering	KHOB 2018 Economic Outlook Report

1. Characterizing the Long Term Inflammatory Response to Zinc Stent Materials

Student Presenter: Alexander Oliver, Biomedical Engineering
Faculty Advisor: Jeremy Goldman, Biomedical Engineering

Introduction:

The permanent presence of a stent exacerbates restenosis. Therefore, if a stent could remain in the artery long enough for it to heal and then completely bioabsorb, failure methods associated with permanent stents could be avoided. Zinc has been a major focus of efforts to develop a biodegradable stent due to its ideal corrosion rate and biocompatible degradation byproducts. Investigating the body's response to novel metals is vital to the development of new stent materials. The objective of the present work was to characterize the chronic inflammatory response to pure zinc wires that were implanted into the arteries of rats.

Materials and Methods:

Pure zinc wires with a diameter of 0.25 mm were implanted into the abdominal aorta of 16 adult Sprague-Dawley rats in order to simulate a stent strut in the arterial environment. At 6 and 11 month implant residency time points (n = 8 for both time points), the rats were euthanized and the implant containing arteries were collected. The arteries were cross sectioned for Immunofluorescence (IHC-IF) analysis. CD68 protein was used to label the general macrophage (MΦ) marker. MΦ phenotype identifying markers iNOS and CD206 were employed. iNOS is expressed by aggressive MΦs that are associated with upregulating the inflammatory response. CD206 is expressed by MΦs that are associated with tissue repair and downregulating the inflammatory response. MetaMorph image processing software was used to threshold and count positive pixels to describe the inflammatory cell population as it progresses from 6 to 11 months. IHC-IF was also performed for the general endothelial cell (EC) marker CD31 as well as the dysfunctional/inflammatory EC marker vWf.

Results and Discussion:

Pixel count data for CD68 and iNOS remained constant from 6 to 11 months. CD206 expression significantly decreased from 6 to 11 months. Preliminary staining for endothelial cell markers CD31 and vWf displayed a confluent layer of positive cells surrounding the neointima. The preliminary data depicts a low/moderate inflammatory response and therefore satisfactory biocompatibility of zinc based materials for application as biodegradable stents. The constant CD68 expression between 6 and 11 months may be due to a steady corrosion rate that sustained the macrophage response. iNOS expression also

remained constant, contrary to CD206 expression, which significantly decreased from 6 to 11 months. This implies that matrix remodeling and healing was completed around 6 months, resulting in a decrease in CD206 expression. The data suggests that iNOS (but not CD206) expression is regulated by corrosion activity. The confluent layer of CD31 positive cells surrounding the neointima confirms complete endothelialization surrounding the implant. The sustained expression of vWf by endothelial cells surrounding the neointima at 11 months suggests an activated regenerated endothelium, which corresponds to the sustained MΦ population.

2. Impact of Fibrin Microparticle Crosslinking Density on Physical and Rheological Properties of Composite Polyethylene Glycol-Fibrin Microparticle Hydrogels for use in Tendon Repair

Student Presenter: Kiaya Caspers, Biomedical Engineering and Material Science and Engineering
Faculty Advisor: Rupak Rajachar, Biomedical Engineering

Introduction:
To supplement conventional tendinopathy treatments, our lab is developing a novel composite adhesive hydrogel composed of polyethylene glycol (PEG), fibrinogen (Fgn), and fibrin microparticles (Fbn-mP) (Joseph, C.A. ACS Biomater. Sci. & Eng. 2018; under revision). The purpose of this work is to modify and optimize the existing hydrogel formulation using Fbn-mP that have different crosslinking densities in order to tune the stiffness of our composite hydrogels to better match the biomechanical properties of tendon tissues.

Materials and Methods:
Fbn-μP were synthesized using a previously established protocol (Joseph, C.A. ACS Biomater. Sci. & Eng. 2018; Under Review.). The microparticles were vapor crosslinked with a 37% formaldehyde solution for 6 hours to create a relatively high crosslinking density (Standeven, K.F. Blood J. 2007;110(3):902-7.) (Fig. 1 i-ii). Swelling tests were performed on low (control) and high crosslinked Fbn-μP by comparing the diameter of the dry versus swollen Fbn-μP using a high resolution (EVOS FL Auto) imaging system. Indentation tests were performed on previously synthesized fibrin disks of the same composition as the

Fbn-μP using a custom micro indentation system with a rounded indenter. Stiffness and relative deformation as measured by contact area were determined for relatively low crosslinking density (control) disks and relatively high crosslinking density (i.e. crosslinked for 21 hours in 37% formaldehyde) disks.

Results and Discussion:
The Fbn-μP with higher crosslinking density swelled significantly less than those with lower crosslinking density. Indentation testing indicated that increased crosslinking resulted in a significant increase in the stiffness of the Fbn- matrix. This result was further verified by the significant decrease in indentation contact area with increasing crosslinking density. Ongoing research involves indentation tests on PEG-Fgn hydrogels containing Fbn-μP with different crosslinking densities. It is anticipated that the PEG-Fgn hydrogels containing the Fbn-μP with higher relative crosslinking density will be stiffer. Ongoing work also utilizes rheometric measurements to characterize the viscoelastic behavior of the composite hydrogels containing relatively low, medium, and high Fbn-μP concentrations with varying cross linking densities (Fig. 1 iii). Storage modulus (G') and loss modulus (G'') will be determined to measure the stiffness and viscous energy dissipation of the composite hydrogels, respectively.

3. Synthesis of Small Diameter BNNTs for Biomedical Application

Student Presenter: Conner Hawry, Physics and Applied and Computational Mathematics
Faculty Advisor: Yoke Khin Yap, Physics

Introduction:
An analysis of the optimization in using chemical vapor deposition (CVD) as a process to synthesize boron nitride nanotubes (BNNTs) is presented. Specifically, the use of a novel liquid catalyst to synthesize small diameter BNNTs without sacrificing the minimum requisite density for numerous biomedical applications. This include methods for coating silicon substrates with the catalyst and the use of aluminum oxide coating and potassium hydroxide etching as a method to encourage even catalyst distribution and porous deposition sites.

Materials and Methods:
Catalyst coverage over the substrate was tested on the polished and the rough sides of the substrate and used for synthesis. The hydrophobicity of the substrate prevented the

water-based catalyst from completely covering the substrate and disallowed uniform deposition of particles over the substrate. Potential solutions include coating the substrate with Al2O3 to negate any hydrophobicity and to create a porous surface for particle deposition as well as etching the substrate in KOH to remove the hydrophobic silicon oxide layer and provide a porous surface. Various concentrations of Al2O3 suspended in ethanol were used to coat the surface of
each substrate before catalyst application. Each substrate was used for BNNT synthesis using CVD. A silicon etching process was used similar to that of Ralu Divan et al [2]. Substrates were etched in groups of four at a constant temperature and were magnetically stirred at 100rpm. Etching duration was varied from 20 minutes to 120 minutes, after which substrates were analyzed with a scanning electron microscope, (SEM), to determine etching consistency across the substrate. Each substrate was then used for BNNT synthesis.

Results and Discussion:
Diameter and growth density of BNNTs were measured using SEM imaging. Application of the catalyst directly to the polished and rough surfaces of the substrate yielded little to no growth of small diameter. Application of liquid Al2O3 solution before catalyst deposition at volumes between 50ul to 300ul per substrate yielded low to moderate density growth of BNNTs 50nm to 200nm in diameter. Silicon substrates were etched using 25% KOH as the etchant. Etching durations under 40 minutes yielded low density growth between 20nm and 50nm in diameter. Etching time was increased to 80 -120 min to establish more catalyst deposition sites. This resulted in high density growth of BNNTs ranging 10-30 nm in diameter. The use of a novel liquid catalyst for <20nm diameter growth of BNNTs without sacrificing growth density has shown to be achievable using KOH etching as a surface preparation method for catalyst deposition using etching times between 80 and 120 minutes.

4. Physiological Effects of α-Amanitin in Various Mycophagous Drosophila Species

Student Presenter: Emily Byrne, Applied Ecology and Environmental Science
Faculty Advisor: Thomas Werner, Biological Sciences

Introduction:
Specific species of fruit flies are known to be resistant to mushroom toxins such as Alpha Amanita. Studying the potential impacts of mushroom toxin on phenotype could provide

more insight to the physiological mechanism behind toxin resistance in later projects. Studying the mushroom/insect biodiversity of the Keweenaw could also provide opportunity for a field guide to be published.

Materials and Methods:
Mushrooms were collected several times per week from the Michigan Tech trails, as well as other locations from around the Keweenaw. Various species of mushrooms were collected. Mushroom-specific data as well as observable traits in the hatched flies that indicate physiological stress were recorded, as outlined in Aim 1. An initial experiment was done to determine which type of food would best suit the fly stocks. Eggs from each species under various types of food were counted. Flies that hatched out of the mushrooms collected were identified and used in experiments to measure their fecundity and longevity. The fly thoraxes were measured under a microscope to determine if phenotype changes existed across habitat in various species of mushrooms.

Results and Discussion:
Mushrooms were found in South Range, the Tech trails, the Huron Mountains, and the NARA trails in Houghton. It was found that non-toxic mushrooms from the Bolete genus and the species Trichloromopsis platyphylla hatched the most fruit flies. Flies reared on food containing sugar, mushrooms, and yeast produced the most eggs. Dropsophila falleni, Drosophila neotestacea, and Dropsophila recens, and others were found in the wild mushrooms. A wide array of other insects were found to have hatched out of the mushrooms, and were mailed to our collaborators. Toxic mushrooms were scarce and the small sample size could not accurately represent the population and conclusions regarding the changes in fly phenotype could not be made.

