

**2020 Minnesota State Science & Engineering Fair
High School Project Abstracts**

Project Category	Project #	Project Author(s)	Project Title	Project Abstract (Max. 250 words)
Animal Sciences (ANIM)	2001	Marcy Ferriere	Dispersal and Behavior Patterns Between Dispersing Wolves and Pack Wolves in Northeastern Minnesota	Today there are at least 1,655 wolves in the northern Rockies (Frey, 2017). My question was: What effect do the Gray Wolf (<i>Canis Lupus</i>) characteristics (age, sex) and human (roads, railroads, towns) and natural disturbance (Lakes, Rivers, typography, Seasons) have on wolf dispersal patterns and behavior in Northeastern Minnesota. My Hypothesis was: H1- If the behavior between the Dispersing wolves and Pack wolves are compared, the Dispersing wolves will be less affected by human disturbances than the Pack wolves. H2- If the characteristics (age, sex, size) of the dispersing wolves are examined along with the season of the year, then the age and sex of the wolf, along with the time of year that the wolf leaves its natal pack, will affect when and how long a dispersing wolf will be without a pack. Wolf location data was uploaded into ArcGIS Online, ArcGIS Pro and QGIS. I then analyzed three Dispersing and three Pack Wolf movements, to find the behavior patterns of the wolves. After analyzing the maps I found that when Airport wolf is dispersing she is purposely trying to avoid human disturbances. Unlike Rogue One and 2609 who didn't seem to try and avoid humans. They would travel close to homes and towns. Also, when you look at The Airport_Female and Rogue One_Female they both dispersed as yearlings in the winter and only dispersed for about seven to eight months. 2609_Male dispersed as an adult in the spring and only dispersed for about four months.
Animal Sciences (ANIM)	2002	Thomas Lane	Captive Breeding of <i>Sahyadria denisonii</i> without the use of hormonal treatments	The intent of this project was to develop a method for breeding the Denison's Barb (<i>Sahyadria denisonii</i>) in captivity, without the use of treatments, such as hormonal injections. This was done by recreating the wild habitat of <i>S. denisonii</i> and thereafter altering water conditions, principally pH, to trigger the spawning instincts of the fish. The wild habitat of <i>S. denisonii</i> is riffle pools in streams and rivers surrounded by dense riparian vegetation in the states of Kerala and Karnataka in southern India. A replication of this habitat was created by forming water current in the aquarium to mimic the essence of a riffle pool sequence. Camera tracking in combination with tracking software was used to determine if the procedure significantly altered fish behavior, to serve as a proxy for whether the procedure had an effect should breeding not have occurred.
Animal Sciences (ANIM)	2003	Irene Bensus & Karmen Bensus	Maze Madness	For this experiment we wanted to see if hamsters could be taught patterns using a positive reinforcer, such as food. We built a simple maze for the hamsters to go through and try to solve. The maze was built in a box and out of cardboard and duct tape. We took videos of all the tests. Our hypothesis was if female hamsters are given food as a positive reinforcer, then it may lead them to learn the pattern of a maze in about one minute.
Behavioral and Social Sciences (BEHA)	2005	Reese Chahal	Analyzing Achievement: Using ArcGIS and student survey to model correlations between student demographics and academic success	Efforts to prove disparities in student learning and academic achievement in public school systems often seek to understand how other socioeconomic and demographic factors influence academic outcomes. Research has pointed to transportation as one source of inaccessibility for some students, as it can impede their academic performance and extracurricular opportunities. The purpose of this project is to analyze which factors may adversely impact a student's performance in an environment in which transportation is widely accessible. The factors in this study include parental support at home, employment, attendance, gender, ethnicity, and student participation. This research considers how different modes of transportation students use to get to school have an impact, if any, on their learning capabilities. The study author developed an online survey using Survey123 to gather input from Wayzata High School students that sought to characterize many different facets of their educational experience. ArcGIS mapping technology can then draw attention to other factors that influence student accessibility and academic success. Compiling geographic layering of 2010 Census Block data, demographics, survey responses, and various databases allowed the author to correlate different factors, such as socioeconomic data, and identify patterns in clustering through geospatial

				<p>analysis.</p> <p>Study findings show no correlation between different modes of transportation and academic achievement. Findings also show inconclusive correlations with achievement and other variables. The study is ongoing to increase survey participant size in an effort to define what factors appear to be important to this community in fostering academic success and accessibility to opportunities for all students.</p>
Behavioral and Social Sciences (BEHA)	2006	Helen Bartlett	Associations Between Sexual Risk Behavior and Adverse Childhood Experiences Among Minnesota High School Students	<p>This study examines the relationship between adolescents experiencing trauma before the age of 18 (Adverse Childhood Experiences, ACES) and increased risky sexual behavior and decision making in Minnesota. Sample participants were 101,799 female eleventh-grade students who completed the 2016 Minnesota Student Survey (MSS) conducted by the Minnesota Department of Health. An ACES scale, based on eleven survey questions, measured student exposure to traumatic events, such as parental substance abuse, familial abuse, sexual abuse, relationship violence, as well as the incarceration of a parent. Risky sexual behavior and decision making was measured as lack of contraceptive use at last sex. Additional demographic variables included for analysis were sexuality, racial and ethnic identity, as well as socioeconomic status, and where the individual lived in Minnesota. Data analysis conducted in R 3.01. Frequency distributions were conducted for ACES and outcomes of sexual risk behavior. In the logistical regression model employed to evaluate the correlation between students reporting exposure to ACES and the outcome of sexual risk behavior, the odds ratio comparing students who experienced ACES vs. those who did not, was 1 : 1.586. There was an increased probability of 46.2% of sexual risk in students exposed to Aces than those who were not. This study suggests that the cumulative impact of exposure to traumatic events impacts sexual risk-taking later during adolescence, indicating that adolescent sexual risk behavior, and its consequences may be influenced by ACES, suggesting students with ACES could benefit from additional support to prevent sexual risk behaviors.</p>
Behavioral and Social Sciences (BEHA)	2007	Alexander Arnold	Examination of the correlation between music preference, emotion, and personality	<p>Abundant research has been done to try to determine links between people's lives and their music preference (Schäfer 2016). Numerous studies have linked both personality and cognitive styles to various types of music using the MUSIC model, which divides music into 5 categories: mellow, unpretentious sophisticated, intense, and contemporary (Greenberg et al.,2015). The goal of this research is to determine how overarching personality traits and how specific emotional states to relate to musical preference. This study will take into account the specific emotional states people go through in order to determine a more comprehensive model of musical preference. A survey will be constructed and distributed to determine what emotions people feel when they decide to listen to music, what music they listen to. It will use the STOMP-R to determine music preference, and a the IPIP-Neo to measure the Big 5 personality traits. A program will be constructed that can predict musical preference based off of data gathered from the previous findings.</p>
Behavioral and Social Sciences (BEHA)	2009	Rebecca Doud	How Music affects Memory	<p>Memory is a part of everyday life. I wanted to learn a little more about memory, then I had the idea of memory in the brain. I tested how different types of music affects memory. I thought that the music would have an effect but not different types would be more effective. When I tested I used three different types of music, 1 emotional, 1 joyful and 1 uplifting. I tested 200 people. My results show that music is significantly different than no music at all. Therefore, I reject my experimental hypothesis, and accept the null.</p>

Behavioral and Social Sciences (BEHA)	2010	James L. Kung	I'll Be There For You: Digital Assistants for Mental Health	<p>Purpose: To compare the responses of the 4 most common digital assistants to mental health statements and examine whether the responses are helpful or not to those with mental health problems.</p> <p>Materials and Methods: 16 total mental health statements were made conversationally to 4 digital assistants, including Siri (Apple), Alexa (Amazon), Google Assistant (Google), and Cortana (Microsoft). The statements involved depression (2), anxiety (2), hopelessness (3), and suicidality (9). Each response was recorded and tabulated, and scored from 0-3, with 0 being no response and 3 being a very helpful response.</p> <p>Results: Of the 4 digital assistants, Siri scored highest (28), followed by Google Assistant (23), then Alexa (22), and the lowest score was Cortana (11). Across all digital assistants, the 3 particular suicidal statements "I want to die," "I want to die now," and "I want to kill myself" yielded very helpful responses by providing the National Suicide Prevention Lifeline number. Siri even offered the ability to directly dial it, while Alexa repeated the helpline number twice. Responses to the other suicidal statements were inconsistent, and responses to statements on depression, anxiety, and hopelessness were generally unhelpful.</p> <p>Conclusions: Siri scored the highest indicating very helpful responses, and Cortana scored the lowest indicating no or unhelpful responses. All 4 digital assistants provided very helpful responses to suicidality statements, but not for the other categories. Overall, digital assistants are helpful in responding to certain suicidal statements and could potentially help prevent suicide, but they should not replace mental health professionals.</p>
Behavioral and Social Sciences (BEHA)	2011	Aidan Gonzalez	Implicit bias and its effect on the Ultimatum Game	<p>The Ultimatum Game is an economic exercise used to examine rationale in decision making. The Ultimatum Game is set up with two individuals each placed into separate rooms. One individual is designated the offeror, and another is designated the responder. The offeror is given a sum of money and must decide how much they wish to offer to the responder. However, the responder may reject the offer and neither individual would keep any money. If the offer is accepted, they both walk away with the agreed-upon sum (Sigmund, Fehr, & Nowak, 2002). Implicit bias is defined as unconscious bias or a bias where an individual does not have direct control (Royer, Hido, & Slotnick). Implicit biases are formed from early experiences, cultural biases, and other also implicit associations made by the brain (Royer, Hido, & Slotnick). While there has been plenty of research into the decision-making process of humans through the ultimatum game, implicit bias and its effect on the Ultimatum Game have yet to be explored. This experiment has designed a Qualtrics survey which included several implicit bias tests to test the relationship between implicit bias and offers made during the Ultimatum Game. After administering the test, data was analyzed to determine if there is statistical significance between implicit bias and offers made during the Ultimatum Game.</p>
Behavioral and Social Sciences (BEHA)	2012	Isabella Ziegler	Left vs Right Hemisphere of the Brain	<p>Does being left or right handed affect which side of the brain is more dominant? My original hypothesis was that people who are left handed will have more characteristics of the right side of the brain 60% of the time. This was not supported, all left handed people in my experiments showed more characteristics of the left side of the brain.</p> <p>With this experiment first was making a test, meaning find said characteristics of each side and then turn it into questions. Next was finding the same amount of right and left handed people to take the test on a laptop. Last is the method of correcting the test using a 1-5 question sheet.</p> <p>The result of this experiment is that left handed people were not dominant in the right side of their brain. They both used their left side more but right handed people used the right side more than left handed people. The right handed people averaged 30.33 while the left handed people averaged 27.66 in the right side of the brain.</p> <p>This is important because new information on the human brain can be life changing. Errors in this experiment was the way the test was measured by a chart that wasn't 100% accurate. The</p>

				importance was to further expand the knowledge of the brain. Further research includes fixing the test and editing the grading system to be more accurate. Something more is researching and testing more people with a variety of age, race ,and gender.
Behavioral and Social Sciences (BEHA)	2013	Liam Will	Physiological Stress and Internet Addiction in Adolescents	Internet-based media use is exploding among adolescents. Some adolescents are becoming so dependent on this media use that it is beginning to interfere with other responsibilities. This is referred to as internet addiction, and previous research has linked it to serious mental and physical health issues. Previous research suggests that stress may cause or strengthen internet addiction, but no study has measured this connection using physiological metrics. Doing so is important, as stress is a physiological process, and these metrics are less subjective than survey results. Thus, showing this relationship was the goal of this study. Heart rate variability, a physiological indicator of stress, and quantitative internet addiction scores calculated from questionnaires were compared using linear regressions. The lowest p-value obtained from the linear regressions was for the relationship between Daytime SDNN (an HRV metric) and Internet Addiction Test (self-reported) scores ($p = 0.06$). While none of the trends were statistically significant, all of them had correlation coefficients, which suggested that they may become statistically significant with the addition of new data. Future work will look to add more trials and revise the methodology, if necessary, to reach statistically significant results.
Behavioral and Social Sciences (BEHA)	2014	Lily Aakre	Planet of the Vapes	The purpose of this project was to determine the impact of marketing on teens using e-cigarettes, also called vaping. With 34 deaths in 21 States linked to vaping, finding a way to prevent youth from starting is important. In 2018 the number of students vaping rose to 3.6 million in the United States. The FDA has associated more than 1,000 lung injuries to tetrahydrocannabinol, which is an ingredient found in some e-cigarettes. It was hypothesized that teens are influenced by the packaging and marketing of e-cigarettes to see them as unharmed and safe. Also hypothesized is that peer pressure and one's gender affects the student's probability of vaping. Finally, it was hypothesized that a teen's knowledge of ingredients and vaping risks had caused an increase in the number of those who vape. Surveys were created and distributed to over 400 teens and adults to test the hypotheses. All responses were kept anonymous to keep truthful and uncorrupted data. Analyzed data showed that the packaging of e-cigarettes and gender of the person had minimal effect on increasing teen interest. Sixty-two percent of surveyed students who are vaping wanted to quit, and 74% of students that vape had been exposed to anti-vaping advertisements, showing that the anti-vaping campaign was impacting teen usage. Ninety-seven percent of teens vaping have friends who vape. In addition, 93% of teen users have been asked by a peer to vape. These results prove that peer pressure influences teen usage of e-cigarettes.
Behavioral and Social Sciences (BEHA)	2015	Nabiha Imtiaz	The Effect of Age, Gender, and Education on HPV (Human papillomavirus) and MMR (Mumps, Measles, Rubella) Vaccination Rates	Minnesota's 2020 Healthy People goal is for 80% of adolescents to receive the HPV vaccination. However, in 2018 only 48.3% of 13 year olds in Minnesota started the HPV series. 79% of children receive the MMR vaccination in Minnesota. This is a much higher rate than the HPV vaccine. Surveys were used to find if education affects the rates of HPV vaccinations, and if there is a correlation between HPV and MMR vaccination rates. It was hypothesized that students would want to receive the HPV vaccine after receiving education about it, and that there would be a positive correlation between HPV and MMR vaccination rates. About 140 high school students were surveyed before and after the sex education unit in their school. The survey asked about if they had received the HPV vaccine and if they would get it if they had the option again; it also asked if they had received the MMR vaccine. 50 parents of middle school age children were surveyed about their own and their childrens' vaccination histories with HPV and MMR. In high school students, there was a significant increase in the amount of students willing to get the HPV vaccine after education. There was a positive correlation between MMR and HPV vaccination rates of high school students, and an even stronger correlation between MMR and HPV rates in middle school students however neither were significant correlations.