5. Signal Processing for Carbon NanoTube Speakers

Student Presenter:Joshua Langlois, Electrical Engineering
Faculty Advisor: Andrew Barnard, Mechanical Engineering

Introduction:
Carbon Nanotubes (CNT) can be used as thermoacoustic speakers meaning they use fluctuations in heat to create sound. They are ultra-light weight, they do not use rare earth

materials, and can withstand high temperatures. Unlike typical speakers, CNT speakers are nonlinear, which in this case results in the output frequency being double that of the input. In the past signal preprocessing has been used. Either a DC offset or amplitude modulation was applied to the audio files. This made it so the speakers output the expected sound, but only certain audio files could be played. To make it so any song can be played, an active signal processing unit is needed.

Materials and Methods:
The signal processing unit chosen is a Raspberry Pi 3 with an audio injector card. The Raspberry Pi and the audio injector card have audio inputs and outputs. This set up allows for active signal processing. Using active signal processing, the device reads in the input signal and then makes an amplitude modulated version of it that is used as the output.

Results and Discussion:
The active signal processing allows for any song from any device, with an audio output, to be played on the CNT speakers. The system have been proven to work. When running audio directly from an input source through the Raspberry Pi and into the CNT speaker, the output that is heard is correct. This makes the CNT speakers a more viable alternative for the average consumer.

6. Recycled Waste Polypropylene and Glass Composite for 3-D Printing Applications

Student Presenter: Christopher Wallenfang, Materials Science and Engineering
Faculty Advisor: Joshua Pearce, Materials Science and Engineering

Introduction:
As the market shifts toward distributed manufacturing of products for cost-effectiveness, open-source 3-D printing is becoming increasingly popular. Polypropylene (PP) is a chemically stable, 3-D printable polymer that can be used in high performance environments such as clean rooms. Recent research at Michigan Tech has shown that recycled PP makes an adequate 3-D printing feedstock for small parts. Unfortunately, large PP 3-D printed parts deform upon cooling, compromising the dimensional integrity of the parts. Previous studies

have shown that the addition of glass powder filler material reduces this shrinkage by constricting flow upon solidification of PP.

Materials and Methods:
In this project, granulated recycled waste PP and recycled soda-lime glass powder are used to fabricate a recycled waste composite. This composite is further granulated and extruded into filament through an open-source recyclebot at 250°C. Once a uniform filament diameter is reached, this filament is spooled upon cooling and processed with an open-source 3-D printer. Composites of 10%-50% glass by weight are drawn into filament, in increments of 10% glass by weight. Tensile bars of this composite are printed and tested to assess mechanical properties. Finally, a large vacuum chamber part is printed.

Results and Discussion:
This research will demonstrate the success of an approach of combining two waste streams to make a high-value product using open-source recycling and 3-D printing.

7. Comparison of Nannochloropsis and Chlorella vulgaris Algae to Energy Efficiency in the Rio Grande Watershed

Student Presenter: Ceily Fessel Doan, Environmental Engineering
Faculty Advisor: Alex Mayer, Civil & Environmental Engineering

Introduction:
Biofuel from algae lipids has been suggested as a promising alternative energy source. Many areas considered ideal for algae cultivation are in the sunny and warm semi-arid southwest US. While these areas have optimal sunlight and temperatures, water resources are often scarce. This project is an analysis of the Rio Grande watershed covering New Mexico, Texas, and Chihuahua (Mexico) states. Potential sources of water include relatively fresh (<500 mg/L total dissolved solids (TDS)) to brackish (1,000 to 10,000 mg/L TDS) surface and groundwater.

Materials and Methods:
Water, salinity, and algal biomass balance equations are derived in order to determine water demand for cultivation. Local climate data, including temperature, solar radiation,

evaporation, and precipitation are used to determine the impacts of climate on algal growth. Given the variations in salinity from different aquifers, we examine the potential use of Nannochloropsis and Chlorella vulgaris algae species. The Nannochloropsis genus are less sensitive to high salinity, that can withstand a TDS of 40,000 mg/L. Whereas, the Chlorella v. species can survive in waters with a TDS less than 2,254 mg/L.

Results and Discussion:
Ultimately, this research will be used to determine the viability of algae cultivation as a renewable, alternative energy source in a region where freshwater sources are limited. The results will demonstrate the tradeoffs between salinities and availability of various water sources and compare the water use to biomass production efficiency of each species.

8. Hemolysin X (HelyX): A New Bioactive Compound with Therapeutic Potential

Student Presenter: Michael Hromada, Biochemistry and Molecular Biology - Chemistry
Faculty Advisor: Tarun Dam, Laboratory of Mechanistic Glycobiology, Chemistry

Introduction:
Plant-derived compounds play important roles in modern drug discovery and development. These compounds sometimes used directly as drugs or they act as prototypes that are modified into active drug molecules. Natural compounds of plant origin have contributed to the production of drugs for combating infection, pain, cancer and cardiovascular diseases. Some of these drugs are cytotoxic agents, meaning they are capable of killing undesirable cells. While screening various plant species for bioactive compounds, our lab recently discovered a novel cytotoxic molecule termed as Hemolysin X (HelyX).

Materials and Methods:
HelyX was isolated through aqueous and organic solvent extraction techniques. Further purification was done by precipitation and chromatography. Unlike many cytotoxic agents, HelyX is capable of rupturing/inactivating a variety of cell types including mammalian red blood cells (RBCs), cancer cells, and fungal cells. Therefore, activity of HelyX was tested with all three types of cells. Ligand binding property of HelyX was studied by inhibition assays and spectroscopic analysis. Purity of HelyX and its molecular mass was checked by

MALDI. Images of HelyX-treated red blood cells were generated by scanning electron microscopy.

Results and Discussion:
HelyX was isolated and purified in both aqueous and organic solvent system. MALDI analysis of this compound revealed a molecular weight of approximately 2 kDa. HelyX displayed sub-micromolar affinity towards specific lipids and glycoproteins that are found on mammalian cells. Our result suggests that HelyX binds to the lipid and glycoprotein molecules present on the surfaces of the cells and subsequently rupture the membranes by forming pores. Microscopic analysis demonstrated HelyX indeed induced pore formation on the cellular membrane of RBCs. Interestingly, when the cytotoxic potential of HelyX was tested against fungal and cancer cells, HelyX demonstrated significant apoptotic (systematic process of cell killing) activities. Considering its robust cytotoxic properties, HelyX has the potential to become a valuable tool for clinical research.

9. Synthesis of Boron Nitride Nanosheets for Use in Two-dimensional Devices

Student Presenter: Zack Hjorth, Physics
Faculty Advisor: Yoke Khin Yap, Physics

Introduction:
There has been a growing interest in flexible electronics, as well as the synthesis of 2D materials. Boron Nitride Nanosheets (BNNS) could be used as flexible buffers between graphene and a substrate to increase the electron mobility of the graphene by nearly ten times. Currently, producing large BNNS is a challenge because of etching on the surface of the copper catalyst used to grow the sheet. My research was attempting to fix this problem and synthesize better BNNS.

Materials and Methods:
The BNNS were grown on copper foil substrates. These acted as the catalyst for the reaction. Boron oxide powder was used for the source of boron, and ammonia gas was used as the nitrogen source. First, I would use sonication and acids to clean the surface of the copper. The substrates were then put in alumina crucibles inside a quartz tube. This was

then put into a furnace, which then was put under vacuum. The ammonia and other carrier gasses would then flow, and the temperature would be increased. Temperatures would vary, but were generally near 1100 Celsius. Once growth was complete, the samples were analyzed using SEM to see if progress was made.

Results and Discussion:
I was unsuccessful in being able to grow good quality BNNS. The process either wasn't optimized, or the summer humidity was an issue. Therefore, much of my work focused solely on the copper substrate, and what caused it to etch. I successfully demonstrated that it was not the vapor from the precursor powder that was causing etching. From literature and from my experiments, I believed it was the hydrogen gas resulting from the break-down of the ammonia gas as well as any present moisture. Unfortunately, I could not use another nitrogen source, as diatomic nitrogen was our only other gas containing nitrogen, and I could not grow in temperatures high enough to break down diatomic nitrogen. As for the moisture, I tried to curb this by annealing the powder and the substrates to remove any water, but this proved unsuccessful. Finally, to reduce etching from hydrogen interacting with the impurities on the surface of the copper, I used cleaning techniques with acid and well as annealing. This showed some success, but not enough to fix the BNNS problem.

10. Impacts of a Gradient of Silvicultural Harvests and Site Preparation Treatments on Presence of Eastern Red-Backed Salamander (Plethodon cinereus) in Northern Hardwoods

Student Presenter: Lauren Cohen, Applied Ecology and Environmental Sciences
Faculty Advisor: Yvette Dickinson, School of Forest Resources and Environmental Sciences

Introduction:
Plethodontid salamanders are sensitive to changes in forest floor microhabitat and are used as indicators of broader ecosystem change. This research examines how several silvicultural activities impact the habitat usage of the salamander Plethodon cinereus in northern hardwood forests. Our treatments included four overstory treatments (clearcut, low and high residual shelterwoods, and single-tree selection) and three understory treatments (no treatment, scarification, and artificial tip-up mound creation). Single-tree selection is the standard management for northern hardwoods and served as our control. This research

provides forest managers the necessary information to sustainably manage salamander populations in northern hardwoods.

Materials and Methods:
This experiment was conducted in the Ford Forest in Baraga, MI. We used a split-plot design with four overstory treatments and three understory treatments across 2 replicates with twelve treatment units each. In the center of each treatment unit we established a grid of 21 cover boards which we allowed to weather for nine months before beginning surveys. Roughly every four weeks in the summers of 2016, 2017, and 2018 we looked under each board and recorded the number of salamanders found and the species of each.