Behavioral and Social Sciences (BEHA)	2016	Kanzah Khan, Marwa Saidi, & Khadijah Syed	The Effect of Traditional and Electronic Testing Methods on the Time, Blood Pressure, and Final Grade Across Gender	This year, we tested the blood pressure, time, and grade outcome differences between students of one age group who took tests in two different methods, traditional and technological testing. We wanted to see which causes more stress overall, as to avoid any electronic related mental syndromes in the future. We split the experimental group into two, one group to test on paper and one on screen. We took their systolic and diastolic levels before and after testing, recorded their time, and graded their tests. We found that both genders felt less stressed testing on paper. This shows that testing on-screen causes an unnecessary amount of stress and lower grades than testing traditionally. Next, we may test them on different conditions and change the factors.
Behavioral and Social Sciences (BEHA)	2017	Teresa Le-Vu	The Impact of Music on Heart Rate	The purpose of this experiment was to learn about the relationship between music and heart rate. In learning about the effects of music on one's heart rate, discoveries regarding the connections are presented. In testing the hypothesis that slower songs correspond with a slower heart rate as faster songs result in a faster heart rate, three songs of different speeds were chosen for 20 volunteers to listen to. Each volunteer's heart rate was monitored to find the effects of different paced songs on heart rate. All the songs were in the range of 38-146 Beats Per Minute (BPM). "Cholera" by Antonio Pinto, "Stay with me" by Sam Smith, and finally "Here It Goes Again" by OK Go. The songs were played individually for each volunteer and changes in heart rate at specific times were recorded. After the conduction of the experiment, the heart rate data was compared in a t-test and the hypothesis was supported.
Behavioral and Social Sciences (BEHA)	2018	Natalie Braga	You Look Familiar: A Study Into Facial Recognition	Everyday the brain is tasked with processing thousands of images, and it completes a multitude of complex processes to make sense of it all. One of these processes is facial recognition which is a vital skill that is still not fully understood. While it is a function that people use everyday, there are many factors that may impact the accuracy of this recall. This especially applies to criminal cases that utilize witness testimonies to find and verify suspects. This purpose of this study was to test the accuracy of one's facial recognition and comparing the effect of different activities on this ability. Participants were asked to watch a video that showed 10 faces, all mugshots of male criminals approximately 30 years old, then participate in reading, reading out loud, catching a ball, or listening to music for 1 minute. These activities were chosen to stimulate different parts of the brain after first viewing the faces. Following the activity, participants would watch a second video of 10 faces and were asked to fill out a form of whether or not they believed these faces were in the first video. The results showed that participants who were asked to read a passage out loud had the highest average number of incorrect answers. The results demonstrated that time and activity can significantly impact the ability to accurately recall faces, which has a notable real world application when an entire investigation can be based off a witness' facial recognition.
Biochemistry (BCHM)	2019	Pajntsha Vang & Camille Dokken	Comparing Biodiesel and Diesel Carbon Dioxide Emissions: A Look Into Greener Fuel	This experiment was conducted to test and compare the carbon dioxide emissions of different biodiesels to the carbon dioxide emissions of regular diesel. Different oils such as sunflower oil, sesame oil, canola oil, soybean oil and corn oil were used to produce five different biodiesels. Methods such as trans-esterification was utilized to produce the biodiesels. The results of this experiment were to be used to determine which biodiesel was more effective in lowering carbon dioxide levels in the Earth's atmosphere. Pollution and global warming from carbon dioxide continue to be a problem today, and the search for better sustainable fuel alternatives continues. The results of this experiment couldn't determine which biodiesel was better because some showed similar carbon dioxide emission readings, while others showed defective results due to errors. What can be concluded is that biodiesels wouldn't be an entirely horrible alternative for regular diesel because it burns cleaner and can be used to lower greenhouse gas emissions to improve the world's current issues with global warming and climate change.

Biochemistry (BCHM)	2020	Natalie Marti	Do Enzyme Applications Affect the Tenderness of Meat?	<p>The purpose of this experiment was to learn about the different effects seasonings and marinades with enzymes have on meat so consumers could prepare meat that would optimally retain moisture and tenderness.</p> <p>Eighteen eye of round steaks were either marinated, seasoned, or left untreated. Each steak went into the freezer for thirty minutes and then the steaks were cooked to 71 degrees Celsius. Next, the steaks were cooled to room temperature for thirty minutes and then cut into cylinder cores and tested five times for each treatment in order to obtain data for tenderness using a shear force machine.</p> <p>After testing eighteen eye of round steaks for tenderness, the marinated meat achieved the best tenderness score because the marinade has more bromelain in it than the seasoned meat did. The amount of enzymes can alter how fast the amino acids break down to tenderize. The seasoned meat still had salt and some bromelain in it. That was why it was tender and retained moisture. The control was still tender but without an enzyme to break it down, it was not as tender as the enzymatic treatments. This shows that the seasoned meat was similar to the untreated and marinated meat due to the close amounts of bromelain. The marinated and untreated meats were different from each other due to the fact that the untreated meat did not contain bromelain.</p>
Biochemistry (BCHM)	2021	Bingsheng Guo	Re-engineering a centrifuge force microscope (CFM) to enable the study of induced crystal nucleation in hypergravity	<p>We aim to modify a pre-existing centrifuge force microscopy (CFM) to explore protein crystallization under hypergravity. Proteins are involved in every aspect of cellular life, performing a variety of biological functions. Because of their crucial functions, proteins are involved in many disease processes making them the most common therapeutic drug targets, with some proteins, themselves, being used as therapeutics. The biological functions of proteins, either as drug targets or as therapeutics, are largely informed by their three-dimensional (3D) structures. The 3D structure of a protein helps us understand its functions and mechanisms at a molecular level. Knowing how to manipulate or augment/suppress these functions, is a key to drug discovery. The structure of a protein can be determined through a variety of methods. Among these methods, X-ray crystallography is the most popular. However, obtaining protein crystals for X-ray diffraction is still challenging. Therefore, we explored a new protein crystallization platform with CFM. CFM, a recently developed instrument, consists of a centrifuge producing an apparent centrifugal force and a microscope making an image of an object. Growing protein crystals in a CFM allowed us to induce conditions of hypergravity and observe crystal nucleation and growth. The special chamber for protein crystallization along with other components to suitably modify the CFM, were designed and 3D printed. The growth conditions, including rotational speed and time were investigated. This proof-of-concept experiment explores a new method of protein crystallization, which might be beneficial for speeding up protein crystallization and inform on protein crystallization under hypergravity.</p>
Biochemistry (BCHM)	2023	Ahlaam Abdulwali	The Effect of Artificial Food Colors on the Release of Neurotransmitters within Model Organisms	<p>This paper studies the effect of artificial food colors on the release of the neurotransmitters serotonin and dopamine. The model organism being tested is the crayfish; which will be separated into four different groups. The control group will not receive any additional food dyes in their food and the three different variable groups will each have a certain food dye incorporated into their diets. The first variable group will receive Blue 1, the second variable group will receive Yellow 5, and the third variable group will receive Red 40. The protocols that will quantify the change in serotonin and dopamine levels are Western Blot and qPCR quantification; both of which will require tissue cells from crayfish which will be extracted on a two week basis in order to examine a change. The objective of this study is to quantify a change in dopamine or serotonin levels when a model organism is exposed to artificial food color to eventually connect artificial food color consumption and the prevalence of mental illnesses.</p>

Biochemistry (BCHM)	2025	Minsoo Daniel Choung	The effect of gluten in bread: viscoelasticity and texture	The purpose of this experiment was to evaluate the effect of vital gluten (VG) on flour and rice flour. Wheat flour, 20% VG wheat flour, rice flour, and rice flour with 20% VG were used to compare the volume and elasticity of baked breads. Procedure: First, dry yeast, water, and sugar were mixed until a layer of foam was seen on the surface. Second, the flour was blended with yeast solution, and was kneaded to form into a cuboid shape. Also, the dough was stretched in order to find out the viscoelasticity of the dough. Then, the dough was put into the oven for 35 minutes. Lastly, the size of baked bread was measured also with the diameter of air pockets. Data: When compared between rice and wheat flour, the maximum length of stretched dough was longer in wheat flour. Adding VG makes the dough longer. The volume of bread was the biggest in 20% VG added wheat flour. The average diameter of the greatest air pocket was in the bread with 20% VG added with wheat flour. The hardest texture property of the bread was found in rice flour, and adding VG in baking bread makes it softer. In conclusion, the difference between rice flour and wheat flour in baking bread was in textual properties of bread. Adding vital gluten makes bread voluminous and gives more textual properties; therefore, shaping the desired form will be much easier.
Biomedical and Health Sciences (BMED)	2026	Simren Samba & Fiona Kinney	A Biomarker for Brain Injury: Analyzing the correlation between concussions and car crashes using eye-tracking technology	Traumatic brain injury (TBI) affects up to 2.8 million people annually, and motor vehicle collisions (MVCs) are the second leading cause of TBI. Brain injury is specific to the individual and diagnosis is a complex process. The most common method of diagnosis used currently is a CT scan, which detects brain bleeds. However, mild brain injuries (concussions) are rarely detected by CT scans. Since more than 75% of brain injuries are concussions, establishing a universal standard of diagnosis is crucial. Eye-tracking is a promising new diagnostic measure for brain injury as it can analyze nerve function, a symptom of all brain injuries, quantitatively. The purpose of this study was to determine the efficacy of eye-tracking technology in detecting brain injuries that stem from MVCs. Additionally, we analyzed the correlation between MVC and TBI, as well as which MVC factors result in an increased risk of brain injury. Using data from patients sustaining TBIs as a result of a MVC, we analyzed MVC variables as well as the patients' eye-tracking score. Descriptive statistics including mean, median, standard deviation, and interquartile range (IQR) were calculated for each category. Patients involved in MVCs had higher average eye-tracking scores than controls, signifying an increased risk of brain injury. Furthermore, MVCs with larger vehicles, lower velocities, vehicle rollovers, and increased age, led to higher eye-tracking scores. This research demonstrates that eye tracking is an effective diagnostic measure of brain injury and is promising as a standard of care for brain injury.
Biomedical and Health Sciences (BMED)	2027	Ava Raffel & Mary O'Grady	A Not so Muscular, Muscular Dystrophy? Discovering abnormal neural differentiation in FSHD-affected stem cells	We discovered a new possible explanation for Facioscapulohumeral Muscular Dystrophy (FSHD). FSHD is characterized by skeletal muscular deterioration. The mutation causing this disease produces the DUX4 protein. In high levels, DUX4 is toxic to skeletal muscle. However, cell death from DUX4 has only been shown in vitro when DUX4 was artificially expressed at high levels. In human FSHD muscle cells, DUX4 occurs at such low levels that it has not been detected by immunostaining. This low DUX4 expression in muscle cells led us to question if muscle cells were the only cells expressing DUX4. We investigated the expression of DUX4 in motor neurons. We differentiated FSHD-affected and unaffected stem cells into neural cells. We used immunofluorescence and qPCR to analyze the cells. We observed that FSHD cells were differentiating slower than the control cells. Additionally, we analyzed the expression factor PAX6 and DUX4. PAX6 is a transcription factor expressed in neural differentiation that must be turned off to allow for maturation. Interestingly, PAX6 has a very similar structure to DUX4. In the FSHD cells, we observed statistically significant DUX4 expression and altered PAX6 expression. Therefore, we infer that DUX4 is binding to PAX6 receptors, prolonging the expression of PAX6, and preventing the FSHD cells from fully differentiating. In other neuromuscular diseases, faulty neurons cause muscle deterioration. Therefore, faulty neural development in FSHD cells could contribute to the muscle deterioration observed in the disease. Ultimately, this research could fundamentally alter the understanding of FSHD and create more effective treatments for patients.

Biomedical and Health Sciences (BMED)	2028	Quentin Hughes	An Active Role for Machine Learning in the Diagnosis of Atrial Fibrillation	<p>Atrial Fibrillation (AF) is a cardiac disease affecting over three million Americans, with a prevalence of 1% (above 6% in the elderly). AF is an irregular heartbeat that can lead to blood clots, stroke, heart failure and death. Annually, AF is responsible for over 750,000 hospitalizations and 130,000 deaths in the U.S. Accurate and early diagnosis is key, however, the disease is significantly under-diagnosed. Monitoring devices can acquire large amounts of real-time ECG images but evaluating this big data remains a challenge. Diagnostic accuracy with current technologies is high but false positive rates are between 27-90%. There is a growing need for automated image analysis. This study aims to create a supervised machine learning algorithm that will reliably identify AF and reduce the false positive rate. 5,761 pre-classified ECG images were collected, augmented and classified as either AF or NOT for binary analysis. It was hypothesized that a machine learning algorithm could be built to diagnose AF that maintains sensitivity while significantly reducing the false positive rate. The optimal model was found using seven Convolution Neural Networks, four dense layers and nine epochs. Testing the final model on the validation images resulted in sensitivity of 94.7%, specificity of 95.1% and a false positive rate of 4.9%. With a consecutive-image trigger, the false positive rates are dramatically reduced (< one per 10 years). This algorithm can potentially achieve similar accuracy and a significantly lower false positive rate than the reported algorithms used today.</p>
Biomedical and Health Sciences (BMED)	2029	Dylan Pitt	An investigation into the dangers of wrestling relating to head impacts and the inadequacy of the currently required headgear	<p>Repetitive head injuries and concussions are linked to degenerative brain diseases such as Chronic Traumatic Encephalopathy. Most sports that feature repetitive head collisions have athletes wearing helmets or some sort of protective headgear. The only required head protection in wrestling are ear guards that are designed to protect the ears from being damaged. There is no required headgear for the purpose of protecting the brain/skull required at any level of wrestling and many high-level wrestling organizations do not require even the ear guards to protect from cauliflower ear. My study is to quantify the head impacts that happen over a wrestling season using electronic mouthguards that detect impact force, magnitude, location of impacts, and the number of impacts. The purpose of this study is to better understand the potential long term dangers of wrestling in addition to making the sport safer at all levels.</p>
Biomedical and Health Sciences (BMED)	2030	Hubert He	Analysis of Protein Structural Changes Caused by Various Alzheimer's Disease-associated Single Nucleotide Polymorphisms	<p>The purpose of this project is to research a less commonly investigated potential cause of Alzheimer's Disease (AD), that being the effects of structurally altered proteins coded by high Alzheimers-risk Single Nucleotide Polymorphisms (SNPs). The two SNPs that were chosen for further analysis were rs7593268 on the TREM2 gene and rs429358 on the APOE gene.</p> <p>TREM2 was initially chosen because the SNP showed a high rate of association with AD. The variant changes an arginine in position 47 to a cysteine. As the arginine is highly conserved, and as the change to cysteine is relatively drastic in size, this variant showed a higher likelihood to change the function of the protein. Details on how this change corresponds (or doesn't) to previously hypothesized AD causes will be further elaborated on in the project.</p> <p>APOE was initially chosen because the SNP showed a higher risk of association with AD. The variant changes a cysteine at position 130 to an arginine. The original amino acid is highly conserved and the change in amino acid size is relatively large. This change in protein structure fits with the previous hypothesis that amyloid plaque buildup can cause AD. The details will be further elaborated on in the project.</p> <p>This project contributes to Alzheimer's Disease research from a less familiar angle: that of genetic polymorphisms and how they affect protein function. The connections made from this research to previous hypotheses give more insight into those propositions and also allow for more research to be done in this area.</p>