Results and Discussion:
The number of salamanders we found per treatment unit per survey ranged from zero to seven. Our results show that clearcutting reduced the number of salamanders found in the treated areas. We found no difference in any of the other overstory treatments. From this we conclude that clearcutting has a negative impact on salamander habitat usage, and that salamanders require some amount of canopy cover. Additionally, we found that scarification had a negative impact, yet the artificial tip-up mounds appeared to have a positive impact. Our findings suggest that if salamander presence is a concern for forest managers, some amount of canopy cover should be retained, and clearcutting and scarification treatments should be avoided.

11. Determinants of breastfeeding among younger mothers in Michigan's U.P.: A secondary analysis

Student Presenter: Bella Nutini, Exercise Science
Faculty Advisor: Kelly Kamm, Kinesiology & Integrative Physiology

Introduction:
Breastfeeding is known to have many benefits to the mother and child. Health organizations & agencies recommend to start breastfeeding within the first hour of birth, and to exclusively breastfeed for the first 6 months. However, an increase in the population of those who breastfeed is needed, specifically in our local areas where breastfeeding rates are low. Factors associated with breastfeeding in the Upper Peninsula may differ from urban areas. I

decided to analyze whether or not education level, family influences, and the knowledge of breastfeeding is associated with a mother's decision to breastfeeding for at least 4 weeks after birth.

Materials and Methods:
The Infant Feeding Practices Study was advertised to mothers of children <5 years old living in the U.P. in 2018. Interested, eligible mothers completed an anonymous, self administered survey. The majority of respondents (>90%) completed the online version of the study. Data was converted to a secure excel file. I conducted a secondary analysis of this data that contained over 108 questions. The statistical analysis was done using Chi square tests with SAS statistical software (version 9.4). By looking into detailed results between the mothers' responses, we were able to analyze whether or not there were differences in education levels, family influences, and knowledge between mothers who breastfed their youngest child for less than 4 weeks and mothers who breastfed for at least 4 weeks. I hypothesized that these factors may impact breastfeeding differently in older and younger women, therefore I limited my analysis to mothers who were less than 30 years old at the time of the birth of their youngest child.

Results and Discussion:
Of the 413 women who responded, 364 were eligible and completed the survey. My final sample was limited to mothers who were less than 30 years old at the time of the birth of the index child. An example of the analyzations that took place can be shown within the knowledge on breastfeeding section of my results. The p values for whether the advice from a lactation consultant was helpful showed no difference, whereas the p values for a health care provider (HCP) did show a difference. The HCP values showed that 16% of women who breastfed for less than 4 weeks did feel that the advice was helpful, while 32% of women who breastfed for at least 4 weeks felt it was helpful. Identifying modifiable factors that are related to a longer duration of breastfeeding can provide evidence for specific populations to target for interventions. This feedback made it apparent that advice is helpful and important to them, and healthcare providers should continue to give advice before and after birth. Based on these results, a program that improves advice given by lactation providers may be useful in order to improve breastfeeding among younger mothers in the U.P.

12. Statistical Optimization of Lignin Precipitation from Hardwood Black Liquor

Student Presenter:Lauren Spahn, Chemical Engineering
Faculty Advisor: Rebecca Ong, Chemical Engineering

Introduction:
Black liquor is a byproduct of the pulp and paper industry. Lignin is an organic polymer that can be precipitated from black liquor. This lignin can then be used in a variety of applications such as the synthesis of nanoparticles for drug delivery, and as a copolymer, increasing profit for the paper and pulp industry.

Materials and Methods:
In this project, lignin was recovered from black liquor at a pH of 14 using a modified Lingo-Boost procedure. A Box-Behnken statistical design of the experiment in Minitab was created to compare a range of temperatures (50-85 °C), pH values (1.7-7), and reaction times (1.5-3.5 hour). The black liquor was diluted with water to facilitate the reaction and was bubbled with CO_2 in order to reduce the pH to about 9-10. The pH was further reduced by the addition of 3M H_2SO_4. Following precipitation, the lignin was washed with water and vacuum filtered. A final model was created to predict the optimal experimental conditions. This process is different from a traditional lingo-boost procedure because of the water added before CO_2 flow and the added sulfuric acid to reach lower pH levels. High Performance Liquid Chromatography and ash analysis were also used to measure the amount of sugar and mineral impurities in the lignin.

Results and Discussion:
Upon initial trials, the lignin yield appeared to increase with a decrease in pH and an increase in temperature. It was found that the most optimal experimental conditions were at 85 °C, pH of 1.7, and a reaction time of 1.5 hours, with a mass yield of about 93.2 % of lignin. Ash analysis was performed to find a mineral content of about 4%-6% throughout the samples. This percentage is an estimate of the total amount of inorganic compounds in the lignin, including Na and S. The amount of inorganic content increased with reaction temperature and reaction time, while pH did not appear to have an effect. Among the sugars tested, xylose was the most abundant in the lignin samples. The lignin from the higher temperature trials had the lowest sugar content. Under high temperature acidic conditions, sugars degrade and polymerize into humans that precipitate with the lignin. The lignin resulting from this project can be used as a co-polymer in plastics, fuels, carbon fibers, and rubber products. Lignin can also be used in the synthesis of nanoparticles for drug delivery in pesticides and fertilizers.

13. Creating a New Family of Poly Carboxybetaine Copolymers

Student Presenter: Deanna Springgay, Biochemistry and Molecular Biology - Chemistry
Faculty Advisor: Patricia Heiden, Chemistry Department

Introduction:
Researchers have been pursuing the use of nanoparticles in application to cancer treatment due to their advantages of passive and targeted delivery. A popular approach for coating nanoparticles is using polyethylene glycol (PEG), though it has been found to make nanoparticles less effective in entering cells and causing immune reactions. Poly Carboxybetaine (PCBs) as a surface platform has superior performance in undiluted blood serum, along with a low immune response. PCBs are a relatively new class of polymers, with only a handful appear to have been prepared and studied for any use.

Materials and Methods:
This work focuses on the synthesis of the hydrophobic monomer in a scheme to synthesis a zwitterionic diblock copolymer. The monomer is synthesized from γ-butyrolactone and 2-(dimethylamino)ethyl acrylate in a dry environment in the presence of nitrogen gas.

Results and Discussion:
The implications of this work is in a synthesis of a new monomer that is expected to have value in biomedical applications with its advantages in comparison to PEG in stealth drug delivery. Further, this monomer is less costly in reactant prices than current alternatives studied. Further work includes polymerization with methyl methacrylate (MMA) and analyzing critical micelle concentration and micelle shapes.

14. Monitoring Migration of Cancer Cells Pre-Treated with Fructose Analogs

Student Presenter: Brennan Vogl, Biomedical Engineering
Faculty Advisor: Smitha Rao, Biomedical Engineering

Introduction:

The life expectancy of cancer patients severely decreases when cancer cells metastasize-the phenomenon where cancer cells invade surrounding tissues or migrate to distant regions of the body forming secondary tumors.1 Hence, it is imperative to understand the nature of cancer cell migration and the factors that affect it. Recent studies have shown strong dependence on fructose in growth and progression of breast cancer cells [2]. Our goal is to gain a better understanding of the links between cancer metastasis and nutrition. Towards this end, we will use microfluidic devices for visualization and characterization of cancer cell migration under different nutritional environments [3].

Materials and Methods:

Microfluidic devices (MFD) comprised of a primary chamber for cells and a secondary chamber for treatments, connected by microchannels were fabricated by soft lithography using Polydimethylsiloxane (PDMS). The microchannels were 20μm x 10μm x 1000μm (wxhxl). By placing these devices directly on tissue culture dishes, a controlled microenvironment is formed. Migration of the cells across the microchannels is monitored in real time. The cells lines used were: Normal mammary gland/breast cell line (184B5) for control, MCF7 (adenocarcinoma), and MDA-MB-231 (triple negative). The experiments were set-up as previously described. Briefly, cells seeded in a primary chamber were monitored in real time as they responded to nutritional conditions in the secondary chamber for 72 hours. The cells were fixed, stained, and imaged to assess membrane glucose transporters (GLUT2, GLUT5) and cancer migration markers (AKT3, actin, JAM-A).

Results and Discussion:

In breast cancer cells, higher expressions of the fructose-specific transporter GLUT5 has been reported. Our group has reported the fluorescently-tagged, high affinity, GLUT5-specific fructose analog ManCou-H that can distinguish between normal and cancer cells [4-6]. Using the fructose-analog, the response to uptake through GLUT5 is indicative of a fructose-specific response in cells. Using fluorescent imaging, ManCou-H uptake was quantified using ImageJ [5-6]. There was basal-level uptake in 185B5 and higher uptake in the cancer cells with MDAMB231 being highest. In terms of migration, there was no response among 184B5 cells while MDAMB231 cells had the highest migration. There was also a concentration dependent response with highest migration observed for 20μM after which migration was low or absent. Among the different cells, the fastest response was in MDAMB231, within 24 hours and with highest number of cells. Future studies will include detailed determination of cancer migration specific markers using western blot and immunostaining. Additional cell lines will also be included.

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15. Improvement of virus purification methods using cation exchange chromatography

Student Presenter: Jacob LeBarre, Chemical Engineering
Faculty Advisor: Caryn Heldt, Chemical Engineering

Introduction:
Vaccine manufacturer's ability to make pure and potent vaccines depends directly on the capability to purify viruses without a decrease in yield. Currently, anion exchange chromatography is used in virus purification, but cation exchange has the potential to have improved purity. Improved methods of purification are needed to bring to market new vaccines and gene therapy vectors. Our goal was to purify porcine parvovirus (PPV) from native cell supernatant using an ÄKTA pure FPLC with few to no pre-separation or filtration steps.