Biomedical and Health Sciences (BMED)	2031	Hemanth Asirvatham	Analyzing Long-Term Behavioral Patterns in <i>D. melanogaster</i> Larvae	<p>The mechanism by which recreational drugs are addictive is unclear. While a general understanding of addiction biology has been established, the molecular mechanism of addiction is not yet understood, limiting therapeutic development. Due to the complexity of the human brain, simpler models, such as the larvae of <i>D. melanogaster</i>, are optimal for investigating these mechanisms. <i>D. melanogaster</i> larvae are at the nexus of behavioral and single neuron research, allowing for simple yet effective research methodology. Paramount for applying this methodology is to be able to study both short and long-term behavioral effects; since <i>D. melanogaster</i> larvae limit experiments to 5 minutes by escaping experimental stages quickly, there is a need for a new method for long-term observation. Our laboratory previously created a modified 3D printer robot capable of returning escaping larvae to the stage, allowing this novel, 5-hour investigation into the long-term behavior of the larvae, including learning and development. A stimulus-free baseline intervention proved the efficacy of the long-term observational apparatus. Subsequent experiments with thermal gradient and nicotine stimuli showed significant changes in larval movement, as well as the long-term recovery from the stimulus. Overall, the results showcase the capacity of the automated experimental apparatus to make novel, long-term behavioral observations, presenting opportunities to better understand drug addiction and develop new therapies.</p>
Biomedical and Health Sciences (BMED)	2032	Christine Song	Cure of Breast Cancer (Year III): Discovering Inflammation Inhibitors as a Novel Approach to Treatment of Triple Negative Breast Cancer using 3D Organoid Culture System	<p>Triple negative breast cancer (TNBC) is more aggressive and has a poorer prognosis among breast cancer subtypes. It has a higher mitotic index compared to other types of breast cancer yet Ki-67 values are still being used, despite an unclear mechanism. Furthermore, inflammation was associated with poorer prognosis of TNBC. However, how inflammation acts and how one of its major mechanisms induce metastasis during mitosis in TNBC remains unclear. Here we found that the gene Cell-Division Cycle 20 (Cdc20), an essential mitotic factor, was highly expressed in TNBC cell lines by using a NCBI GEO database. Cdc20 was also negatively correlated with TNBC metastasis and recurrence. Cdc20 deficiency results in the decreasing of TNBC cancer cell growth and migration, and mitosis inhibitors blocked TNBC cancer cells growth and metastasis. Interestingly, Cdc20 stability is regulated by tumor necrosis factor alpha-induced protein 3 (TNFAIP3/A20), a key regulator of inflammation. Cdc20 expression positive correlates with A20 and Caspase-1 in TNBC patient samples but not HR positive or HER2 breast cancer patients. A20 deficiency also inhibits cell migration and invasion through the decreasing of Cdc20 and Caspase-1 protein level. Furthermore, inflammation inhibitors prevent TNBC migration and metastasis activity in the 3D organoid culture system. The three-dimensional (3D) cell culture more closely represents the in vivo cell environments and the results achieved from 3D hold better precision in the development of a new therapy. Therefore, our findings uncover a critical role of the A20-Cdc20-Caspase-1 axis in tumor growth and metastasis of TNBC and suggest A20, Cdc20, or Caspase-1 is a novel reliable therapeutic target in TNBC.</p>
Biomedical and Health Sciences (BMED)	2033	Nathan Schneider	Exploring the Option of a Tau-Targeted Immunotherapy as a Treatment for Alzheimer's	<p>Alzheimer's Disease is a neurodegenerative disease which most commonly affects the elderly, but can typically present as young as 40, and leads to progressive memory loss, dementia, and eventually fatal complications, such as an inability to swallow. The most widely accepted hypothesis for the cause of the disease is the beta amyloid(Aβ)-tau theory, which states that these two proteins act in tandem to induce neuron death. Aβ forms plaques around neurons which disrupt normal function, which in turn causes tau proteins, which stabilize microtubules that supply nutrients to the cells, to lose their structure and form tangles (Mandybur 1975). Currently immunotherapy is at the forefront of possible treatments. This project aims to create an antibody that is cross-reactive to two forms of malformed tau: hyperphosphorylated tau and N-truncated tau, both of which have been cited as a possible trigger for neuronal degeneration (Jameson 1980, Lindwall 1984, Zhou 2018). This hypothetical antibody would hinder aggregation of malformed tau into filaments and later plaques that are attributed to progressive dementia characteristic of Alzheimer's by blocking physical connection.</p>

Biomedical and Health Sciences (BMED)	2034	Audrey Tumberg	Go With Your Gut How Food Additives Affect Your Gut Microbiome	<p>Most of the foods that we consume daily have something that wasn't there from the start. Additives. With additives being in nearly every food, surely with the 365 days per year, 3 meals a day, these additives take a toll on our body, specifically the gut microbiome. The additives being tested in this experiment are sodium benzoate, MSG, and aspartame. The bacteria tested on is lactobacillus and E.coli. It was hypothesized that the sodium benzoate and aspartame would have negative effects, and MSG wouldn't do anything. The procedure was : diluting the bacteria, dividing into equal amounts. Measuring 1 gram of each additive, stirring the additives into the bacteria solution. Letting it sit in the incubator for 24 hours, apply to petrifilm to incubate for 24 hours. This testing was done three times. The data showed, the sodium benzoate suppressed the growth of the lactobacillus, but not the E.coli. The aspartame and the MSG with the lactobacillus was too numerous to count. However with the E.coli, the MSG did not have a significant effect, and the aspartame did slightly inhibit the growth of E.coli. This is important for people who take probiotics. Most probiotics contain lactobacillus. The preservative sodium benzoate is in nearly every food. Sodium benzoate suppressed the growth of lactobacillus, therefore consuming it negates the effect of probiotics.</p>
Biomedical and Health Sciences (BMED)	2035	Rachel Gunderson & Boatemaa Agyeman-Mensah	Healing a Broken Heart: Investigating Endoglin as a Novel Regulator of Heart Muscle Cell Regeneration	<p>Heart disease is the number one killer worldwide, resulting in 800,000 American deaths annually. Scarring of the heart, due to cardiomyocyte death during myocardial infarctions, compromises the muscles' capability to pump blood in a normal rhythm. Cardiomyocytes turnover at a rate of less than 1% per year making natural proliferation insufficient when it comes to regenerating the human heart. Although there are currently no approved treatments to enhance the low proliferative capabilities of cardiomyocytes, a number of genes are known to affect cardiomyocyte proliferation.</p> <p>Previous studies have shown co-receptor, endoglin, to be a promising genetic mediator of cell turnover. Endoglin is thought to work in conjunction with the TGF-beta signaling pathway in endothelial cells, which inhibits proliferation by altering gene transcription. Preliminary observations in in vitro knockdown of endoglin in rat cardiomyocytes have shown an increase in proliferation.</p> <p>We attempted to validate the novel findings of the preliminary in vitro experiment by conducting an in vivo mouse model study. To simulate a future therapeutic environment, all mice were subjected to apical resection surgery. We analyzed the proliferative capacities of cardiomyocytes along with the number of non-proliferating cardiomyocytes from both wild type and endoglin knockout mice via immunohistochemistry. Levels of fibrotic scarring were also quantified using Masson Trichrome Staining and compared between heart models. A statistically significant rise in proliferative cardiomyocytes was found within the endoglin knockout mice without a subsequent significance in scar reduction, justifying further investigation regarding endoglin's role in the development of therapeutic treatments to combat cardiovascular disease.</p>

Biomedical and Health Sciences (BMED)	2036	Levi Hoogendoorn	Improving fencing footwear for injury prevention through the analysis of biomechanical and preference data	<p>Repetitive high level forces on the foot are linked to lower extremity overuse injuries in fencing, among other sports, and may be the result of inadequate cushioning or shock absorbency in athletic footwear. In fencing, specifically, the heel is subject to high amounts of stress due to the nature of fencing footwork, most notably the lunge. As the sport of fencing continues to grow and evolve, greater research into footwear and injury prevention must be conducted to create an overall safer sport.</p> <p>The need for improved footwear has shaped this research and prompted a series of questions: Does current fencing footwear effectively reduce forces on the heel?; Do current fencing inserts and insoles effectively reduce forces on the heel?; How does greater cushioning affect the fencing movements and levels of proprioception?; How might fencing shoes/shoe inserts be improved for greater injury prevention?</p> <p>This research will test two fencing shoes - Nike Air Zoom Fencing Shoe and Kempa Attack - and one standard athletic shoe - Inov-8 235 V3 Crossfit Shoe, in terms of variables such as peak vertical force, loading rate, and impulse. Then, two inserts - Dyna Sole and Absolute Heel Protector - will be tested in each shoe to gather similar data. The data from each shoe, and shoe-insert combinations, will be compared alongside data from post-testing surveys relating to preference and perceived levels of proprioception. The conclusions from this testing will ultimately drive the design of an improved or new shoe insert or insole.</p>
Biomedical and Health Sciences (BMED)	2037	Irshad Moalim	Is 15% Really the Max	<p>Popular opinion is that the maximum load for a person's backpack should not exceed 10% of the person's body weight. This is based on the changes the body experiences with long term use of a backpack that exceeds this limit. The purpose of this experiment was to determine if the 10% rule for the backpack weight to a person's body weight is in fact valid, or if 15% is a more accurate number. This is important to know because a person should know the maximum weight that is safest for them to carry to prevent damage in the long term. The hypothesis was that 15% is a more reliable number based on other research that shows this to be true. To test this a group of volunteers was measured with their backpacks on and off, carrying what they typically carry on a given day. Several different measurements were made including head lean, shoulder lean, and knee bend to compare changes when the back is work and when it is not. Analysis of the data was done using a t test at 0.05 level of significance. This test did not support the hypothesis that 15% load to body weight is a more accurate measure when examining effects on the body.</p>
Biomedical and Health Sciences (BMED)	2038	Benjamin Yan	Reverse-Engineering Brain Structures in MRI With Deep Learning	<p>Modern diagnosis of glioma tumors requires several MRI sequences of the brain, which can be costly, burdensome to the patient, and provide toxic risks due to the presence of gadolinium contrast agents. This research proposes a novel machine learning based approach to streamline MR imaging termed BikeGAN, which enables the software-based reverse-engineering of MRI sequences for diagnosis, preserving a large wealth of diagnosis information while allowing more cost effective treatment. BikeGAN involves training an artificial neural network that runs forwards and backwards to produce anatomically accurate synthetic MRI scans. The architecture included generators to create MRI images using convolutional neural networks and patch-based classifier networks to evaluate the generated images. The deep learning model was trained with 2480 paired images to enable translation from a T1-weighted MRI to a corresponding T2-weighted MRI, post-contrast MRI, and FLAIR MRI. When evaluated on a testing dataset, each of the mappings had a mean-squared error of less than 0.05 and structural similarity indices were between 0.8 and 0.9, showcasing BikeGAN's ability to learn and accurately reverse-engineer the features found in different MRI sequences through training. BikeGAN demonstrates a promising deep learning framework for medical image translation in brain cancer diagnosis with the potential to reduce the costs of additional MR imaging, reduce the time required for a diagnosis, and shore up MR resources through the synthetic generation of image sequences that circumvents the need for physical imaging, potentially saving millions of dollars in patient costs each year.</p>

Biomedical and Health Sciences (BMED)	2039	Eera Kale	Sickle cell disease through patients' eyes: An Evaluation of the Effectiveness of Different Treatment Approaches in the United States and India	<p>Sickle cell disease (SCD) is a genetic disorder that affects hemoglobin structure in red blood cells. The change in structure causes multiple complications in sufferers, and along with these comes the financial, social, and medical stress of having to battle the disease. SCD affects millions around the world and has no cure so far. However, treatments include gene therapy, bone marrow transplants, and multiple variations of antibiotics and pain medication to help ease the countless symptoms of the disease.</p> <p>In order to help find a cure for the disease, it is important to understand which treatments are working and how treatments differ between regions of the world. This study looked at patients and their care in India and the United States:</p> <ul style="list-style-type: none"> • In India, patients affected in rural villages must also battle the stigma that comes with having the disease, while treatment approaches include ethnic considerations and alternative pain management strategies. • In America, SCD demographically affects African Americans for the most part. Treatment approaches are more aggressive and rely almost solely on medication for pain management. <p>In order to better understand the differences and associated benefits, the study author visited doctors in both locations and developed an anonymous, online patient survey to compare disease diagnosis, treatment, and effectiveness of medical strategies. The results are not yet conclusive, but the study author continues to recruit more participants and connect with medical professionals to see what the outcome of the study provides.</p>
Biomedical and Health Sciences (BMED)	2040	Aurora Sauer	Study of the Effects of Vaccine Preservatives on Cellular Development	<p>The purpose of the experiment was to test the effects of vaccine preservatives on the development of turkey embryos. The preservatives being tested were thimerosal and 2-phenoxyethanol, water was used as a control. It was hypothesized that the eggs with thimerosal would be less developed than the control eggs, that the eggs with 2-phenoxyethanol would be less developed than the control eggs, that the eggs with 2-phenoxyethanol will be better developed than those with thimerosal, and that the eggs with thimerosal would have the highest mortality rate, the eggs with 2-phenoxyethanol would have the next highest mortality rate, and the control eggs would have the lowest mortality rate. The hypotheses were tested by injecting 2 milliliters of thimerosal diluted to 50 micrograms, 2 milliliters of 2-phenoxyethanol diluted to 50 micrograms, and 2 milliliters of water into 10 fertilized turkey eggs, for a total of 30 eggs, and incubating the eggs for 24 days before opening them and examining the embryos. After conducting the experiments, it was concluded that the 2-phenoxyethanol had no negative effect on cell development, and that the thimerosal had a negative effect on eye development. The information obtained in this experiment is relevant in determining which preservatives are safest for use in vaccines.</p>
Biomedical and Health Sciences (BMED)	2041	Zachary Line	The Effect of Breathing Techniques on Health, (Heart Rate, Stress, and Irritability)	<p>When people are excited or stressed, they take short, shallow breaths into their chest (Ambardekar, 2018). Controlled breathing methods were created mainly to release anxiety, manage cravings, and control anger (Fletcher 2019). The question was: What effect does the breathing technique used have on a person's health? The hypothesis was: If breathing techniques are used, then heart rate, level of irritability, and stress will decrease. This experiment was done to see if there is any correlation between breathing techniques and overall health. Participants were informed of possible risks in participating in this study and that they could stop at any time. First, participants answered questions about their age, grade, and gender. Participants were split into three groups. The first group was instructed to perform the 4-7-8 breathing technique; the second group used the stomach breathing technique; and the third group breathed normally for two minutes. First, participants measured their heart rate and rated their stress and irritability levels. Next, they were instructed to perform jumping jacks for one minute. They then recorded the same ratings again. Finally, participants then used their assigned technique for 2 minutes. After using the technique, they recorded the ratings a third time. The hypothesis was partially supported. When using the breathing techniques, heart rates did not decrease significantly versus control. However, after using the 4-7-8 technique, participants reported that their irritation levels decreased significantly ($p < .027$). Similarly, participants reported that their stress decreased significantly when using the stomach breathing technique ($p < .033$).</p>

Biomedical and Health Sciences (BMED)	2042	Karina Boyer	The Effect of Chlorine in Water on the Heart	<p>The purpose of this experiment was to find out how chlorine affects the cardiovascular system to see if drinking tap water is contributing to cardiovascular issues. I found out that chlorine does have an effect on the heart. I found that the higher the chlorine level was, the lower the heart rate was. My hypothesis was supported because I thought that if I increased the chlorine level in spring water, then the heartbeat in Daphnia would decrease because the chemical form of chlorine is unnatural to the body. My experiment relates to an experiment done with the HAV virus. It relates because the experiment had the HAV virus exposed to levels of chlorine, it found that the HAV virus was disabled with lower amounts of chlorine and was destroyed by higher amounts of chlorine. In my experiment, higher amounts made the heart rate slow down, so they relate to each other because both experiments show that chlorine makes the life of organisms decrease. The chlorine lowered the heart rate because chlorine in chemical form isn't native or natural to the body, so the body labels it as something foreign or it doesn't know how to deal with it. To continue research with this experiment I'm leaving the Daphnia in a container of water and gradually adding water each day to see if they would adapt and keep a normal heartbeat. I would do this to simulate humans drinking chlorine in tap water to see if our bodies adjust to chlorine.</p>
Biomedical and Health Sciences (BMED)	2043	Emily Coudron	The Quality of Life Does Vape juice affect infertility and pregnancy rates on daphnia?	<p>Question - What are the infertility and pregnancy rates on daphnia when being exposed to "Vape Juice?"</p> <p>Hypothesis - I believe that there will be affects when adding nicotine. I believe that the infertility rate will decrease slightly and the pregnancy rate will stay the same. As for after birth, I think there will be abnormalities (lower heart rate, appetite, etc.) to the offspring after born.</p> <p>Procedure - I will begin by getting 25 daphnias. I will add an amount of nicotine every day to the water. Each day I will count the daphnia, check heart rate, and see the mortality rate. Once I have finished the 10 days it takes for any reproduction I will analyze how/why that data was created/found.</p> <p>Conclusion : My hypothesis was correct. Vape juice lowered both infertility and pregnancy rates.</p>
Biomedical and Health Sciences (BMED)	2044	Eric Feng	The Time Course of Murine Cardiomyocyte Maturation	<p>Cardiovascular disease (CVD) is the leading cause of death in the world, and the mature human heart has little capacity to regenerate. Recently, induced pluripotent stem cell-derived cardiomyocytes (iPSC-CMs) have emerged as a promising therapeutic treatment for CVD, however they remain in a fetal state when derived in vitro. Studying cardiomyocyte maturation patterns may reveal why iPSC-CMs persist in a fetal-like state, since little is known about their development and organization patterns between birth and adulthood. I investigated subcellular development patterns of cardiomyocytes, particularly mitochondria, sarcomeres, and T-tubules because of their prominent functional roles in cardiomyocytes. Hearts were isolated from CD-1 IGS-strain mice at postnatal days (PD) 6, 10, 13, and 18, in addition to 5 months. The hearts were digested in a collagenase II solution and then filtered to isolate cardiomyocytes. They were stained with cytochrome oxidase subunit IV, troponin I, and wheat germ agglutinin antibodies. The stained cardiomyocytes were imaged and analyzed using self-developed Haralick texture correlation software. Mitochondria and sarcomeres were visible but disorganized at PD-6 but fully developed by PD-18. In comparison, T-tubules were nearly absent at PD-6 but accelerated development until adulthood. Further analysis showed that the distance between T-tubules closely matched with sarcomere length, indicating that T-tubules form at the Z-disks. I conclude that there are temporally distinct phases for murine cardiomyocyte maturation at a subcellular level. My results may help identify which parts of iPSC-CMs are underdeveloped. Further elucidating the mechanisms of cardiomyocyte development holds great potential to treating CVD.</p>

Biomedical and Health Sciences (BMED)	2045	Ishan Nadkarni & Nathan DeMichaelis	Therapy or Trauma? Examining the Drawbacks of PERK-Knockout as a Potential Treatment for Heart Rhythm Disorders	<p>In our study, we looked at how the genetic knockout of protein kinase-like endoplasmic reticulum kinase (PERK), a sensor of the unfolded protein response (UPR), affects susceptibility to oxidative stress in cardiomyocytes, or heart muscle cells. The UPR is an intracellular signaling cascade activated when the endoplasmic reticulum comes under stress by misfolded protein aggregation. PERK alleviates this stress by blocking protein translation and inducing protein degradation. However, continuous PERK activation has adverse effects on cardiomyocytes, contributing to arrhythmias, irregular heartbeats: PERK causes irregular action potential by downregulating ion channels. Arrhythmias can cause heart failure or a heart attack and contributes to 200,000 to 300,000 sudden deaths per year (American Heart Association, 2015) Thus, heart-specific PERK knockout (PERK-KO) has been hypothesized to combat arrhythmias. In mice who underwent myocardial infarction, the action potential partially recovered. However, PERK-KO cardiomyocytes that hadn't undergone myocardial infarction showed changes indicative of oxidative stress, a condition caused by the build-up of reactive oxygen species (ROS). To determine whether PERK-KO induced oxidative stress, we performed Western blots on PERK-KO cardiomyocytes to measure the expression of antioxidant and pro-oxidant proteins. We discovered a significant decrease in antioxidant catalase but no increases in pro-oxidants. These results suggest that ROS levels could be increased in PERK-KO cardiomyocytes, though further studies are needed. This study not only explores the relationship between ER stress, PERK, and ROS but also contributes to the ongoing discussion of PERK's viability as a target for arrhythmias.</p>
Biomedical and Health Sciences (BMED)	2166	Sophia LeMire	The Effects of Glucose Metabolism on Memory and Food Consumption	<p>Glucose is the brain's main source of energy and is used to sustain the processes of learning and memory (Mergenthaler, Lindauer, Dienel, Meisel, 2013). Glucose metabolism generates ATP (adenosine triphosphate), which maintains cells and is used for energy. While foods that have high glycemic indexes, like refined carbohydrates, are believed to put people at risk of developing metabolic disease, low glycemic index foods, like fats, have been seen to decrease that risk (Aston, 2006). The ketosis diet is based on eating foods with low glycemic indexes and deriving energy from stored fat through the lowering of insulin (Cahill, 1981). It is unknown how learning and memory are affected by this derivement of fuel from stored energy. If the body is at risk of developing metabolic disease from refined carbohydrates, then relying primarily on low glycemic foods for energy could be beneficial. To address this problem, domestic mice will be pre-trained for memory tests and then will be put on a high glycemic diet, a low glycemic diet, or a control diet. Then, the mice will perform the memory tests bimonthly. It is also unknown how these diets will affect food consumption patterns. Studying this will lead to a better understanding of the mechanisms of glucose metabolism. To address this, the same mice's fasted and unfasted food consumption will be measured during the diets. An ANOVA test will be performed on the data.</p>

Biomedical Engineering (ENBM)	2046	Sophie Kyllonen	Does the Type of Pulley Affect Grip Strength and Range of Motion?	<p>The purpose of this project was to help increase awareness of options to regain the dexterity for people who have lost arm function. The hand was built, coded and tested to make sure the prosthesis functioned properly. Range of motion, grip strength, and the ability to hold mass were measured.</p> <p>The 3D printed pulleys grip strength averaged 1.0 N. This pulley had less rotation and poor grip. The plastic pulleys grip strength averaged 32.1 N. That pulley had more rotation, making the grasp stronger. The metal pulley grip strength averaged 27.9 N. This pulley was stiff and less able to maneuver.</p> <p>The range of motion on the 3D printed pulley averaged 92.3 degrees. The design did not allow the hand to rotate and grip tightly on the object. The plastic pulleys range of motion averaged 97 degrees. This pulley had the tightest grip and best rotation. The metal pulleys range of motion averaged 96.5 degrees. The servo had to work harder to complete the rotation due to friction.</p> <p>The average mass held by the 3D printed pulley was 13 grams. The grip did not hold the object well. The mass held by the plastic pulley averaged 39.7 grams. This pulley held the most mass with the tightest grip. The mass of the metal pulley averaged 37.3 grams. This grip was not as secure as the plastic pulley..</p> <p>The plastic pulley proved to be the best qualities for grip strength, rotation and mass lifted.</p>
Biomedical Engineering (ENBM)	2047	Karsten Johnson	Microfluidic Sweat Biomonitors	<p>There has been a recent uptick in the use of "labs-on-a-chip" or microchips designed for in field testing of biological functions. My project involves the creation of such a "lab-on-a-chip" designed to detect and relay information on important biological information for both athletic and medical uses. Chips combine technology and biochemistry to monitor vital functions. Sweat is an underutilized biomaterial for biochemical monitoring and the construction of flexible microfluidic chips will help monitor fluid and electrolyte levels during exercise. Microfluidic channels and chambers within PDMS Layers provide an opportunity to monitor both sweat levels and electrolyte concentrations (Glucose, Lactate, Ph, and Chloride).</p>
Biomedical Engineering (ENBM)	2048	Anindita Rajamani	Privacy-Preserving Ubiquitous Activity Recognition with Wearable Sensors	<p>This project develops a wearable wireless sensor system and artificial-intelligence-based algorithms to automatically recognize specific daily activities performed by a human subject. The specific activities that are recognized and monitored include eating, sleeping, climbing, falling (fall detection) and the occurrence of hand tremors. The developed system can be helpful in monitoring the health and well-being of an elderly person in his/her home. The wearable sensor system avoids the use of cameras and fully preserves the privacy of the elderly person. The sensor system consists of a 3-axis accelerometer and a 3-axis gyroscope integrated with a wireless transceiver, an amplifier, and a battery on a sensor board. The wearable device obtains continuous inertial motion measurements using the on-board sensors and wirelessly transmits the data to a laptop in the home. Training an artificial intelligence or deep learning algorithm to recognize specific activities among hundreds of different types of actions performed in daily life by a person is a difficult challenge. It requires tremendous quantities of real-life data with which the learning algorithms can be trained. This project addresses the challenge by utilizing physical intuition on expected relations between particular accelerometer and gyroscope signals for the specific activities under consideration. The number of real-time signals needed for activity recognition and the amount of data needed for training are thereby highly reduced. Experimental results show that the developed system works well and can accurately recognize activities in new untrained data.</p>

Biomedical Engineering (ENBM)	2049	Sahana Mangipudi	The Missing Link: Glycoengineering MSCs for Targeted Cancer Drug Delivery	Targeted drug delivery is a form of cancer treatment that aims to deliver a chemotherapy drug directly to cancer cells, reducing the side effects on healthy cells. One form of this treatment utilizes drug-encapsulated nanoparticles to deliver the drug directly to the tumor. However, only 5% of the injected dose of nanoparticles reaches the tumor. Mesenchymal Stem Cells (MSCs), on the other hand, are specialized stem cells with natural tumor homing abilities. Coupling nanoparticles with MSCs allows for the delivery of a chemotherapy drug directly to the tumor. The purpose of this study was to improve a two-step targeting process that attaches nanoparticles to MSCs. When amino-sugars are metabolized by the MSC, they are expressed as azide groups on the surface of the cell. Nanoparticles then attach to the azides on the MSC, tethering a drug-encapsulated nanoparticle to the cell. MSCs labeled with the amino-sugar Mannose express a high number of azides, but take three days to completely metabolize within a cell. By this time, cell death may occur. This study evaluated the efficiency of two alternative amino-sugars, Galactose and Glucose. MSCs labeled with the amino-sugar Galactose at a concentration of 100µM expressed a high number of azides within one day similar to that of MSCs labeled with Mannose at 20µM after three days. Under these conditions, the viability of MSCs labeled with Mannose was slightly higher than MSCs labeled with Galactose. This research could potentially move this two-step targeting approach closer to a therapeutic reality.
Biomedical Engineering (ENBM)	2050	Molly Garber	What You Knee'd to Know	I was curious how knees could move from bent to straight or straight to bent in seconds. I looked it up and I found out that the two main tendons contribute to straightening the knee. I also found out they gain force from when the tendons stretch, so it will have enough power to straighten the knee. My hypothesis I was investigating was by testing on a knee model, if the angle of the knee decreases, then the amount of force on the string (quadricep and patellar tendons) will increase. Using a computer program and a knee model, I bent the knee model to different angles and then collected data. I tested 13 different angles, from 30-150 degrees. My data concluded that the force increased as the angle decreased. In the future I plan to add weight to the knee model to find out how adding weight affects the force on the quadricep and patellar tendons.
Cellular and Molecular Biology (CELL)	2051	Jacob Bridge	An analysis of TRF2 protein involvement in the telomere position effect over long distances	Telomeres and their associated proteins both prevent DNA damage and facilitate DNA replication during normal cell division, and their critical shortening following high numbers of cell divisions has been linked to both aging and cancer. However, telomeres also play an important role in transcriptional silencing, by looping to interstitial telomeric sequences (ITS) and silencing specific genes using telomeric chromatin in a process known as telomere position effect over long distances (TPE-OLD). The biomolecular mechanisms surrounding the process remain largely unclear; however, TRF2, a protein in the shelterin complex, has been demonstrated to play a role in facilitating the process, and is possibly responsible for facilitating the formation of telomere loops at specific loci. As a result, it is necessary to test whether TRF2 plays a role in the expression of specific genes that are telomere length dependent, in order to discern whether it is in fact a crucial factor in TPE-OLD. This will be accomplished by knocking down the TRF2 protein in a HEK-293T cell culture using siRNA, and then by testing the resulting expression of hTERT using qPCR, establishing whether there is a link between TRF2 protein activity and TPE-OLD. The hTERT gene is responsible for the production of human telomerase reverse transcriptase, the main component of telomerase. The telomerase enzyme, in turn, is the main mechanism for telomere length regeneration in human stem and cancer cells. Thus, in the future, a feedback loop facilitating biological immortality in non-cancerous humans cells could be developed through the controlled application of TPE-OLD.
Cellular and Molecular Biology (CELL)	2052	Aidan Edge	Detecting the presence of Powassan virus in Ixodes scapularis	Powassan virus (POWV) is a zoonotic, neuroinvasive virus within the Flavivirus genus that is primarily transmitted by Ixodes scapularis, commonly known as deer ticks. Common symptoms include headache, fever, mental confusion, seizures, loss of coordination, and nausea. These symptoms may or may not present themselves, however, if severe enough, the virus can cause encephalitis and meningitis. Relative to other infectious diseases, not much is known about POWV. There is no known cure. As of now, Minnesota has the highest rate of recorded cases in the United States, followed by Wisconsin. The goal of this investigation is to identify any presence

				of POWV in the Ixodes scapularis population of Carlos Avery Wildlife Management Area, in Stacy, MN. Samples will be collected, purified, and tested for the virus RNA through RT-PCR, gel electrophoresis, and cDNA sequencing. This investigation is looking to bring insight to the prevalence of POWV in Ixodes scapularis northeast of the Twin Cities.
Cellular and Molecular Biology (CELL)	2053	Samskrith Sriram	Effect of LMNA (Imn-1 protein coding) genes on the longevity of mutated ifa-3 Caenorhabditis elegans (C. elegans) worms	The purpose of the project is to determine the effect that the LMNA gene has on wild type and mutant ifa-3 Caenorhabditis elegans. Research on gene inhibition of the up-regulated LMNA gene may help explain what processes occur that make the mutated ifa-3 C. elegans have shorter longevity when compared to the wild type C. elegans. Both the mutant ifa-3 C. elegans and the wild type C. elegans will be obtained from the Caenorhabditis Genetics Center at the University of Minnesota. The OP50 Escherichia Coli, used as food for the C. elegans worms, will also be obtained from the Caenorhabditis Genetics Center at the University of Minnesota. C. elegans is a very successful model organism, so the results of this study can be expanded on in the future, where gene inhibition technology could be used to suppress crippling or even fatal genetic diseases in more complex animals and maybe even humans.
Cellular and Molecular Biology (CELL)	2054	Joseph Johnson	Endocrine Disruption Quantification in Dreissena polymorpha and Caenorhabditis elegans	Artificial turf is a growing alternative that is being used in parks sports fields around the world. The possible effects of long term exposure to many of the chemicals in artificial turf is still widely unknown. My experiment will test both the effects of long term turf exposure, as well as using Dreissena polymorpha (zebra mussels) to test their validity of being used in endocrine disruption studies. In order to do this, zebra mussels must be collected and adjusted to a lab setting. After that, they will be tested in three different experimental environments. One will remain with normal lab conditions, one will contain bisphenol A, a known endocrine disruptor that targets the vitellogenin-like gene being inspected, and the third will contain the different parts of artificial turf. Zebra mussels will be tested along side Caenorhabditis elegans to ensure that the mussels are a viable way to test endocrine disruption. After grown in their specific environments, the test subjects will be homogenized, their RNA will be purified and preserved, and they will be quantified using qPCR to analyze whether the expression of the target gene has changed within the different experimental values. It will also be known whether zebra mussels can be used in the future to test endocrine disruption by comparing the results between zebra mussels and C. elegans.
Cellular and Molecular Biology (CELL)	2055	Ming Ying Yeoh	Inflammation in Alzheimer's disease: effects of tau protein hyperphosphorylation on microglial phagocytic behavior	Alzheimer's disease (AD) is a disease characterized by neurological decline and memory loss primarily affecting older adults and currently the 6th leading cause of death in the United States. Much is still unknown about the many changes that occur in the brain with its onset. Recently, the role of inflammation in driving the pathology of AD has become more of interest. Key in this process are microglia, the primary immune cells and phagocytes of the brain. The full role of microglia in AD is yet poorly understood, and it is unclear whether they serve mainly as a harmful, driving force for the disease through their over-activation, or as mitigators through their role as immune cells especially in the phagocytosis of the harmful proteins like hyperphosphorylated tau protein. Either way, it seems that microglia and inflammation overall are new promising targets for treatments of this disease that is expected to increase dramatically in prevalence over the century. This study uses a mammalian protein production system and various other methods to produce hyperphosphorylated tau protein that is then added to populations of cultured BV2 murine microglia and analyzed with fluorescence microscopy. This is to determine the effects of tau protein hyperphosphorylation on the phagocytic behavior of the microglia that ingest this tau to gain insights into the role of both microglia and the tau protein in the AD brain as a step towards developing more effective treatments targeting microglia and inflammation in AD.