Materials and Methods:

This method is modeled after successful separation of proteins, ribonuclease A (RNase A) and lysozyme, as well as purification of recombinant adeno associated viruses (rAVVs). A 1 ml cation exchange POROS HS-50 column will be used for purification. The column will be equilibrated with a 50mM citrate/phosphate buffer at pH 3.5 and loaded with virus. Elution is to be performed with 50mM citrate/phosphate buffers at pH 4-7 increasing in 1 pH unit increments. An MTT assay will be used to evaluate the titer of the virus before and after purification and purity will be assessed with SDS-PAGE. The goal is a greater than 60% recovery of virus and a reduction in impurities by more than 90%.

Results and Discussion:
A chromatogram was generated to display time of elution of virus from the column while showing the change in the pH in the system simultaneously. With the known isoelectric point of PPV at 5, we can expect it will elute at around pH 5 because its net charge will be zero. Using the chromatogram, the process was then optimized by reducing the number of pH steps, thus decreasing cycle time. Development of this method resulted in a process more versatile to apply to other viruses.

16. Impact of Community and Institutional Factors on Breastfeeding Practices in the U.P.

Student Presenter: Alexa Destrampe, Exercise Science
Faculty Advisor: Kelly Kamm, Kinesiology and Integrative Physiology

Introduction:
Breastfeeding is recognized as having important health effects to both mothers and infants. Breast milk contains unique immunological factors and holds the nutritional value necessary for a child. Despite these known benefits of breastfeeding, many mothers in the U.P. never start or breastfeed less than the recommended 6 months. In a rural, medically underserved area, like the Upper Peninsula, it is unknown if inadequate availability or low access to resources promoting breastfeeding affect a mother's choice to breastfeed. This information will give insight into what future interventions are needed in order to foster a growing number of breastfeeding mothers.

Materials and Methods:
A cross-sectional study to collect information from mothers of children <5 years old who reside in the Upper Peninsula of Michigan was conducted in 2018. Participants responded to advertisements about the study and completed an anonymous survey. I used this data for a secondary analysis. I used SAS statistical software to calculate chi-square values to determine whether or not a factor was significantly associated with a mother exclusively breastfeeding at least 4 weeks after birth. Examples of factors include demographics, access to medical care from prenatal to postnatal stages, knowledge of community resources, and social support.

Results and Discussion:
Of the 413 women who responded to the survey, 317 were eligible to participate in this analysis. They completed the survey and provided information about the duration of exclusive breastfeeding for their youngest child. Distance to prenatal care, information about breastfeeding support programs, attending a prenatal class, or having help with breastfeeding after birth were not associated with breastfeeding at least 4 weeks after birth. However, working mothers who breastfed for at least 4 weeks (84%) were more likely to report that they had a location to breastfeed or pump at their workplace than those who had breastfed for <4 weeks (60%). In addition, women who breastfed for at least four weeks (38%) were more likely to report being very comfortable while nursing or pumping at work than the women who had breastfed <4 weeks (6%). There are large variations in workplaces in the Upper Peninsula. Small businesses are exempt from policies set by the Affordable Care Act regarding spaces for pumping. Having institutional policies that support breastfeeding is not only important to ensure women have a space to breastfeed or pump but to also to maximize comfort in a workplace.

17. Motor learning as a sensitive behavioral marker of early Alzheimer's disease

Student Presenter:Michelle Burge, Exercise Science
Faculty Advisor: Kevin Trewartha, Cognitive and Learning Science

Introduction:
Alzheimer’s disease (AD) is the sixth leading cause of death in the United States and is apparent in 60-80% of all cases of dementia. While there have been studies done to learn about the early onsets of AD and mild cognitive impairment (MCI), most are done assessing

the diseases as cognition based and not motor control based. It is hypothesized that patients with MCI and AD will show impairments during cognition and motor control testing compared to healthy aging adults.

Materials and Methods:
There will be three separate sessions to test declarative and nondeclarative memory. The first session is to determine the sensitivity and specificity of motor learning measures to cognitive impairments. To execute this there will be a robot with a force channel attached and subjects will go through four phases; familiarization, adaptation, counter-adaptation, and error-clamp phase. This is used to observe quickly or slowly the MCI and AD patients adapt to changing forces over time. The second session is going to identify impairments in long-term retention of motor learning in MCI and AD patients. The purpose of this is to test the savings in memory after a 24-hour period. For execution participants will arrive on Day 1 and adapt to a perturbation task and then on Day 2 they will go through a 'wash-out' period to ensure they will need to re-learn the task. After some time on Day 2 the participants will go through the entire motor task again to see how well they remember and learned the task prior. The final session is to determine the utility of a self-report aiming method for isolating multiple memory systems for motor learning in MCI and AD patients.

Results and Discussion:
We recently used this procedure to collect pilot data from four AD patients. Importantly, these patients exhibit reduced rebound in the error-clamp phase, similar to healthy older adults with poor working memory performance, taken from our previous study. However, they also show an additional decline in performance during the initial adaptation phase that was not observed in the healthy older adults. This observation is consistent with our prediction that AD patients will exhibit additional impairments in the fast learning rate and fast retention factor compared to healthy elderly. In our project we will expand this sample to include more AD patients as well as an MCI group. We will model the data from each individual and correlate the fast and slow learning rates and retention factors with scores on the neuropsychological battery, and our spatial paired-associate working memory task, to determine if impairments in the fast and slow process scale with disease severity.

18. Blood-typing and Hematocrit Testing Using Point of Care Methods on Medical Microdevices

Student Presenter: Logan McMillan, Chemical Engineering
Faculty Advisor: Adrienne Minerick, Chemical Engineering

Introduction:
This research is so important, because many people across the globe have blood diseases, mild and severe, they don't know they have. What we have been doing the last 6 months is immersing ourselves in the world of assembling medical micro-devices and utilizing them to conduct hematocrit and blood type testing. Our devices are point of care testing and will be the answer to many obstacles that plague medical teams in and out of states of emergency. Determining someone's blood type can be crucial especially in dire need. These new devices will aid in quick field thinking.

Materials and Methods:
These microdevices are composed of carbon electrodes on a silicon wafer stretching 300 microns apart. Whole blood from a donor is centrifuged down, supernatant (plasma) removed, and a 0.25% red blood cell to 99.75% 1X Phosphate buffered saline solution, with a conductivity of 500.0 μS/cm, is mixed together. This allows us to control the concentration variable and clearly see the red blood cells as they go through pDEP (positive Dielectrophoresis) and nDEP (negative Dielectrophoresis). A single drop of diluted blood solution is inserted into the inlet of the device, a small field of 0.012 volts/micron is applied, and a GUI program designed specifically for this testing operated through the computer generates a plot of frequency versus current. Depending on blood type the graphs will appear different, giving us peaks of currents at different frequencies. Blood types A+, O+, and O- from several donors have been experimented on. Each data collected from a single run is compared to that of the other blood types and similar blood types, but different donors and is categorized into specific current ranges.

Results and Discussion:
Even though we are still working, the results we have secured so far have indicated there being a difference in current peaking at various frequencies depending on blood type. There is a noticeable shift in red blood cell movement, but it appears that this does not affect the peaks or lack thereof. We will be conducting new experiments with a much higher red blood cell concentration to imitate whole blood concentrations of 40% red blood cells to 60% plasma since blood tests are done with whole blood serum and not diluted solutions.

19. Fuzzy C-Means Algorithm Applied for Fraud Detection

Student Presenter: Jessica Brown, Computer Science
Faculty Advisor: Tim Havens, Computer Engineering

Introduction:
A bank reached out to Dr. Havens regarding the application of his research to a portion of their customer data. Our customer is asking for an algorithm that sorts transactions that are made through the bank into multiple clusters. The clustering will be based on many different elements of the transactions, including common signs of fraud. Results will provide groupings of common transactions, including potential fraudulent transactions. The customer will then be able to use this information to identify and prevent fraud.

Materials and Methods:
Completing this task involves the creation of an algorithm and adapting it to the given dataset. We are using the coding language python for implementation, and creating this in Jupyter Lab. The algorithm is a fuzzy c-means. It not only clusters data into multiple different groups, but it allows for the data points to be part of more than one cluster. The algorithm is:

$$\theta_j(t) = \left(\sum_{i=1}^{N} [u_{ij}^{q}(t-1)x_i]\right) / \left(\sum_{i=1}^{N} [u_{ij}^{q}(t-1)]\right)$$

Θ = the cluster q= “fuzzifier”
N = Width of matrix t= variable
u= N × m matrix x= dataset

It will input the data from a file, and analyze all unique aspects to each datapoint. Based off of these results, data points that are deemed as similar to each other will be “clumped” together into a grouping. This process will repeat itself until the algorithm has converged. We will first create the basis of the algorithm. And then adapt it to fit the dataset, and import the dataset into it to test. Then we will finetune until the desired results are achieved.

Results and Discussion:
Due to the classified nature of the dataset (bank transactions), the legal processes took some time and we just recently a sample set of invoices for testing purposes. We are now beginning to analyze and understand all the different dimensions of the data, and in upcoming weeks will begin to create the algorithm. We anticipate that the algorithm will compute the data properly, and output multiple clusters of data giving us an idea of how likely the transaction was fraudulent.

While waiting for this dataset, I have been learning about the nature of this algorithm and how it works. I have been given the task of coding a k-means algorithm, which is very similar to the fuzzy c-means. They are the same except for the k-means doesn't allow for data points to be part of multiple clusters. Working with this algorithm has given me knowledge of the fundamentals of this algorithm, which are essential for when I begin to work on the more complicated fuzzy c-means.