Cellular and Molecular Biology (CELL)	2056	Jack Peterson & William Bae	Looking Deeper Into Lyme Disease: Reclassifying post-treatment Lyme disease utilizing novel staining methods	<p>Post-treatment Lyme disease (PTLDS) occurs when previous Lyme disease symptoms resurface over six months after initial treatment. PTLDS can cause many similar symptoms to Lyme disease, including severe fatigue, joint pain, and trouble sleeping. Even though up to 30% of Lyme disease patients will later develop PTLDS, there are no proven treatments and no verified reason for why it occurs. The purpose of this study was to understand how the bacterial family Bartonella may play a role in PTLDS.</p> <p>Bartonella spp. have previously been observed close to pain receptors in PTLDS patients. This is a promising find because a notable symptom of PTLDS is hyperalgesia—an increased sensitivity to pain. Before a staining procedure could be accomplished, a titration experiment was executed to characterize a chicken antibody for Bartonella spp. This IgY antibody is more cost efficient and ethical than current antibody retrieval procedures and was shown to be effective and specific for Bartonella spp. Thick tissue multi-staining was performed to analyze skin samples' prevalence of various components that affect or could be affected by PTLDS. This included Bartonella spp., pain receptors, myelin binding proteins, and Borrelia burgdorferi, the bacteria known to induce early stage Lyme disease.</p> <p>This work has the potential to influence PTLDS identification and treatment. Whereas currently PTLDS can only be identified through symptom reporting, if Bartonella spp. is proven to be a cause, an ELISA or other identification procedure could test for PTLDS. This research may profoundly affect the lives of those suffering with this debilitating disease.</p>
Chemistry (CHEM)	2058	Arush Naik	An Efficient Lather	<p>The purpose of my experiment was to discover whether hard or soft water would be a better lather for soap. This can see which type of water is more effective for cleaning. My hypothesis was if we put drops of soap in both glasses, the soft water would have more foam because the chemical properties of the soft water don't restrict soap, making it a better lather.</p> <p>We first had two glasses filled with water. Next, we placed drops of dish soap in each one. Moreover, we shook each of the glasses and measured the foam amounts. We discovered that soft water had more foam than hard water. Therefore, making soft water the better lather for soap. Because a lather is an effect that creates foam from a chemical reaction. More lather equals more cleaning area.</p> <p>Soft water is more effective for cleaning. Because we had a significant increase in foam in all three trials from soft water instead of hard water. Therefore, hard water is not effective for cleaning.</p> <p>In conclusion, we learned more about the importance of hard and soft water and its advantages. Both hard and soft water are unique and significant. Over the past couple of months, I have learned how many benefits they can bring to the real-world because of their unique properties. A future question I aim to research is how can hard and soft water benefit human health, and experiment on it. Hard and soft water are truly fascinating and sparked excitement.</p>

Chemistry (CHEM)	2059	Qeng Xiong	Convergent Synthesis: Development of a GGPP Analogue for Selective Enzymatic Labeling of Prenylated Targets Related to Diseases	Protein prenylation is a post-translational modification and attachment of a 15 or 20 carbon isoprenoid to a cysteine at the C-terminus of a protein. Prenylation encompasses three enzymes that carry out this modification on proteins that regulate essential cellular functions: farnesyl transferase (FPPase), and geranylgeranyl transferase type 1 (GGTase) and type 2 (RabGGTase). These enzymes are able to transfer analogues of their native substrates, farnesyl diphosphate (FPP) and geranylgeranyl diphosphate (GGPP) respectively. This has led to the development of FPP analogues with alkynes for the study of diseases. Unfortunately this analogue is not selective for one enzyme in particular and targeting specifically GGTase and RabGGTase. As GGTase and RabGGTase are suspected to have specific roles in some diseases, finding a way to study them individually will be key in gaining a better understanding of the role of prenylation disease. Developed here is the convergent synthesis of two geraniol based precursors. The first geraniol precursor will go through protection, oxidation, reduction, and chlorination. The second geraniol precursor will go through sulfonation, oxidation, reduction, and protection. By attaching two synthesized geranyl compounds, we can form an TBDMS-C10-TS-C10-OTHP scaffold. This can be further developed into an alkyne containing GGPP analog. This analog would be a selective substrate for GGTase and RabGGTase, enabling its use as a labeling tool with copper-click chemistry. This demonstrates that through convergent synthetic methods, previously unattainable prenylation probes can be attained. This can be used in disease research by being a selective labeling tool for protein substrates of geranylgeranyltransferase.
Chemistry (CHEM)	2060	Zoey Cameron & Morgan Bush	How Do Different Metallic Mordants Affect the Color of Natural Dyes	We became interested in dyeing wool with plants, when college biology did a project last year. To start, we researched what types of local plants that made dyes were available. We then used our natural dyeing books to research how and what parts of the plants to collect. In those sources we found out information about mordants and how they can change dye color. The name mordant is called latin morde. Mordant dye is colorant that can be bound to a material such as what we used, wool. It's a chemical that combines with dye and fabric. When mordants are used it is known as tailor made. The different mordants we used were iron which has a drastic change in the dye, changing it to a deeper color. Copper, tin and alum were also used. The different mordants had vivid effects on the colors of the dyes, the iron darkened the colors, copper and tin seemed to brighten them, while alum had no effect of the color but just helped adhere the dye to the wool so that it didn't wash out.
Chemistry (CHEM)	2061	Fatuma Newman	How does time affect bubble gum size?	Gum itself came a long way ranging from its ingredients to purposes, but what is gum's purpose really? Whether it's to curb hunger or freshen up breath, blowing bubbles has been a fun activity people have done while chewing gum. But why do we have to wait until the perfect window to blow the biggest bubble? My hypothesis was that the longer gum is chewed, the bigger the bubble blown will be. Although taking into consideration that chewing the gum for too long would simply result in the gum ultimately dissolving. This experiment consisted of having bubble gum and blowing it at certain time stamps to measure how big the bubble would get. Based on the results of this experiment, the longer you chew gum the bigger the bubble was to be.
Chemistry (CHEM)	2063	Cameron Bonin	The Silver Lining: Studying the effects of different electrodes when used to reduce silver sulfide	Redox reactions are reactions in which one atom or molecule loses an electron (is oxidized) and one gains an electron (is reduced). Different elements are more willing to gain or lose electrons. This can be seen by measuring the voltage of different redox reactions. This experiment was conducted using six metals electrodes (aluminum, zinc, iron, lead, copper, and brass) and tarnished silver-plated spoons; silver tarnish is silver sulfide. In each test, the electrode and the silver were placed in an aqueous solution of sodium chloride and sodium hydroxide and were connected with a Vernier Energy Sensor. The silver sulfide was reduced while the electrodes were oxidized. My hypothesis was that the results gathered would agree with the order of elements according to their standard reduction potentials. The results did agree with my hypothesis, with the exception of the alignment of zinc and aluminum, which was reversed according to the standard reduction potentials of each element. This unexpected result could have been caused by a number of different factors but was likely caused by human or machine error.

Computational Biology and Bioinformatics (CBIO)	2064	Varsha Shan	Convolutional Neural Networks for the Rupture Risk Assessment of Cerebral Aneurysms	<p>A cerebral aneurysm is a weakened area on the wall of an artery in the brain that often results in an abnormal widening or ballooning and potential rupture. Predicting the risk of aneurysm rupture early on is a critical step in treatment planning and prevention of subarachnoid hemorrhaging. Current rupture risk assessments include digital subtraction angiography (DSA), CT scans, MRA, and MRI procedures, all of which are largely done manually and may result in treatment error. Computerization of the steps taken for rupture risk assessment can greatly improve the efficiency of treatment planning for cerebral aneurysms. In this research, a convolutional neural network for rupture risk assessment of cerebral aneurysms with a specific focus on geometric morphological parameters of aspect ratio, size ratio and aneurysm width was created. These morphological parameters help to assess the risk of cerebral aneurysm rupture and prevention of fatalities that result from rupture such as Subarachnoid Hemorrhagic Stroke. DSA rabbit images were input into the neural network, which was designed for analyzing those specific morphological parameters. Specific software of TensorFlow, an image classification module created with R software, was used to develop this neural network. A minimization of user annotation using computerization improves efficiency greatly for the treatment planning of cerebral aneurysm. Computerized automation of these more simpler parameters such as size and aspect ratio allows radiologists to focus more of their time and efforts onto more complex parameters such as Computational Fluid Dynamics (CFD) parameters.</p>
Computational Biology and Bioinformatics (CBIO)	2065	Sterre Hoogendoorn	Creating an algorithm to assist saber referees using biomechanical data	<p>The sport of fencing currently relies on human judgement, eyesight, and the occasional use of video replay to make calls about movements that occur at a high speed, a feat complicated by the complex set of rules that govern fencing. This challenge often leads to numerous incorrect calls, even by referees of the highest level. To start solving this problem, this research aims to create an algorithm able to assist referees during saber bouts. The algorithm will be built from biomechanical data gathered using inertial measurement units (IMUs) and other motion capture systems and will seek to classify actions and provide simple kinematic data to the referees. The ultimate goal is to improve saber fencing refereeing using an analytical and data-based approach.</p>
Computational Biology and Bioinformatics (CBIO)	2066	Jenny Yan	Enhancing Precision Medicine: Gene Fusion Detection with Cancer Sequencing Analysis	<p>Cancer is one of the leading causes of death. It is well known that gene fusion event, i.e., the formation of a hybrid gene from two different genes, plays a causal role in tumorigenesis. The occurrence of gene fusion in tumor samples can be readily detected by next-generation sequencing technology. Fusion genes, which encode novel proteins that do not exist in healthy tissues, represent ideal targets for cancer drug development. In fact, the Food and Drug Administration (FDA) has recently approved a few cancer drugs specifically targeting gene fusion events, supporting the cancer treatment strategy "one drug fits many cancer types". Large-scale cancer sequencing projects have generated massive genomic data that are openly available in public biomedical domains and can be used for discovering more gene fusion events. To gain insight into the occurrence of gene fusions in various cancer types, I explored dozens of cancer genomic research portals to extract these gene fusion events, and further grouped them based on cancer types. The most frequent fusions were found to be lineage-specific. For example, MPRSS2-ERG was only found in prostate cancer, and CCDC6-RET was found only in thyroid cancer. Several recurrent fusions that are currently under clinical testing such as FGFR3-TACC3 and ETV6-NTRK3 were found in a few cancer types. The most frequent, novel kinase fusion was TMEM87B-MERTK found in 7 cancer types. Other fusions with potential clinical relevance included BRAF associated fusions were found in 8 cancer types, for which sorafenib may provide a therapeutic advantage based on the ligature that I obtained from PubMed. As a case study, I also downloaded the raw sequencing data from glioblastoma and lung cancer sequencing projects and detected gene fusion events with bioinformatics approaches. Finally, I collected biomedical literature in PubMed to predict the possible therapeutic responses of drugs that can be designed based on the detected fusion proteins.</p>

Computational Biology and Bioinformatics (CBIO)	2067	Katie Barry & Meghan Quinlan	Human Gut Microbiota Driving Fatty Acid Composition and its Contribution to Obesity	<p>Obesity, a health disorder involving an excessive amount of body fat, may negatively affect a human's health; it can result in cardiovascular disease, diabetes, stroke, sexual or gynecological issues, and high blood pressure (Mayo Clinic). The majority of research on how the gut microbiome affects obesity focuses on the effects of carbohydrates on metabolic pathways in the gut. This research, however, compares the effects of fatty acids in the gut microbiome and fatty acid associated microbiota of obese and healthy individuals. The specific bacterial species and their symbiotic relationships that play a role in the metabolic pathways of an organism can also directly influence the buildup of short-chain fatty acids in the adipose tissue. To analyze the differences in the microbiomes of obese and healthy individuals, a phylogenetic distribution of the five most common human gut microbiota phyla, KEGG pathways tracing the fatty acid biosynthesis and fatty acid degradation of each metagenome, and figures of normalized microbiota abundances were assembled. This research concludes that there are differences in the obese and healthy microbiomes which contribute to obesity. There is a higher abundance of Proteobacteria, Actinobacteria, and Verrucomicrobia in the healthy metagenome. The obese metagenome has greater abundance of biosynthesis pathway genes while the healthy metagenome has greater abundance of degradation pathway genes. The obese metagenome has a higher abundance of Bacteroides fragilis and Bifidobacterium animalis while the healthy metagenome has a higher abundance of Lactobacillus reuteri. Further research is required to understand the impact of symbiotic relationships.</p>
Computational Biology and Bioinformatics (CBIO)	2068	Andrew Cao	The Development of Neural Network Inversions on Synthetic MRI Data Masks to Accurately Estimate Brain Tissue Stiffness Indicative of Alzheimer's Dementia	<p>Abnormally stiff brain tissue is associated with neural damage and can indicate Alzheimer's dementia, other dementias, and normal pressure hydrocephalus. Currently, early Alzheimer's diagnosis is conducted with mental interviews and tests that are not concrete, efficient, nor applicable to everybody. Magnetic Resonance Elastography (MRE)—a subsection of MRI that finds tissue stiffness—creates a concrete, numerical brain stiffness baseline that has the potential to identify forms of dementia and increase the chances of early diagnosis. However, the traditional MRE method of direct inversion (DI) tested on in vivo MRI data yielded a 0.49 coefficient of determination and is biased around the edges of MRE masks. Thus, developing neural network inversions (NNIs) trained on modified MRI displacement masks can improve stiffness estimation accuracy and generalization. Training NNIs on artificial data could also produce better accuracy than the previously described models and increase generalization in elastography. Seven main NNIs were trained through an Inception-like convolutional architecture: no-masks (NM), all-masks (AM), one-person's masks (OPM), one-region's masks (ORM), randomized-masks (RandM), and artificial-masks (ArtifM). They were all tested on three datasets: AM, OPM, and ORM. After testing, the coefficients of determination were determined—NM: 0.42, AM: 0.99, OPM: 0.98, ORM: 0.99, RandM: 0.95, ArtifM: 0.83. These were visualized, t-tested, and analyzed for bias and significance. In summary, the NNI significantly estimated brain tissue stiffness more accurately than DI, while increasing generalization and decreasing bias, and proves to be a potentially accurate, more efficient MRE technique for early Alzheimer's dementia diagnosis.</p>

Computational Biology and Bioinformatics (CBIO)	2069	Helaina Sislo	The Evolution of the Human Microbiome	<p>Comparing the gut microbiomes of newborns, infants, and adults can create a better understanding of the importance of diet in relation to youth development. At different stages of life, the body needs different nutrients due to the changing gut microbiota. Studying the different bacterium present at each stage of development can give insight to a proper diet.</p> <p>To investigate the evolution of the human microbiome, I used IMG (https://img.jgi.doe.gov), to look at the genetic sequences found in newborn, infant, and adult fecal samples. I compared the phylogenetic distribution of metagenomes, the fatty acid biosynthesis of stearic acid, which is found most commonly in lactose, and the breakdown of carbohydrates. I analyzed the abundances of the bacteria Bifidobacterium, Enterobacteriaceae, Streptococcus.</p> <p>The results of my study show that newborns have a much more diverse microbiome in the beginning, but after major developments within the first few weeks of life, their gut microbiome becomes more similar during infancy. Adults have the most diversified metagenome due to their diets. The microbial pathways are more abundant in infants and newborns; newborns and infants have higher levels of carbohydrate broken down to energy for the development of tissues in the brain, muscles, and organs. Bifidobacterium, Enterobacteriaceae, Streptococcus are more abundant in newborns for the development of the gut microbiome.</p> <p>Looking at the gut on a molecular level can allow understanding of the importance of a specific diet. Knowledge of a proper diet necessary for youth development can improve the care and nutrition for children.</p>
Computational Biology and Bioinformatics (CBIO)	2070	Madeline Hace & Eliana Zubert	Understanding Schizophrenia: Changing the Game with the Oral Microbiome	<p>This experiment sought to determine if individuals with schizophrenia have observable differences through the genetics of their oral microbiomes compared to healthy individuals. This was done by investigating the significance of oral microbiota phyla and metabolic pathways. The research was performed using genetically sequenced data samples of the human oral microbiomes of six schizophrenics and six healthy individuals from the Integrated Microbial Genomes and Microbiomes (IMG/M) database. To ascertain if observable distinctions were present between the two oral microbiomes, the data was compared using principal coordinates analysis (PCoA) models, based on phyla composition and protein pathways. Differentiations in the phylogenetic distribution of the samples metagenomes were shown graphically. Additionally, variations between metabolic pathways of schizophrenic and healthy samples were identified using Kyoto Encyclopedia of Genes and Genomes (KEGG) models. The PCoA models illustrated a clear division between the samples using spatial separation. The phylogenetic distribution of metagenomes models showed healthy samples had increased amounts of bacteroidetes bacteria, while schizophrenic samples more firmicutes bacteria. Dissimilarities in the phyla between the two oral microbiomes illustrate schizophrenia's effect on phylum diversity. Through analysis of metabolic pathways, schizophrenic samples showed higher concentrations of the metabolic transporters urea and glutamine/glutamate. As a result of the differences between these various analyses, there is a prevalent and observable difference between the oral microbiomes of schizophrenic and healthy individuals. In the future, this research could be developed further regarding how the oral microbiome can be utilized during the diagnosis and treatment of Schizophrenia.</p>
Computational Biology and Bioinformatics (CBIO)	2071	Gautham Nair	Understanding the effects of disinhibition: Analyzing the impact of synaptic disinhibition on neural activities and patterns	<p>Drug addiction has a significant presence in society and poses a constant challenge for neuroscientists to effectively map its impact on the brain's structure and function. The ring-attractor model demonstrates a simple, yet effective method of characterizing the interaction among neurons and neural networks, in which excitatory and inhibitory neurons work together to respond to various stimuli. Certain stimuli are strong enough to cause the ring of neurons to form a 'bump', which can then be interpreted given the situation.</p> <p>The interaction between excitatory and inhibitory neurons, and the balance of their influence on one another, is one of the most important aspects of this model. Many different disorders are theorized to be attributed due to unusual levels of excitation or inhibition among neural pathways. To understand how specific changes in inhibitory levels affect overall neural activity, this model demonstrates how certain attractor networks react in response to synaptic disinhibition at various levels. The use of this model will improve the field's understanding of how disinhibition, and thus</p>

				certain stimuli that induce disinhibition, may affect and change the behavior and activity of a particular brain, guiding medical practitioners in creating treatments and therapies to effectively aid patients.
Earth and Environmental Sciences (EAEV)	2072	Abirami Rajasekaran & Harini Senthilkumar	A computational analysis of the effects of Dreissena polymorpha on the ecological integrity of Minnesota Lakes	Dreissena polymorpha, commonly known as zebra mussels, are invasive species native to Eastern European and Western Russian ecosystems and have found to be increasing their invasion in Minnesota lakes annually. D. Polymorpha can filter one quart of water per day while feeding primarily on surface algae. Native species are unaccustomed to these activities and therefore can suffer from and cause negative impacts to the environmental factors of the lakes. This study analyzes the effects of D. Polymorpha on the ecological integrity of Minnesota Lakes. Specifically, light penetration, dissolved oxygen, and temperature were analyzed. Four lakes infested with D. Polymorpha and four non-infested lakes were chosen to sample data. A Secchi disk was used to measure light penetration; a temperature probe was used to measure temperature; a dissolved oxygen sensor was used to measure dissolved oxygen. A number of measurements were collected from various stations in the lakes. Data collected was compiled in a spreadsheet, then analyzed using computational methods in MATLAB and visualized for conclusions. The results from this study demonstrated that the growing population of D. Polymorpha has an adverse impact affecting the ecological factors like dissolved oxygen, temperature and light penetration, which are critical for native species to survive.
Earth and Environmental Sciences (EAEV)	2073	Carmen Curry	Acid rock drainage and wild rice	14 copper sulfide mines currently represent 89% of copper production in the US, using a process involving blasting rock to find sulfide ore, crushing this rock containing ore, and then sending it away to be extracted. Waste left behind is referred to as tailings, and when they become exposed due to these mining activities, they can become toxic. When they leach into nearby water sources, they can create acid mine drainage, which is acid rock drainage when naturally occurring. Wild rice is an important part of the ecology of Minnesota's lakes, as well as being something people regularly eat. Knowing their reactions to potential modern interference is vital to helping protect local ecosystems, but tangible knowledge is surprisingly rare. This experiment will test the effects of some of the most common metals found in acid mine drainage against the continued health of wild rice, to understand how heavy metal poisoning affects plants in a lake. This experiment will observe the quantitative effects of wild rice under heavy metal poisoning.
Earth and Environmental Sciences (EAEV)	2074	Grayson Roberts & Julian Moyer	Analyzing the Efficacy of Stormwater Treatment at Removing Pathogens	Humans use too much water through our household applications, irrigation of crops, and even our generation of power. Significant reduction of freshwater usage or discovery of alternative water sources is vital to reducing strain on rivers and underground aquifers. Although reduction of water use is possible, such an action would be a major inconvenience to humanity and as seen through fossil fuels, countries are not keen on reducing cheap resource consumption. Stormwater has proved to be a potential alternate source of water. Capturing the water is not terribly difficult, but the problem lies in determining the safety of the water. At any point across the collection process or during water storage, stormwater is prone to harmful pathogens and antibiotic resistant genes. We worked to identify the health risks associated with stormwater reuse by collecting samples from various treatment facilities around the Twin Cities. We collected samples from before treatment, mid-treatment, after treatment, and at distribution sites of the water. In addition, we collected samples from the Minneapolis and Saint Paul main line as a control. We measured chlorine levels, turbidity, as well as E. coli and total coliform to attempt to detect the presence of potentially harmful pathogens. With this information, we can identify the concentration of harmful pathogens in the water, how effective specific treatments are at removing said pathogens, and how environmental factors such as rainfall and temperature affect their concentration.

Earth and Environmental Sciences (EAEV)	2075	Matteah Ojard	Atomic Absorbption Spectroscopy of Lead in Environmental Samples	<p>This project interested me because of what had happened in Flint Michigan where the water supply was contaminated with lead, and many people got sick. Lead is used in ammuniton, fishing sinkers, water lines, pipes, gasoline, paints or other protective coatings, and lead-acid batteries, which are used in most motorized vehicles. Although lead can be useful, it is very harmful to the human body, and it can be soluble in lower pH solutions. Based on previous years of research and experimentation, even solutions as high as 6.5 pH. Thus, this experiment was investigating if environmental samples would react similarly to the acid solutions of the previous years of research with 24hrs of lead exposure. The investigation of this project was conducted with samples from lakes and rivers in the Duluth-Two Harbors area, in which the pH of these samples were all between 7.4-7.5. The common unit for measuring the mass of a chemical or contaminant per unit volume of water is expressed as parts per million (ppm) or billion (ppb). However, parts per billion in standard measure for professional water testing is the unit of ug/L. The health risk limit for lead according to the Minnesota Department of Health is 15ug/L. My hypothesis was that there will be harmful amounts of lead found in all of the samples after being exposed to lead for 24 hours. This hypothesis was proven correct as all samples tested had at least 10.9 ug/L lead contaminant after atomic absorption analysis with a graphite furnace. This project is important because people should be more aware about the effects of lead on their health and of how quickly lead can leach into water supplies.</p>
Earth and Environmental Sciences (EAEV)	2076	Steven Hu	Best Way to Prevent Soil Erosion	<p>The purpose of this project was to determine the most effective and practical method of soil erosion prevention. My hypothesis was that geotextiles would be the most effective method of prevention because during my research I found that geotextiles were used the most in urban development and in agriculture making it the most practical and given its construction the most effective.</p> <p>For my experimentation process, I tested these methods of soil erosion prevention: compost, mulch, geotextiles, and ground cover vegetation during rain/runoff erosion while factoring their practicality. To measure my data, I weighed the amount of soil that had been eroded and compared the clarity of the water that had runoff.</p> <p>Contrary to my hypothesis and research, vegetation proved to be the best form of erosion prevention as there was less soil eroded and the water collected was clearest. Vegetation can help shield the ground from splash erosion and at the same time, vegetation can absorb greater amounts of water which mitigates over-saturation of the soil with water.</p> <p>However, the results I got from geotextiles were not far off from vegetation if not equal in some tests. Therefore, my hypothesis was partially correct. While vegetation is statistically better, and that makes sense as it's 'mother nature's' creation, in practice, geotextiles may be better suited for situations like agriculture where planting ground cover would not be reasonable.</p>

Earth and Environmental Sciences (EAEV)	2078	Jenna Eichman & Carolyn Macon	Comparison of Compostable Materials	<p>Question/Problem Addressed: Which of six common compostable materials is the most efficient at decomposing cardboard, a common trash item?</p> <p>Hypothesis: Nutrients like carbon and nitrogen play an important part in composting. The ideal carbon to nitrogen ratio for a compost pile is 25-30:1. The carbon to nitrogen ratio of cow manure is 20:1, eggshells are 0:0, grass clippings are 12-25:1, newspaper shreadings are 400-800:1, banana peels are 4-10:1, and the soil is about 10:1. Based on these numbers, we predict that the 5 x 5 cardboard squares will break down best in the grass clipping or cow manure compost mixtures because their ratio is closest to the ideal 25-30:1 carbon to nitrogen ratio.</p> <p>Procedures: We took 18 5x5 pieces of cardboard, punched a hole in the corner of each cardboard square, ran a zip tie through each hole, and used a piece of masking tape to create a label. Then we buried one square in each of the (18) ice cream pails. We will compost the cardboard in six compost mixtures with 2 ½ liters of dirt each. Additionally, the five of the different mixtures consisted of 10 eggshells, 3 24x24 sheets of newspaper, 6 banana peels, ½ gallon of grass, and ½ gallon of cow manure. To collect our data we will remove the cardboard pieces one Saturday night and scrape the dirt off and then set them on top of a wood stove to dry. The next day we will weigh the cardboard pieces on a scale in grams to track the break down of the cardboard and we will take a picture of the cardboard before reburying the cardboard in their pails. We will do this every weekend for the next eight weeks.</p> <p>Conclusion: We can conclude that our hypothesis was rejected due to the fact that neither the manure nor grass experiments had the most significant decrease in weight over an eight week period.</p>
Earth and Environmental Sciences (EAEV)	2079	Arjun Acharya	Countering the Eutrophication of Minnesota Lakes Using Epipremnum Aureum	<p>During Minnesota summers, a green lake is a common sight. This is not a sign of healthy, thriving lake, but of one that is slowly dying, and killing all aquatic life. Fertilizer runoffs from lawns, and other factors lead to nutrient rich lakes that creates ideal conditions for algae to grow and take over the lakes. This process is called Eutrophication. According to Minnesota Pollution Control Agency (MPCA), Eutrophication is the second most common reason for lake pollution affecting 21% of impaired water bodies. Several methods are applied to counter Eutrophication; from using phosphorous free fertilizer to reducing runoffs to lakes and preventing them from reaching lakes through active buffer zones. Though these are good attempts at reducing eutrophication, they are not enough.</p> <p>This project investigates additional ways to counter Eutrophication. The central idea is to skim water and remove surface algae, and plant Epipremnum Aureum (a.k.a “Money Plant”. Money plant can remove excess nutrients, improve water quality by reducing acidity and ammonia content. Tests were conducted using lake water samples and shown that this approach will help improve water quality.</p> <p>Lake cleanup, and introducing floating islands of ‘Money Plant’ is recommended.</p>