20. Low emissions /High Efficiency Three Way Catalyst in a Micro-Pilot Diesel Natural Gas Dual Fuel Combustion Engine

Student Presenter: Zachary A. Kondrad, Mechanical Engineering
Faculty Advisor: Jeffrey Naber, Mechanical Engineering-Engineering Mechanics

Introduction:
As environmental concerns regarding pollutants and the search for alternative fuel sources increase, it becomes necessary to understand harmful emissions and how to reduce them in internal combustion engine processes. The purpose of this study is to quantify the tailpipe emissions and conversion efficiency of a three way catalyst (TWC) in a Diesel/Natural Gas dual-fuel combustion system at light loads operating at stoichiometric condition. The study is performed through analysis of emissions data with and without a catalytic converter, identifying how a TWC operates under stoichiometric and different air-to-fuel ratios (lambda), and examining catalytic operation at different temperatures.

Materials and Methods:
The engine under study is a Cummins ISB 6.7L converted to dual fuel (Diesel/ Natural gas) operation, with the primary interest in the dual fuel system running at light loads (5-4 bar IMEP) and low speeds (1200 RPM) with exhaust gas recirculation (EGR) and stoichiometric air to fuel ratio. Data collection occurred via the Five Gas Analyzer Horiba Mexa 1600D emissions bench, allowing for measurements including unburned hydrocarbons, carbon dioxide, nitrogen oxides, oxygen, and carbon monoxide. This data was measured for three distinct testing conditions: emissions as measured both upstream and downstream the TWC, a lambda sweep, and light off temperature. The emissions with versus without the catalyst provide a baseline to determine catalytic efficiency at removing harmful pollutants at standard conditions. The lambda sweep, which varies the air-to-fuel ratio, will provide answers as to how the catalyst runs in different air to fuel ratio conditions. Finally, the light off temperature, which is taken by measuring emissions from the engine before the catalysts

temperature increases, providing evidence as to what the minimum temperature is for the TWC reactions to take place. This data will be processed using a MATLAB code and the Engineering Equation Solver (EES).

Results and Discussion:
The anticipated result of this study is to verify the efficiency of the TWC application in a dual fuel engine running at light loads, which main disadvantage is the increase in unburned hydrocarbons. Furthermore, the lambda sweep test is expected to show the performance at various operating air to fuel ratios. These results are expected to confirm the trend of nitrogen oxide conversion efficiency decline as lambda goes lean and that tailpipe hydrocarbon emissions remain near zero in these conditions. This provides a basis for ideal operating conditions to maximize catalyst performance and minimize emissions in the studied internal combustion engine. Finally, as a result of the light off temperature, it is expected that as the temperature increases, approaching the normal catalyst operating temperature, the catalytic efficiency should improve. This is a result of increased atomic kinetic energy, which promotes the catalytic reaction and ensures that more harmful emissions are transformed into clean waste.

21. Ultrafiltration of Colloidal Silica: Reduction of Concentration Polarization by Turbulence

Student Presenter: Samuel Jacobs, Chemical Engineering
Faculty Advisor: Andre R. Da Costa, Chemical Engineering

Introduction:
Removal of contaminants from water is essential to provide safe drinking water. Membrane separation is increasingly being adopted in water purification processes for drinking and industrial needs. The biggest issue encountered with membrane filtration is fouling, which decreases membrane performance. Fouling occurs when particles are deposited on the membrane surface or in the membrane pores. One strategy to decrease fouling is through turbulence promotion such as stirring. Turbulence decreases the rejected solute concentration at the membrane surface, called concentration polarization. In this work we

studied the effect of stirring speed (rpm) on fouling and the overall membrane ultrafiltration performance.

Materials and Methods:
Data on the effect of turbulence on fouling was obtained using a stirred cell dead-end ultrafiltration (UF) set up. A polyethersulfone UF membrane was used with a MWCO of 10 kDa. Low concentrations of colloidal silica in water (0.5-2%) were used as the feed to the UF membrane at 30 PSI. Stirring speeds were varied from 0 to 1000 RPM using a magnetic stirrer. Pure water flux was recorded before and after each experiment to measure the membrane fouling. Colloidal silica concentration was measured using a Cary 60 UV-Vis Spectrophotometer at a wavelength of 270 nm.

Results and Discussion:
It was hypothesized that as stirring speed increased an increase in flux would be observed. The results from our experiments confirm this hypothesis. It was found that stirring can successfully be used as a turbulence promoter to increase membrane flux up to 300 %, compared with absence of turbulence. Rejection rates of colloidal silica by the UF membrane were found to be 81% +/- 6%. The results indicate that there may be a limiting flux for stirring speeds above 600 RPM. Future work will look more deeply into the limiting flux and also into other strategies to decrease fouling.

22. Extraction of Waxes and Lipids from Sorghum Using Green and Renewable Solvents

Student Presenter: Marissa Gallmeyer, Chemical Engineering
Faculty Advisor: Rebecca Ong, Chemical Engineering

Introduction:
Plant matter contains waxes and lipids that can be extracted and used or sold as a value-added product prior to conversion of the remaining plant material to biofuels. Wax and lipid extraction of plant materials is currently performed using volatile, non-renewable hydrocarbons, primarily hexane, which is produced from fossil fuels and can pose a health and safety hazard. The purpose of this study is to compare the amount and characteristics of waxes extracted by hexane with those extracted using organic solvents that are less toxic and can be produced from renewable sources.

Materials and Methods:
The energy sorghum used for this study was grown in Arlington, WI in 2014 and milled to pass through a 5 mm screen. Sorghum extractions were carried out using the Dionex ASE 350 Accelerated Solvent Extractor. Biomass samples were extracted separately with hexane, tetrahydrofuran, 2-methyltetrahydrofuran, gamma-valerolactone, and d-limonene. Each solvent was used to conduct triplicate extractions on untreated sorghum at 40°C, 60°C, 80°C, and 100°C. After the extractions were performed, the solvent was evaporated using the Genevac Rocket Evaporation System. The amount of wax extracted was determined, and then redissolved in a small amount of solvent for further characterization. The biomass used for extractions was dried and stored for further testing.

Results and Discussion:
Experiments are currently ongoing, however initial data on hexane extractions show an increasing effect due to temperature. The hexane extracted an average of 0.0134±0.0017 grams of extractive per gram of biomass in extractions performed at 40°C, 0.0194±0.0061 grams of extractive per gram of biomass at 60°C, 0.0108±0.0013 grams of extractive per gram of biomass at 80°C and 0.0262±0.0065 grams of extractive per gram of biomass at 100°C. We anticipate that tetrahydrofuran, 2-methyltetrahydrofuran, gamma-valerolactone, and d-limonene will produce similar or more favorable results. The use of these solvents could increase safety, profits, and renewability.

23. Viral Partitioning in Aqueous Two Phase System with Osmolytes

Student Presenter: Michael Anthony Schroeder, Chemical Engineering
Faculty Advisor:Caryn Heldt, Chemical Engineering

Introduction:
One contributor to the low vaccinate rate globally is the high cost and low yields of production by the traditional methods, such as filtration and chromatography. In this view, a non-conventional unit operation, aqueous two-phase system (ATPS) has the potential to abate cost and processing time of vaccines. ATPS are generally formed by two aqueous solution, e.g. polymer-polymer and polymer-salt, separating into two-phases (like oil and water) above certain critical concentrations. The current research proposed is to enhance

virus recoveries using lower concentration ATPS by adding osmolytes, which are naturally occurring water-loving compounds.

Materials and Methods:
A relatively hydrophobic polyethylene glycol (PEG) 12 kDa and highly hydrated citrate salt were used to form two-phases at pH 7, with the inclusion of osmolytes (glycine and betaine). The systems were characterized by binodal curves and tie lines. Binodal curves are the minimum compositions required to form two-phases and tie lines are systems that separate into the same top (PEG-rich) and bottom (citrate-rich) phase compositions. Binodal curves were determined by the turbidity method and tie lines were generated by measuring the citrate concentration in the bottom phases using conductivity. A non-enveloped virus -porcine parvovirus (PPV) was used as a model to determine the recovery and purification of the ATPS. The virus recoveries were calculated by measuring viral titers in a cell proliferation assay – MTT50 assay and reading the equilibrium phase volumes.

Results and Discussion:
Our previous study concluded that virus partitioning is driven by salting-out effect from the citrate-rich phase and hydrophobic interaction from the PEG-rich phase. However, the optimum driving forces were observed at higher concentrations of PEG and citrate. This both increases the cost of the ATPS and also increases the viscosity, making pumping at manufacturing scale very difficult. The initial characterization of the osmolyte ATPS showed two-phase formation at lower PEG and citrate concentrations. Tie line slopes decreased, resulting in less water in the PEG-rich phase and a more hydrated citrate-rich phase. This change in water composition improved the salting-out of the citrate-rich phase and improved the hydrophobic interactions of the PEG-rich phase, therefore improving virus recovery and purification. Systems with glycine showed ~100% virus recoveries as compared to 30% recoveries without osmolytes. Systems with betaine were able to achieve ~90% recoveries. These higher recoveries use less PEG and citrate, therefore reducing viscosity and improving the processing of the system at large scale. Therefore, this new ATPS can not only improve the production capacity of vaccines but also can help reduce the cost. This will help to improve the overall coverage of vaccines worldwide.

24. Curcumin Binding Modulates SOD1 Stability: A Computational Study

Student Presenter: Sam Willard, Biochemistry and Molecular Biology - Chemistry and Cheminformatics
Faculty Advisor: Ashutosh Tiwari, Chemistry

Introduction:
Amyotrophic Lateral Sclerosis (ALS) is a fatal neurodegenerative disease that leads to muscle loss, paralysis and eventual death. Nearly 6% of ALS patients have one of over 100 identified mutations in the Cu/Zn Superoxide Dismutase I (SOD1) gene. The hallmark of ALS is observation of SOD1 cytoplasmic aggregates in late stage of the disease that maybe oligomeric, or fibrillar in nature. Recently, curcumin, a diphenyl compound found in turmeric, was shown to control SOD1 oligomerization in vitro. We wanted to study how curcumin binding modulates SOD1 stability, hence aggregation, which is key to understanding its role in ALS.