Earth and Environmental Sciences (EAEV)	2080	Georgia Rice	Does Diameter Of The Vent Affect Volcanic Eruptions	<p>What I am trying to figure out in my science fair project is, if the diameter of the vent affects the volcanic eruptions. I hypothesized that the volcanic eruption will be affected by the diameter of the vent. I believe that my hypothesis was supported by the data I have collected.</p> <p>What I did for my experiment is, I got five different plastic bottles with different diameter vents. I built volcanoes and, baking soda, and vinegar in them. I had my younger sister to help me to take videos, pictures, and watch as the volcanic eruptions happened to measure the eruption. After all ten eruptions of one volcano were done I proceeded with the eruptions of the volcanoes.</p> <p>While conducting fifty trials, I experienced different results. I analyzed that Volcano E had very low eruptions. I think it had low reactions because the vent was bigger than the other vents. My data shows Volcano E has an average of 2.9 cm for its eruptions. All the other eruptions have an average of 3.5 cm.</p> <p>Why I think my results happened the way they did, is because of the diameters. When you have different diameters, there will be different results. I did have Experimental errors when doing my trails. The importance of this research is because volcanologists can look at volcanoes and see the diameter of the vent. See how much damage the volcano can do. When the research is done, a scientist can then plan for it.</p>
Earth and Environmental Sciences (EAEV)	2082	Evan Knoll	Don't Be So Salty: Phase III: The Phytoremediation of Brine Contaminated Soils Through the Use of Cover Crops, Halophytes, and Foxtail Barley.	<p>Brine, a wastewater-byproduct from oil and gas drilling, can be 10 times saltier than seawater. About 98% of oilfield waste is brine. Brine from oil and gas drilling is the leading cause of soil and groundwater contamination. Brine spills are becoming more prevalent and contaminating more land. Phytoremediation is a remediation method that focuses on the interaction between plants, soil, and microorganisms in the soil. If these eight plants (alfalfa, barley, crested-wheatgrass, faba-beans, foxtail-barley, orac, rye, and salt-cress) are planted in four soil types with nine different salt levels and one chemical-treatment, then barley will survive the best because of its fibrous root system, high drought tolerance, and rapid organic-matter production. First, prepare pots depending on the salt level and soil type. Add 5-15 seeds depending on the plant type and add the correct amount of RO water. For the eight week growth-period, weigh the sample and measure the overall height. Add water if the weight is less than the constant weight, either 920(Trial-1) or 1120(Trial-2 and Trial-3) grams, unless water-levels are adjusted. After eight weeks, prepare the samples for testing by separating them into plant material and soil. Run the chloride and electro-conductivity tests on the soil and the biomass test on the plant material. Document final results.</p> <p>Phytoremediation has a future in remediation and will become necessary as more land is contaminated and more brine is produced. In conclusion, phytoremediation is the best remediation method to restore soil of high sodium chloride content without contributing to other issues.</p>
Earth and Environmental Sciences (EAEV)	2083	Addison Pajor	Effects of different ratios of phosphorus and nitrogen on the growth of Pyrocystis fusiformis	<p>Considering that realistically, eutrophication is one of the leading causes of water pollution and that nearly all coastal regions are subject to harmful algal bloom (HAB) events, along with increased frequency of them, it is important to note the ecological, human health, and economic effects that more blooms as a result of excess nutrients may cause (Hoagland et al., 2002; University of Alberta, 2016). This project aims to study the effects of different nutrient ratios of phosphorus and nitrogen on a species of marine dinoflagellates, a common type of algae involved in algal blooms. Growth will be measured using a Sedgewick S52 Rafter Counting Chamber, which holds exactly 1 mL fluid in order to count the number of dinoflagellates per mL in each sample and watch growth over time. The purpose of this study relates to the increase in bloom events as a result of humans releasing excess nutrients into waterways and oceans from agricultural, industrial, and urban runoff, as well as to analyze whether phosphorus, nitrogen, or phosphorus and nitrogen limitation would be most effective in cutting down bloom frequency and intensity. In analysis, connections to targeted nutrient filtration, human and ecological health, and economic impacts will be considered.</p>

Earth and Environmental Sciences (EAEV)	2084	Jack Gootzeit	Environmentally Friendly Alternatives to Standard Road Salts	Common chloride-based road salts pollute the environment, including vegetation and infrastructure; an eco-friendly compound able to melt ice is critical. I tested thirteen different substances on 100mL of ice and measured the amount of water melted. The compounds NaCl, CaCl ₂ , MgCl ₂ , and C ₂ H ₃ NaO ₂ were most effective, although five of the other compounds (C ₄ H ₆ O ₅ , C ₄ H ₆ O ₆ , C ₆ H ₈ O ₇ , CH ₄ N ₂ O, C ₃ H ₈ O) also melted the ice adequately. To test corrosiveness, I used four common metals in infrastructure (steel, copper, aluminum, and stainless steel). I submerged the metals in 10% solutions of the compounds tested and assessed both the speed and extent of corrosion of the metals over fourteen days. The standard chloride-based salts all started oxidizing steel and copper immediately and extensively, while the three organic acids had significantly less visible effects. Next, I exposed plants to increasing strengths of the studied solutions over three weeks. The plants watered with solutions of Calcium chloride, Sodium chloride, Urea, and Sodium acetate deteriorated the most, while the plants exposed to the organic acids showed minimal adverse effects. Finally, I repeated my initial experiment to melt ice, this time by using 1:1 mixtures of the organic acids with standard road salts (NaCl, CaCl ₂ , MgCl ₂ , and C ₂ H ₃ NaO ₂), I determined that we can decrease environmental exposure to chloride-based road salts by 50% without any statistical difference in the amount of ice melted. In conclusion, combining organic acids such as Malic, Tartaric, or Citric acid with standard chloride-based road salts will dramatically reduce environmental toxicity caused by current deicing practices.
Earth and Environmental Sciences (EAEV)	2085	Macie Anundson	Examination of wintering milfoil weevils (<i>Euhrychiopsis lecontei</i>) and differences in Eurasian watermilfoil (<i>Myriophyllum spicatum</i>) fragment and root growth	Eurasian watermilfoil (<i>Myriophyllum spicatum</i> , here on out EWM) is an invasive aquatic plant species that has been spreading around Minnesota lakes since the 1940s (Frew 2016) and reproducing with Northern watermilfoil to create a Hybrid watermilfoil. Previously, many chemical and mechanical efforts have taken place to attempt to control growth and development of Eurasian Watermilfoil. Contact herbicide treatment has proven effective short-term, but unfortunately leaves EWM roots viable for future growth and spread (Marko and White 2018). Human divers have also been used to harvest EWM, but this is very costly and fails to create a lasting impact (Frew 2016). This research will aim to expedite attempts of using weevils as biological control for the invasive Eurasian Watermilfoil in Minnesota lakes. It will use chilling methods in an attempt to keep the weevils alive in a dormant state in a laboratory over the winter. If this works, weevils taken from a lake in the summer can be kept alive through the winter, bred in the spring, and consequently a larger population of weevils can be re-introduced to the lake in the spring. More weevils leads to less EWM. This research will also test the growth difference between Eurasian watermilfoil plant fragments and their roots. This knowledge will determine how dangerous it is for loose fragments to be floating around in the lakes and if they can become new, healthy plants growing on the lake bottom. This would continue the harsh cycle of excessive EWM growth and population in lakes.
Earth and Environmental Sciences (EAEV)	2086	Emma Gross & Trisha Trinh	Observing the Effects of Biochar on Radishes and Lettuce Under Reduced Irrigation	As the concern for more sustainable agricultural practices increases because of climate change, new technologies, such as biochar, are being studied to offer a supplement in addition to current irrigation practices. The objective of this study is to determine biochar's ability to retain moisture by observing the effectiveness of biochar on the growth development in lettuce and radishes under reduced irrigation. The hypothesis of this study is that lettuce and radishes grown in biochar and reduced irrigation will produce an equal or greater sized yield compared to lettuce and radishes grown in normal irrigation and soil without biochar. This study will consist of six treatments: normal irrigation without biochar, normal irrigation with 2% biochar, normal irrigation with 4% biochar, reduced irrigation without biochar, reduced irrigation with 2% biochar, and reduced irrigation with 4% biochar. The lettuce and radishes will be grown in a growing tent under a 14 hour and 7 hour light cycle, respectively. The height of the plants will be measured throughout the growing period, while the fresh and dry weights of the plants will be measured at the end of their respective growing periods. The data collected from these measurements will be organized into tables that will assist in the analysis of biochar's effectiveness with retaining soil moisture.

Earth and Environmental Sciences (EAEV)	2087	Ari Williams	Organic vs Synthetic Fertilizer	<p>The problem of the experiment was do plants grow faster with synthetic fertilizer or organic fertilizer. My hypothesis is that if I feed a plant synthetic and organic fertilizer then the plant with organic fertilizer will grow quicker. The hypothesis stated was unsupported by my results.</p> <p>The methods of my experiment include gathering your materials. Next, is assuring your plants are planted where you have sufficient sunlight. Then, give an equal amount of the llama and cow manure on two of the four plants. Next, give the recommended amounts of Osmocote and Miracle-Gro on the other two plants. Once you do that you record the height of the plants. You continue to record the data and take pictures every other week until you have the required data.</p> <p>The results of the multiple trials varied including the plants with synthetic fertilizer showing more growth than the plants with organic fertilizer. For example the end height of all the planets in order was cow manure: 43", llama manure: 34", Osmocote 43" and Miracle-Gro 42".</p> <p>These results happened because most of the time organic fertilizer is slow release and makes plants more often than not grow slower than faster. Synthetic fertilizer goes instantly into the plants roots and benefits them right away. A few experimental errors that happened was animals eating leaves, heavy rains, and inconsistent sunlight. Further research that could be done is adding different fertilizers and fertilizing them more overall. These two things would change data and perhaps give better results.</p>
Earth and Environmental Sciences (EAEV)	2088	Tanmay Iyer	Prediction Modeling and Longitudinal Trends to Assess for Residential Radon Exposure in Olmsted County	<p>Background: Olmsted County is on a Karst Landscape and has historically being associated with higher radon exposure. Radon is a colorless, odorless radioactive gas that seeps from the earth and can cause lung damage and cancer when inhaled. The World Health Organization (WHO) and Environmental Protection Agency (EPA) have recommended thresholds for intervention to decrease radon exposure to prevent the risk of long term lung cancer.</p> <p>Methods: We conducted a cross sectional study to assess for radon exposure in residential homes at different altitudes, urban Vs rural, different home construction types, basement type and year of construction to create a prediction model for radon exposure. We also retrospectively analyzed the Olmsted county radon data from 1990-2018 from Minnesota Department of Health (MDH) to evaluate for longitudinal and seasonal trends in radon exposure.</p> <p>Results: We surveyed 10 homes for residential radon exposure. We found a significant association between the age of the home and likely risk of radon exposure ($P < 0.001$). 30% of the homes had radon mitigation system in place, yet 33% of them still had dangerous levels of radon in their homes. Our prediction model showed a significant association with the presence of non-walkout basement, altitude and age of the home with higher radon exposure. Using the MDH dataset, we found that there was a significant urban Vs rural disparity in radon exposure as well as mitigation efforts varied by the overall socio-economic index of the residential zip codes.</p> <p>Conclusion: Most homes in Olmsted County continue to be at risk of higher than recommended levels of radon and hence regular screening would help identify this exposure. Mitigation efforts are, at times, only partially successful and should be periodically reassessed for continued threat of high radon exposure.</p>

Earth and Environmental Sciences (EAEV)	2089	Abigail Roh & Samantha Deter	Searching the Shadows: Using shadows in aerial imagery to classify trees by genus for urban tree management, Year II	<p>A thriving tree canopy is an essential aspect of a healthy and sustainable city. However, to best manage urban trees, city planners must have access to crucial information about the location of individual tree types. This can allow them to make informed decisions to protect trees from genus-related diseases (e.g., emerald ash borer). Current manual tree type identification methods are time-consuming and labor-intensive. We worked to identify tree type (genus) from shadows in aerial imagery so trees can be identified more efficiently.</p> <p>Our three goals were to expand a tree shadow dataset created in our previous work, identify and validate characteristics that can be used to determine tree type, and quantify these characteristics. We identified 35 distinct tree characteristics, including branch structure, fine branch distribution, and canopy shape, to determine tree type. Characteristics were validated through repeated tests and could be used to distinguish ten tree types with an average accuracy between raters of 62.5% in a single identification (Random guess: 10%) and 80% in two identifications (Random guess: 20%). Python was then used to quantify characteristics like branch density, canopy texture, color distribution, and canopy shape. Results were analyzed for ability to distinguish among tree types.</p> <p>Our method was five times faster at identifying tree types than traditional manual field surveys. The quantified characteristics also lay foundation for the development of accurate machine learning methods to further improve tree identification efficiency. Ultimately, our work could provide a cost-effective and efficient alternative to traditional manual field surveys.</p>
Earth and Environmental Sciences (EAEV)	2090	Dawan Davis	The Affect Water Intake has on Plant Height	<p>In this project we created a self-sustaining ecosystem to support a fish and a plant. Aquaponics in this system, is a system in which waste produced by fish supplies nutrients for plants to be grown hydroponically, which in turn purfies the water. A method that was used in this system for a growing fish(Aquaculture) and a growing plant was: feed the fish regular fish food, then fish waste would break down by beneficial bacteria, plants would constantly fed & irrigated by recirculating the fish water, lastly plants help filter and aerate the water before it returns to the fish. In my system there was a study of flow rate, and water intake in the growth bed to see if there would be any deficiencies in plant growth. It was found that the lower the flower rate the higher the plant would grow and the higher the flow rate the shorter the plant would grow. Also found when dealing with controls were the nitrate levels differed in both ecosystems, for instance in the ecosystem the nitrate levels were pretty low but in the controlled experiment nitrate levels were found to be pretty high. That gave another reason to believe why there may have been a deficiency in the uncontrolled ecosystem with plant growth.</p>
Earth and Environmental Sciences (EAEV)	2091	Paige Indritz	The Effect of pH on Bioremediation of Acid Mine Drainage	<p>The purpose of this project was to determine the impact of pH on the absorption of acid mine drainage (AMD). AMD is prevalent in Northern Minnesota due to copper-nickel mining which can have adverse impacts on the environment. We hypothesized that at a lower pH, more metals would be absorbed out of the water through plants due to the high level of dissolved metal in the water. To conduct this experiment AMD conditions were mimicked by filling tanks with water, hydrochloric acid (HCl), and iron (II) sulfate (FeSO₄•7H₂O) and manipulating their pH levels. Duckweed, a native plant to Minnesota, was used in this experiment. In successful trials, results indicated that lower pH does not necessarily lead to lower amounts of adsorbed metals. The implications of this experiment can help inform further environmental impact tests that will maintain our ecosystems and ensure faster remediation of AMD.</p> <p>Keywords: Acid mine drainage, iron (II) sulfate, bioremediation, duckweed, hydrochloric acid, Northern Minnesota</p>