Materials and Methods:
Docking simulations were performed using AutoDock Vina on several common SOD1 mutants: holo-WT, apo-WT, A4V, C57S, G85R, G93A, and D124V. Blind docking of curcumin was performed on each mutant and the ten lowest energy structures were used for further analysis. PyMol was used to visualize the resulting structures, PLIP was used to identify interacting residues and DrugScore DSX provided an independent score. One major limitation of AutoDock is that it doesn't allow for protein flexibility. Therefore, we also used Rosetta Commons, a protein modeling suite that supports ligand docking but not blind ligand docking. We developed two methods to allow for blind docking and benchmarked against known crystal structure of curcumin (both enol and keto forms) and transthyretin. The top 10% of these structures were then clustered and compared to the native structure. The better performing of these two methods can then be used to dock curcumin to SOD1 and its mutants to compare against the AutoDock results.

Results and Discussion:
Our Autodock results matched those reported in a peer reviewed paper with all the SOD1 mutants preferentially binding curcumin in the deep channel at the dimer interface of the protein. This suggests that curcumin may stabilize the dimer interface by acting as a bridge between the two monomers. This stabilization of interface will reduce monomerization, which is believed to be an important step in SOD1 aggregation and toxicity. Interestingly, the A4V, G85R, and G93A mutants also exhibited curcumin binding in locations away from the dimer interface. A4V exhibited binding near the dimer interface but away from the site of mutation and G93A curcumin exhibited a potential binding site on the cap of the beta barrel. To validate these computational results Tiwari lab plans to carry out wet lab experiments

(competitive binding assay with curcumin). If the experimental data agrees with the computational work then the predicted binding site should be the very likely site where the curcumin binds to modulate its effect on protein aggregation and toxicity. This site will serve as an effective target for rational drug design using small molecules.

25. Maize Growth in Lignin-Rich Fermentation Residue Enhanced Upper Peninsula Soils

Student Presenter: Meredith Grusnick, Chemical Engineering
Faculty Advisor: Rebecca G. Ong, Chemical Engineering

Introduction:
During lignocellulosic biofuel production, cell wall sugars are converted into fuel. However, residual biomass remains that is enriched in lignin and high in organic carbon and nitrogen. This residual biomass could be used as a cost effective and environmentally friendly soil enhancement. Soils with higher organic carbon content have shown increased water holding capacity and pH. It is possible for the residue nitrogen to function as fertilizer, reducing the need for other applications. The goal of this experiment was to determine the effect of corn stover-residue amendment on the characteristics of maize plants grown in marginal soil from Escanaba, MI.

Materials and Methods:
Soil with type, Onaway-Ossineke fine sandy loam,1-6% slopes, were collected from the MSU Forest Biomass Innovation Center (FBIC) in Escanaba, MI. Lignin residue was generated from enzymatic hydrolysis of ammonia fiber expansion (AFEX) pretreated corn stover. In an initial experiment, residue was mixed with soil in amounts that increased the percentage of organic carbon by 0%, 2%, 10%, or 25% and packed in triplicate soil columns. Water was added on a 124mL/week basis, and the filtrate was evaluated for pH and volume. To investigate the effect of amendment addition on maize growth, soils were amended with residue to create the same conditions, and added to 3.8 L pots in six replicates for each treatment. Monopotassium phosphate and potassium chloride were mixed in at levels equivalent to 125 lb P_2O_5 and 200 lb K_2O/acre. Urea was added to half the replicates to maintain a constant nitrogen loading of 230 lb N/acre. Prior to planting, corn seeds were

sorted to ensure consistent mass and planted at 1” depth in pots in triplicate. Once 2” in height, the plants were thinned to a single plant per pot and evaluated over time for growth, ear production, and nitrogen deficiency.

Results and Discussion:
Initial work showed that the addition of lignin residue had no major long-term effect on the pH of the soil. The final pH of soil column filtrates were: 8.32±0.222, 8.26±0.256, 8.54±0.090, and 8.85±0.143. For the increased percentage of organic carbon of 25%, 10%, 2%, and 0% respectively. The other major conclusion drawn from the soil column experiment was that the water holding capacity of soils were not affected. Final CN content of the soils was analyzed and showed for the increased percentage of organic carbon of 25%, 10%, 2%, and 0% the percentage of organic carbon was 3.81±2.20, 4.18±1.53, 4.14±1.80, and 3.89±0.83 respectively. The percentage of nitrogen was 0.234±0.177, 0.235±0.086, 0.229±0.101, and 0.243±0.056 respectively. The next step in this research is to analyze the growth of maize plants in the amended soil.

26. Medical Imaging Derived 3D Computational Torso Model: A Future Platform for Ultrasound Simulation

Student Presenter: Austin Goudge, Biomedical/Mechanical Engineering
Faculty Advisor: Jingfeng Jiang, Biomedical Engineering

Introduction:
Generating complex 3D-computational models of the human torso from medical imaging data that is applicable for ultrasound simulation/testing remains a complex problem. The purpose of this project was to develop a 3D representational model that allowed individual assignment of material properties of the many organs and surfaces of the torso. The resulting product will be applied to future ultrasound simulations and studies, and the methods used for model construction could be adapted for complex model creation of other areas of the human body.

Materials and Methods:
The initial model from medical imaging data had two major obstacles to overcome: the surfaces and organs were a single entity and imaging errors altering organ geometry needed correcting. The commercial mesh editing and finite element software 3-matic was used to edit the initial medical imaging data. The skin and muscles first separated into

distinct surfaces. The incomplete geometries and/or errors around organs in the full body scan were corrected by loading in spatially identical models of each organ, taken from organ-specific scans. Boolean operations between the two surfaces then corrected organ geometry and removed surrounding errors. Additional errors in organ geometries that still required correcting (post above method) to more accurately represent anatomical structure(s) were adjusted using a combination of techniques: surface smoothing, lofting (joining cross-sections of separated surfaces), push/pull (adjusting indentations in surface), and filling surface holes.

Results and Discussion:
This project was able to generate and improved 3D model of the surfaces and organs of a human torso based off of medical imaging data. Additionally, the model was able to maintain intra-organ connectivity while keeping individual organs distinct structures so their appropriate material properties could be assigned. As this is an ongoing project, investigations will continue to improve some of the initial limitations of the generated model: limiting user-specific correction of anatomical structure of organs and including additional tissues relevant for mechanical or ultrasound simulation (adipose tissue, large vascular structures). Subsequent investigations will use this model to assess how the current (and additional) model improvements may impact simulation outcomes. Overall this study will be used as a stepping stone for improvements and advancements in ultrasound simulation and model development. As this initial work only focused on the surfaces and organs of the torso, additional work can be performed to include the remaining structures and organ of the human body.

27. Development of an age-predicted maximum heart rate equation for upper-body exercise

Student Presenter: Abby Sutherland, Exercise Science
Faculty Advisor: Steven Elmer, Kinesiology and Integrative Physiology

Introduction:
Upper-body exercise is used as a mode of physical conditioning as well as rehabilitation. Knowledge of a client or patient's maximum heart rate is important for safe and optimal upper-body exercise prescription. Two primary equations found in previous literature predict

maximum heart rate from age: 220 - (age), and 208 - (0.7*age). However, these two equations are targeted toward lower-body exercise such as walking, running, or jogging. These equations could overestimate maximum heart rate and result in unsafe upper-body exercise prescription. The purpose of this study is to identify an age-predicted equation for maximum heart rate specifically for upper-body exercise.

Materials and Methods:
Twenty males and 20 females will be recruited in each of six age categories: ages 20-30, 31-40, 41-50, 51-60, 61-70, and 71-80. Participants will perform an incremental arm cranking testing for determination of upper-body peak oxygen consumption (VO2peak) and peak heart rate. The test will be performed on a cycle ergometer modified for upper-body exercise (arm biking). Achieved upper-body peak heart rate will be plotted against age. Regression techniques will be used to generate a line of best fit, from which the slope and y-intercept will be used to determine the underlying equation that can then be used to predict peak heart rate.

Results and Discussion:
We expect to see an inverse relationship between age and maximum heart rate; maximum heart rate will decrease with increasing age. Prior to testing this hypothesis, we needed to identify arm cranking protocols that would elicit peak responses for males and females within the above named age groups. To date, we have laid the groundwork for this study by developing the arm cranking protocol and ensuring that the equipment is in place and operational. The results of this study will advance the clinical prescription of upper-body exercise, specifically in helping clinicians prescribe safe and accurate arm cranking exercise intensities in cardiac and respiratory rehabilitation, as well as physical therapy. As evident in these clinical settings, this study will have a broad impact on improving human life in the form of safer and more accurate exercise prescriptions. Other groups such as coaches and upper-body trained athletes may also find the equation developed in this study useful for training.

28. Understanding the Possibilities: Local Farmers Share Opportunities for Sustainable Local Food Systems Development

Student Presenter: Jack Wilson, Sustainability Science and Society
Faculty Advisor: Angie Carter, Social Sciences

Introduction:
We are forever grateful to the Keweenaw Bay Indian Community and their ancestors for maintaining the prosperity of this region so that we may today still taste its fruits and be cleansed by its waters. This relationship between people and Earth has existed since time immemorial and continues today. In this preliminary qualitative study, I asked area farmers about our local food system in order to understand the challenges and opportunities that they face in continuing to build upon this relationship.

Materials and Methods:
Given the potential to build a food system contributing to regional social, economic, and environmental sustainability, I interviewed local farmers because they serve as our food system's foundation. My guiding research question was: How can local food system initiatives be designed in a way that addresses the challenges faced by our farmers, as well as build upon the opportunities for growth that they see? To collect exploratory data in response to this question, I conducted six in-depth interviews (Rubin and Rubin, 1995) with local farmers and producers in the Keweenaw community. Interviewees were recruited via email and phone calls. The interview guide built upon initial ethnographic work from two different classes (SS 4211 Ethnographic Methods and SS 4700 Communities & Research). The interview guide included questions about growing, marketing, and the community. Interviews were recorded through digital recordings and/or detailed notes, transcribed, and then analyzed using line-by-line coding through grounded theory (Charmaz 2014). This study contributes to the community food assessment led by the newly-formed Western UP Food Systems Council, a collaborative initiative among local farmers, MTU, Keweenaw Bay Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa Indians, Western UP Planning & Development Region, and local business and civic leaders.

Results and Discussion:
Interviewees were involved in producing a diversity of different foods including vegetables, fruits, berries, nuts, herbs, mushrooms, and many other things. Though their operations differed, these farmers shared common challenges including: accessing labor, managing distribution, and marketing products. Despite the challenges unique to the Keweenaw, many of the farmers are innovating and creating ways to adapt to those challenges through studying and experimenting with different growing methods and getting federal grants to put up hoop houses that extend the season. There is a popular belief that we are too limited by a short growing season because of our latitude to have a strong local food system. However, being a peninsula surrounded by the biggest lake in the world, our geography and dynamic topography actually creates for a heterogenous mosaic of different ecosystems, microclimates, and growing conditions. Additionally, with some of the local farmers that I

interviewed reaching retirement and beginning to downscale, there exists abundant opportunities for more people to get involved in growing food for our community. Finally, ample opportunities exist for transdisciplinary research studying topics from labor access to the diversity growing conditions in the Keweenaw as well as researching the feasibility of a local food hub.

29. Prenatal and Demographic Influences on Breastfeeding in the U.P.

Student Presenter: Anne Fife, Biological Sciences-Pre Professional
Faculty Advisor: Kelly Kamm, Kinesiology and Integrative Physiology

Introduction:
The topic of breastfeeding is one of much debate. The World Health Organization (WHO) recommends that babies are fed exclusively breast milk for the first six months of life and can continue to be breastfed, accompanied with other food sources, up to two years of age. Breastfeeding is beneficial for both mother and child; however, many areas in the U.P. are known to have low rates of breastfeeding. Prenatal education has the potential to impact breastfeeding rates, since research has shown that intention to breastfeed is strongly associated with breastfeeding practices, but demographic factors may also impact a mother's decision. This study looks at the factors that influence a woman's decision to breastfeed, both prenatal and demographic.

Materials and Methods:
In 2018, the Infant Feeding Practices study was advertised in the U.P. Women with at least one child <5 years old that lived in the U.P. were eligible to participate and completed a self-administered, anonymous survey. Of the 413 responses received, 317 were eligible, completed the survey, and provided information on duration of exclusive breastfeeding with their youngest child. This analysis is a secondary analysis of the Infant Feeding Practices study. Prenatal factors in this study include whether or not women took part in a birthing class during their pregnancy, provider advice regarding breastfeeding and family advice regarding breastfeeding. Demographic factors in this study include age, education levels and income of the women. The outcome of interest was breastfeeding at least two weeks after birth. Women taking part in this study were categorized by whether they breastfed their children for less than two weeks or greater than or equal to two weeks. Length of breastfeeding was then stratified by income and education to determine if the results differed

within these groups. Chi square models were used to analyze the effect each of the previously mentioned variables had on the length of breastfeeding.

Results and Discussion:
Chi square models revealed that all six variables had no statistically significant effect on length of breastfeeding in the overall models. Preliminary results indicate provider advice is associated with length of breastfeeding among women with lower income but not among women with higher income. Further results from the stratified results are pending.
Factors that are thought to and have been shown to be related to length of breastfeeding were not significant in this sample of women in the U.P. In this sample the factors associated with breastfeeding are different between lower and higher educated and income mothers. Programs should be put in place that consider these factors and their effects in this population in order to improve breastfeeding rates.

30. Novel Particle Image Velocimetry Method for Traction Force Microscopy Application

Student Presenter: Sue Yon Kim, Biomedical Engineering
Faculty Advisor: Sangyoon Han, Biomedical Engineering

Introduction:
Traction Force Microscopy (TFM) quantifies the traction force of the cell on the matrix from the deformation of a soft gel with known elastic modulus. The deformation has been quantified with the use of Particle Image Velocimetry (PIV) which uses cross-correlation analysis of smaller image patches between a pair of images containing fluorescent markers at contracted and relaxed states of the gel. This research investigates the limitations on the current PIV methods to process images containing large deformation and proposes a better method suitable for high-resolution TFM.

Materials and Methods:
For this research, two distinctive methods of bead tracking methods, Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV) were compared. PIV method subdivides the images into small interrogation areas and the average particle displacements of these areas are determined by cross-correlation between reference and bead images. In PTV, individual beads are detected by defining an interrogation window and a search region

for the process of cross-correlation. To validate the multiple PIV methods and the PTV method, a pair of synthetic bead images are created by super-positioning Gaussian functions with known displacements from the known force field (i.e., bead images at contracted and relaxed gel configuration). The pair of the bead images were tracked with PIV methods (PIVSuite by Jiri Vejrazka, Qingzong Tseng's PIV plugin in ImageJ and mpiv by Mori Nobuhito) and the PTV. Once the displacement field results were obtained, all displacement vectors were evaluated by comparing with the ground-truth displacement field. Parameters for cross-correlation template window, displacement field calculation, and correction are evaluated with testing a range of values for obtaining a result that closely matches the ground truth displacement field.

Results and Discussion:
Although PIV methods and the current PTV method were able to track small displacements, those have failed to track extra-large displacement vectors (> 30 pixels) because of underestimation of the large deformation region and filling the regions with smaller displacement vectors. PIV methods had an inherent problem of interpolating missing vectors from the deformation of the neighboring image templates. To rescue the missing, large vectors, PTV-based "re-tracking" method shows the ability to distinguish and pick up the large displacement vectors. Retracking is done by a comparison of neighboring vectors and determining the displacement of each individual bead using the local distribution pattern of the neighboring vector. Once the re-tracking option was used with PTV, about 70 % of missing vectors were able to be revived. A further improvement of the 're-tracking' algorithm was made by reducing the template size and narrowing the search radius for neighboring vectors. PTV method has shown also the same a superior displacement tracking results when it is applied to bead images obtained from the in-vivo TFM experiment of a CHOK cell on 5 kPa soft gel substrate. The research validates that the new PTV-based method is more promising than currently available PIV methods for TFM application.

31. Understanding physiological relevance of differences in NO production in clinical samples for wound healing

Student Presenter: Sarah Wayward, Biomedical Engineering
Faculty Advisor: Smitha Rao, Biomedical Engineering

Introduction:
As of 2017, about 425 million adults have been diagnosed with diabetes, ranging in ages 20 to 79, with a 34% risk of developing a foot ulcer. More than 50% of the ulcers have the risk of infection and sepsis. Compromised wound healing among the diabetic population contributes to amputation in 20% of diagnosed cases. The 5-year, post-operation mortality rate is approximately 50%. Wound healing is a complex process involving hemostasis, inflammation, proliferation, and remodeling. The vital steps include the interaction between macrophages, fibroblasts, and keratinocytes. While the impact of nitric oxide (NO) on cell proliferation and its cytotoxic effects have been reported, to date, its significance in the various stages of wound healing remain unclear. Existing evidence identifies a dose-dependent interaction between cells and NO. Hence, we hypothesize that physiologically relevant NO released from smart wound dressings will enhance wound healing in diabetes, improving treatment outcomes.

Materials and Methods:
The approach relies on understanding the NO production at the wound site. Here we present the real-time NO measurements obtained from wound dermal fibroblast cells under normal and high glucose conditions.

Results and Discussion:
Currently we are measuring the real time NO levels in wound dermal fibroblast cells under normal and high glucose conditions. The NO levels in normal human dermal fibroblast cells cultured in similar conditions have already been determined. The NO levels obtained from the wound dermal fibroblasts will be compared to the NO levels from normal dermal fibroblasts. Based on the results obtained the typical time and dosage of NO under these specific conditions will be experimentally quantified in order to engineer wound dressings that deliver physiologically controlled doses of NO to facilitate healing in diabetic foot ulcers.

32. Ambulatory Blood Pressure Patterns and Arterial Stiffness in Adults: A Pilot Study

Student Presenter: Thomas Basala, Biological Sciences - SBL5 (Pre-Health Professions)
Faculty Advisor: John J. Durocher, Biological Sciences

Introduction:
Ambulatory blood pressure monitors (ABPMs) provide detailed information about 24-hour blood pressure patterns. Previous studies have demonstrated that hypertensive adults who have non-dipping blood pressure patterns during sleep have increased arterial stiffness. The purpose of the present study was to explore if indices of arterial stiffness and morning blood pressure surges from ABPMs are related to the

gold-standard assessment of arterial stiffness through carotid-femoral pulse wave velocity (cfPWV). We hypothesized that there would be a direct relationship between ambulatory estimates of arterial stiffness and cfPWV, and a direct relationship between morning blood pressure surge and cfPWV.

Materials and Methods:
Ten adults (7 male, 3 female) completed 24-hour ABPM assessment (Spacelabs) with simultaneous wrist accelerometry (Respironics Actiwatch), and then within one week underwent tests of arterial stiffness using a SphygmoCor system. The two primary variables that we calculated via ABPMs were the ambulatory arterial stiffness index (AASI) and morning blood pressure surge. AASI is calculated by subtracting the linear regression of the slope of diastolic blood pressure vs. systolic blood pressure from 1. Blood pressure surge is was calculated by taking the morning systolic arterial pressure (SAP) in the first two hours after waking minus the preawake SAP (from the final two hours of sleep). The higher each index, the greater predicted risk of cardiovascular disease. We performed bivariate Pearson correlations using IBM SPSS statistical software to probe for relations between AASI, morning blood pressure surge, body mass index (BMI), and cfPWV. Pearson correlation coefficients of at least 0.40 were considered a medium correlation.

Results and Discussion:
Both AASI (r=0.460; p=0.181) and morning surge (r=0.669; p=0.070) were found to have a medium correlation with cfPWV. The morning surge also tended to be correlated to BMI (r=0.683; p=0.062). Our preliminary results suggest that AASI estimated by ABPMs may prove to be a useful predictor of laboratory assessed cfPWV. The morning surge from ABPM appears to be heightened by body mass index and is directly related to cfPWV. Our findings may have important clinical implications for assessing cardiovascular risk with ABPMs. We will continue to explore the potential relations between ambulatory blood pressure patterns and arterial stiffness in our ongoing research. Our preliminary results suggest that young adults with normal or elevated blood pressure may have similar relationships between morning blood pressure surges and cfPWV, like that of hypertensive seniors in a previous study.

33. Antibacterial properties of mussel-inspired polydopamine coatings prepared by simple two-step shaking-assisted method

Student Presenter: Elizabeth Polega, Biomedical Engineering
Faculty Advisor: Bruce P. Lee, Biomedical Engineering

Introduction:

Polydopamine (PDA) is a facile surface functionalization method prepared through oxidation of catechol with a free primary amine group (e.g., dopamine) which results in intra-molecular cyclization and polymerization resembling melanin formation. Catechol is an adhesive moieties found in mussel adhesive proteins which generates H_2O_2 during auto oxidation to quinone. In our previous study we showed that the sustained release of low concentrations of H_2O_2 were antimicrobial against both gram-positive (Staphylococcus epidermidis) and gram-negative (Escherichia coli) bacteria. Herein, we prepared PDA coatings through a simple two-step shaking-assisted method on a polypropylene (PP) mesh. Recent studies showed that PDA prepared through one-step shaking-assisted method obtained rough surface coatings with antibacterial properties. Our modified method includes coating of the substrate twice to ensure a thicker and rougher surface can be created using a orbitally shaking solution condition in which fresh dopamine solution is used in each step. The coating was compared with not-shaken and one-step shaking-assisted coatings in term of H_2O_2 generation, as well as the physicochemical and morphological changes using contact angle measurements, cyclic voltammetry, FE-SEM, AFM, and XPS analysis. To our knowledge, we are the first study evaluating the H_2O_2 generated from the PDA coatings. Our results showed that the thicker and rougher surfaces were achieved by two step-shaking method which resulted in higher H_2O_2 generation. The future experiment will include evaluating the bacteria attachment and antibacterial properties towards both gram-positive (Staphylococcus epidermidis) and gram-negative (Escherichia coli) bacteria on the two-step coatings.

Materials and Methods:

First, the preparation of a certain concentration (varied in our experiments) Dopamine HCL/Tris Buffer solution must be added to the cell wells containing polypropylene meshes. After 24 hours, the original solution is then dumped and a second coating of a certain concentration of Dopamine HCL/Tris Buffer is added. After 24 hours, these are washed in HCL baths and then dried. To continue for hydrogen peroxide generation, PBS can then be added to the mesh samples and incubated at varying hours and tested to find the amount of hydrogen peroxide generation of each sample set.

Results and Discussion:

Of the methods tested, shaking the samples has resulted in much higher hydrogen peroxide generation. Changing the pH did not have any great effects on the results, but

changing the concentrations of polydopamine in samples did determine the amount of coating that attached to the polypropylene mesh. Further tests will be done early march to determine the content of bacteria killed.

34. Assessing the Expression and Purification of Arg-Tagged MS2 Coat Protein by Cation Exchange Chromatography

Student Presenter: Brenna Rosso, Biochemistry and Molecular Biology
Faculty Advisor: Ebenezer Tumban, Biochemistry and Molecular Biology

Introduction:
The coat protein from MS2 bacteriophage can be used to create virus-like particles (VLPs). MS2 VLP is a universal vaccine platform that can be customized (by the display of epitopes from pathogens) to develop candidate vaccines. An affinity tag (positively-charged Arginine) can also be included on the coat proteins/VLPs to help with their purification by cation exchange chromatography; the tag on the coat protein binds to negatively charged SP-Sephadex beads while bacteria proteins are left unbound. The bound protein could then be eluted with NaCl solution. The goal of this work was to assess if this was feasible with MS2.

Materials and Methods:
C41 competent bacterial cells were transformed with the pDSP62-Arg3 plasmid (responsible for the production of the MS2-Arg coat protein). Selected colonies were incubated then induced with Isopropyl β-D-1-thiogalactopyranoside. The bacteria were lysed to release MS2-Arg coat protein and the coat protein was assessed by gel electrophoresis. After confirmation of presence, a larger scale of protein expression was initiated and the bacteria (expressing the protein) was spun down. The pellet was resuspended in either urea solution, borax buffer or a combination of the two at various pH values. The samples were incubated on ice, deoxycholate was added and incubated again on ice. The samples were then sonicated. The samples were spun down and the supernatant was saved. A small column was set up with either SP Sepharose Fast Flow or Sephadex CM-25 resins and then washed with of deionized water. After this drained, the column was equilibrated with lysis buffer and drained. The supernatant was added to the resins, the resins and NaCl solution was added to the column. Fractions were collected and analysed by gel electrophoresis for the presence of protein of interest.

Results and Discussion:

The MS2-Arg tagged coat protein was present in the induced bacteria and absent in the uninduced bacteria indicating successful transformation of bacteria with pDSP62-Arg3. In a 4M urea/borax buffer (pH 7.73), the MS2-ArG coat protein was determined to be soluble. The coat protein was determined to be insoluble in borax alone and the best results were collected from a mixture of borax and urea (though I believe that this experiment would work just as well with a solely urea solution). SP Sepharose Fast Flow beads were used to purify the protein from the supernatant. Most of the protein was present in the flow through (pH 7.73). This indicates that the protein was not able to bind to the beads very well. However, since the protein was present in the fractions after elution with NaCl, some level of binding did occur. I also attempted to purify the protein using Sephadex CM-25 beads but no apparent binding occurred.

35.Conductive PDMS Composites

Student Presenter: Daniel Woodall, Mechanical Engineering
Faculty Advisor: Parisa Abadi, Mechanical Engineering Engineering Mechanics

Introduction:
Healing bones via scaffolding, producing flexible batteries with greater power output, lightweight sensors, and touch screens for the blind: all of these products are possible with the use of nanocomposites. Nanocomposites are a material containing a certain type(s) of nanoparticles to improve certain properties. The purpose of this research is to optimize fabrication of various nanofiller-PDMS composites. We propose the use of nano-filler/PDMS composites to tune mechanical and conductive material properties.

Materials and Methods:
Conductive PDMS is a composite of a conductive nanofiller such as carbon nanotubes or metal nanoparticles and PDMS, a silicon-based polymer. Conductive PDMS will be manufactured using a elastomer base, crosslinker, conductive filler and a surfactant. Silver nanoparticles (SNP), multi-walled CNTs (MWCNT), and silicon-dioxide (SiO_2) nanoparticles will be tested in this experiment. Mechanical characterization will include tensile testing in macro-scale and atomic force microscopy (AFM) in micro- and nano-scale. Electrical characterization will consist of two-point probe tests to examine resistivity in macro-scale and small-scale conductivity measurement by AFM.

Results and Discussion:
The preliminary results of the mechanical tests suggest the PDMS/Nano-filler composites have a higher tensile strength compare to the control PDMS. The

preliminary conductivity tests suggest the MWCNT/PDMS composites have an ideal conductivity compared to the rest of the nanofillers due to its high aspect ratio. AFM, tensile, and conductivity tests on SNP-PDMS and CNT-PDMS composites are ongoing.

36. KHOB 2018 Economic Outlook Report

Student Presenter: Sarah Goble, Economics, John Ruf, Mechanical Engineering, and Cole Peppin, Chemical Engineering
Faculty Advisor: Emanuel Oliveira, School of Business and Economics

Introduction:
The purpose of the Keweenaw, Houghton, Ontonagon, and Baraga County Economic Outlook Project is to provide specialized data and information to interested parties. Time series data has been treated with advanced econometric techniques under faculty supervision to create a sound report detailing economic indicators and their implications in the four counties. The goal of the research is to begin to document the economic background and forecast the future of the economic activity in the local area.

Materials and Methods:
After obtaining data from the Bureau of Economic Research, the Federal Reserve Bank, the Bureau of Labor Statistics, and the U.S Census Bureau, we tracked key economic indicators over time. These included population growth rates, labor force participation, unemployment, disconnected youth, and personal income overall, as well as stratified by industry. For key indicators such as personal income, labor participation rate, industry income, and population we used autoregressive techniques taking into account moving averages. This was due to a lack of data for many of the economic sectors in the counties. In addition to this, we also conducted an an online survey targeting 110 local economic experts during October-November 2018. The response rate was 11.82% but there were only 5 fully valid surveys (insights used to complement our judgmental analysis) - we attribute this result to the fact that this was the first edition of the report. As we build awareness, we expect higher response rates.

Results and Discussion:
The KHOB economy has been growing in value despite significant adversities: cost and lack of wide geographic accessibility to high quality telecommunications infrastructure. Its economy grew at an average annual rate of 0.94% per year from 2010 to 2017 while

its real personal income per capita increased at an average rate of 1.29% per year. For the State of Michigan these growth rates were 2.25% and 2.21%, respectively.
The main economic sectors in the region are health care and social assistance, construction, retail trade and manufacturing. Businesses related to tourism, natural resources, financial intermediaries, and higher education institutions along with other professional, scientific and technical services are also of economic and strategic relevance.