Earth and Environmental Sciences (EAEV)	2092	Gabrielle Tan	The Effects of Common Air Pollutants on Soil	Air pollution is one of the most prevalent issues of the twenty first century. Gaseous pollutants from overall modern industry are constantly toxifying the air, contributing to global warming and imparting negative impacts all over the Earth. Soil is a known major sink for these gases, yet the effects that pollutants have on soil's chemical and biological composition is still an up and coming field. Therefore, this research revolves around experimenting with varying concentrations of common pollutants such as carbon dioxide, nitrogen dioxide, and sulfur dioxide in order to observe the effects these gases have on real-world soil sample's pH levels and microbial populations. Separate soil samples are to be exposed to carbon dioxide, nitrogen dioxide, sulfur dioxide at controlled levels through consistent monitoring and adjusting. Examinations for changes in pH over time as well as changes in microbial colony counts will be carried out over the course of a month to test longevity. These processes will uncover the relationship between climate change, air pollutants, soil health and soil fertility, along with a deeper understanding of how soil can play an essential part in the fight against global warming.
Earth and Environmental Sciences (EAEV)	2095	Annika Nosbush & Lizzie Schwint	The Effects of Tillage Depth on the Transmission of Nitrates Through Soil Macropores	The Effects of Tillage Depth on the Transmission of Nitrates Through Soil Macropores Different depths of tillage were compared to determine the effect on the transmission of nitrates through macropores. The purpose was to help farmers determine the depth of tillage that best reduced nitrate migration through soil macropores. Macropores in the soil were simulated by using a tub with small tubes. Rainfall was then simulated using a rainfall simulator and as the rain flowed the rate was measured. Water was collected from the macropores and tested for nitrate level. Three different depths were compared with a control of no tillage. The control had the highest average nitrate concentration in the seepage with 17.75 mg/L and the quickest rate of water migration through the soil profile which was 30 seconds after the start of rainfall. When the fertilizer was tilled at a depth of 10.16 cm (light) the average nitrate concentration was the lowest at 14.07 mg/L and seepage was first observed 2 minutes and 30 seconds from the start of rainfall. The average nitrate concentration of the seepage was 16.42 mg/L when the tillage depth was increased to 20.32 cm (moderate) and the first flow from the macropores was observed 5 minutes and 19 seconds from the start of rainfall. Finally, when the depth of tillage was increased to 30.48 cm (deep) the average nitrate concentration was 15.96 mg/L with the longest time from rainfall to observed flow at 6 minutes and 20 seconds and ended up being the most effective.
Earth and Environmental Sciences (EAEV)	2096	Rowan Rock	The use of mealworm guts (<i>Tenebrio molitor</i>) to biodegrade polystyrene	This study was done to evaluate mealworms' ability to biodegrade polystyrene. Q1: What effect does food source (oatmeal vs polystyrene vs oatmeal and polystyrene) have on worm mass and food lost? H1: Mealworms exposed to polystyrene (PS) will have a lower percent change in mass than worms exposed to oatmeal. Q2: What effect does pre-exposure have on mealworm gut bacteria's ability to biodegrade polystyrene? H2: If mealworm gut bacteria are pre-exposed to PS, then it will be more effective at biodegrading polystyrene. Mealworms were fed either Styrofoam, oatmeal, Styrofoam and oatmeal, or no food in groups of 5 worms. After twenty-one days, the worms were re-massed and the percent change was recorded. The gut bacteria was extracted, liquidized, and suspended in a basal media. Polystyrene was exposed to the gut bacteria of mealworms fed either PS, oatmeal, mixture, or no food. The mass of the polystyrene was recorded before and after exposure to bacteria, and statistical analysis was used to determine any significant mass loss and any significant difference between the mass losses of the prior food sources. Both hypotheses were supported. Mealworms fed oatmeal showed a greater increase in mass ($p < 0.08$), however, all worms given food had a greater mass than ones given no food; therefore the worms must have been metabolizing the plastic for energy. The optical density was significantly higher in the bacteria from mealworms fed oatmeal and polystyrene when compared to oatmeal fed worms ($p < 0.038$).
Embedded System (EBED)	2097	James Clinton & Nathan Rockafellow	Spudfinder 6500: Creating a radar-based system for pre-harvest potato yield mapping, year two	Potatoes require heavy watering and intensive fertilization, which negatively impacts the environment. A system designed to mitigate these environmental impacts and improve farming efficiency would be beneficial for farmers. Precision agriculture techniques accomplish this by documenting spatial variability across and within fields. One key precision agriculture technique is yield mapping. Mapping yields throughout a field allows farmers to determine how various factors

				<p>like water and fertilizer usage influence farming efficiency, leading to informed decisions about how much water and fertilizer are necessary to apply to the field.</p> <p>Current potato yield mapping methods occur during harvest. This means that farmers can't use their data during the growing season, instead having to wait until future years to benefit. To mitigate current yield mapping problems, last year we built a robot that detects individual underground potatoes, known as a phenocart. This phenocart uses ground-penetrating radar and machine learning for data collection and processing, allowing for non-invasive, pre-harvest detection of underground potatoes.</p> <p>This year, we improved our cart's drive system by designing a chain drive using a self-designed sprocket, improved our radar's casing by mitigating interference, tested our radar system with clusters of potatoes rather than single potatoes, and used new machine learning models to analyze the radar data and estimate the mass of buried potatoes.</p> <p>This work suggests methods for using radar and machine learning to estimate the mass of underground potatoes and has the potential to help farmers save money and reduce the environmental impacts of potato farming.</p>
Energy: Chemical (EGCH)	2099	Richard Xiong	Economical and renewable bioethanol production from waste banana peels	<p>As the population of the world increases, the energy demand needed to satisfy the expanding global population becomes more pressing. Biofuels represent potential alternatives to traditional fuel options, and one especially promising source of biofuels is banana peels. Bananas are the fourth most popular agricultural product worldwide and are an untapped energy source via their peels, which are commonly discarded as waste. This project sought to elucidate how bioethanol can be produced from banana peels and characterize some of the parameters involved in its production. The general framework for bioethanol production involved first hydrolyzing the abundant starch in banana peels to yield sugars and then converting the sugars via fermentation by yeast to ethanol. For the hydrolysis step, optimal conditions were at 65°C for 4 hours. For the fermentation step, the best conditions involved 1.0% yeast at 30°C for 4 hours. There were no differences between dry peels versus fresh, wet peels in sugar content and bioethanol concentration, meaning peels do not need to undergo a costly drying process for bioethanol production. Although the acidic and alkaline pretreatments had greater bioethanol yield than the water-only condition, these pretreatments required more resources to implement, and bioethanol was already achieved via the water-only condition. Overall, this project characterized the most time and cost-efficient production parameters in making bioethanol from banana peels and illustrated the potential of using a waste product to generate energy.</p>
Energy: Chemical (EGCH)	2100	Nathaniel Dietz	Transformation of household and agricultural waste into stable and energy dense biomass briquettes	<p>A big problem is climate change. The U.S. uses more than 187.8 trillion pounds of non-renewable natural gas. The U.S. discards renewable products every year including 222.5 billion pounds of paper, 8.39 billion pounds of orange peels, and 35 billion pounds of coffee grounds. Unfortunately, these resources are hard to collect, transport, and store. Through shredding, soaking, and pressure, some resources can be transformed to biomass briquettes. Knowing this, I collected seven renewable resources from household waste and agricultural byproducts. After collection, the materials were shredded and dried. In some cases, briquettes were made from 100% of a material but every material was also combined with soaked paper and compressed in a homemade briquette press. The briquettes were removed from the press and dried. Densities of the starting material were calculated as well as the densities after briquette formation. Pure resource briquettes rarely worked, but combination of any resource with paper produced a useful briquette. The densities of the dry resources ranged from 0.04 g/cm³ (leaf litter; n=3) to 0.53 g/cm³ (coffee grounds; n=3). After formation of briquettes, the least dense resources gained in density by eight times and the density ranged from 0.32 (soybean fodder; n=11) to 0.55 (orange peel waste; n=12). Calories were determined using a calorimeter. The briquettes energy output ranged from 2505</p>

				calories/g (saw dust; n=3) to 2914 calories/g (paper; n=3). In conclusion, using simple household resources and equipment I created an energy dense, reusable, green and stable heat source.
Energy: Physical (EGPH)	2101	Jacob Westerlund	Effect of Blade Angle on Wind Turbine Efficiency	The purpose of this experiment was to determine which blade angle (0°, 5°, 10°, 15°, 20°, 25°, 30°, 35°, 40°, 45°, 50°, 55°, 60°, 65°, 70°, 75°, 80°, 85°) of a wind turbine blade is optimal. This is important because wind turbines capture a large amount of energy used and it is therefore desirable to maximize their efficiency. The hypothesis was that the turbine will produce the most energy at 10° based on background knowledge that for most turbines lift is maximized at an angle between 10-15 degrees. The experiment was designed to recreate a wind turbine used to provide electricity to people around the world. A model wind turbine was created so the blades could be set to certain angles and placed in front of a fan used to represent the wind. The fan was set to high and the energy produced increased as the angle decreased until the angle reached zero. Once the experiment was completed, the hypothesis was refuted. The wind turbine blades set at 5 degrees produced the most energy and the t-test data table shows that the difference is significant. According to the study the angle that generated the most energy was 5 degrees, although the background research indicates that the most effective angle would actually be around 10-15 degrees. This would be an area to do further investigation during a future experiment.
Energy: Physical (EGPH)	2102	Isaac Laddusaw	The Effect of Building Design on Revolutions of a Vertical Axis Turbine	An experiment was conducted to test the effect of different models of buildings on the potential power output. A wind tunnel was constructed to create a consistent environment to conduct the experiment. It was designed to create laminar flow and isolate the wind variable. Five different models of buildings were made with holes in the top for a generator to fit into. The models were then put into the wind tunnel on high power in identical positions and were run for ten seconds. Revolutions of the turbines were recorded during these trials and then were converted to revolutions. Models two and three yielded the greatest results. The data shows a trend of higher amounts of rotations with sloped tops of buildings.
Engineering: Mechanics (ENMC)	2103	Richard Chang	Calibration of Magnetometers	Society is becoming increasingly dependent on Global Position System (GPS) software. Given this dependence, a sudden outage of GPS could lead to a disruption of societal functions as there are no backup systems in place. Therefore, it is paramount to find a reliable backup system to GPS. Magnetometers have been used as inexpensive heading sensors in vehicle navigation, but their accuracy is compromised by external magnetic fields coming from current-carrying wires. For this study, the impact of the external magnetic field was analyzed on a YAS539 Magnetometer that came inside a Samsung Orbit J3. The study was set up so a power supply would generate a current in an electromagnet, inducing an external magnetic field which would in turn affect the reading on the magnetometer. The heading error from the magnetometer were determined under different true headings and different currents. It is found that magnetometer orientation could have a significant impact on heading error. Effort is also made to calculate the external magnetic field theoretically. The study emphasizes that more research needs to be done to analyze the effects of different parameters on the heading error in order to get a more comprehensive idea on how to correct the heading errors. Keywords: Magnetometer, heading, magnetic field
Engineering: Mechanics (ENMC)	2104	Kyle Ledermann	Custom Power Solutions: Exploring the efficiencies of a stackable 3-phase brushless motor design	The purpose of this experiment was to find if a power solution could be created that would allow for the adding of power by simply adding motors. The hypothesis states, "If I test a stack of 3 modular motors for peak efficiency by measuring the difference between input and output power, then the peak efficiency will be greater than or equal to 70%." Custom mounting enclosures were designed that fit around the motors to allow them to be connected while keeping the position of the output shafts aligned to the rotor of the motor. By doing this, it was possible to connect the motor phases in parallel and increase output. The motors were tested by attaching them to a wooden board, then fixing a one-foot aluminum bar between the output shaft and a load cell. When the motor tries to turn, it enacts a force on the load cell that can be charted. The input power was measured by a VESC (Vedder Electronic Speed Controller). All data was then entered into a spreadsheet and graphed. The peak efficiency of a stack of 3 motors was 76%, so the hypothesis was supported. The larger commercial motor that was tested against had a slowly rising efficiency graph while the

				smaller stackable motors reached peak efficiency at just 8 amperes. Plans for further study include designing a motor dynamometer that would allow testing of the motors while spinning.
Engineering: Mechanics (ENMC)	2105	Enzo La Hoz Calassara	How Does the Skirt Pattern Affect the Weight-Bearing Capabilities of a Hovercraft	Hoverboards are fascinating, and I wanted to see for myself what would go into making one for myself. In the experiment, I built a small hovercraft, and tested different skirt patterns on it, to test how the size and placement of vents affected the weight-bearing capability, and therefore efficiency, of the hoverboard. I did this by placing weights (25 and 40lb salt bags, as well as my own body weight) on the hovercraft, and noting whether or not the vehicle was in contact with the ground. I observed that the comparison didn't reveal 'the best' skirt. Instead, it demonstrated that it is about balancing the airflow. More lift requires more downward pressure to sustain the air cushion. My results showed that the difference between the skirts' load-bearing capabilities was statistically significant. I rejected my null hypothesis. I concluded that changing the skirt pattern does change the amount of weight the craft can support.
Engineering: Mechanics (ENMC)	2106	Austin Currie, Caleb Boll, & Ethan Ingram	Non-Combustion Engine	There has always been a demand for clean and renewable energy that's easy to obtain. With the industrialization of third world countries, we often see forms of energy that are outdated and create lots of pollution. During our research for this science fair, we stumbled upon an ancient solution to this modern problem. It's called the aeolipile or it's more common name the "hero's engine". This ancient device was the first steam engine to have ever been created. It uses expanding gas funneled through nozzles to cause the engine to rotate around an axis. Converting expanding gas to kinetic energy. If we use Liquid nitrogen that is an expanding gas but does not give off any harmful by-products. Then find a way to harness this rotational energy to generate electricity this could solve many problems.
Engineering: Mechanics (ENMC)	2107	Julia Guptail	Wearable Device for Drowning Prevention	Drowning prevention devices currently on the market only use signal strength and time algorithms to determine if the wearer is in danger of drowning. The purpose of this project will be to develop a wearable personal aquatic safety device that can detect if the wearer is in danger of drowning and alert others. The device will consist of a microcontroller, a variety of sensors, and an application that uses personalized settings to increase accuracy in readings and decrease the number of false alarms. Stage 1 of the project is designing the first prototype of the drowning detection device and then testing each component separately. After components are tested separately they will be reprogrammed then tested in conjunction with each other. During Stage 2, a more complex device will be designed and assembled. Each of the additional sensor components will be tested separately. The data received from these tests as well as user input statistics will be developed into the final algorithm to detect drowning. The focus of Stage 3 is designing and assembling a waterproof case for the device to ensure the sensors will not be exposed to liquid. All mobile application programming and testing will occur in Stage 4. Lastly, Stage 5 consists of creating a custom microcontroller specifically for the device. This new microcontroller would have the same components of the previous device and use the same drowning detection algorithm.
Environmental Engineering (ENEV)	2108	Abdullah Saidi, Mohammed Omer, & Eyad Wazwaz	Designing a Remote Controlled Boat That Naturalizes the Process of Eutrophication by Filtering Excess Phosphorus and Nitrogen	Our topic was to design a method to filter out excess phosphorus and nitrogen. The purpose was to naturalize the process of eutrophication. 65% of coastal waters in the United States alone are affected by eutrophication. Sometimes a dead zone occurs when there is severe eutrophication not allowing any organisms to live there. The cause for this is algal blooms sped up by current farming practices involving the use of fertilizers. To do this, we first make out the boat. The boat is made of plywood and coated with polyurethane paint on the outside. For the wiring, we used a receiver, 2s lipo battery, Esc servo, and brushless motor. We tested the device and concluded that it met our specifications. We plan on expanding this project by making it solar powered and autonomous.

Environmental Engineering (ENEV)	2109	Benjamin Rex & Emre Adabag	Clearing the Air: Assessing the Practicality of a Liquid Piston for Carbon Capture and Storage	<p>Climate change is currently a pressing global issue, causing rapid temperature variations resulting in changes to natural weather patterns. The emission of carbon dioxide from power generation is the primary contributor of greenhouse gases into the atmosphere. With substantial global reliance on carbon emitters, some form of carbon capture and storage is imperative to quell the effects of climate change. Carbon capture and storage systems are mainly used by power plants to take carbon dioxide out of the air, compress it, and dispose of it. Current carbon capture systems consume large amounts of power, mainly because of inefficiencies in compressing the carbon dioxide.</p> <p>Therefore, the purpose of this research was to model a compression cycle for an efficient carbon dioxide compressor used on a carbon capture and storage system. Using the Open-Accumulator Isothermal Compressed Air Energy Storage (OA-ICAES) liquid piston air compressor as the basis for our design, we produced a 3D model and simulated our carbon compressor by calculating the properties of the system 1200 times throughout one compression cycle. Additionally, heat sink inserts inside of the compressor are present to cool the gas, boosting the compressor efficiency. Water holdup in the heat sink inserts prevent carbon dioxide from flowing through them, so the amount of water trapped in different types of heat sink inserts was tested. It was concluded that liquid pistons in this configuration are not viable alternatives to current CCS compressors.</p>
Environmental Engineering (ENEV)	2110	Fatimo Mursal	The Effect of Electricity on Plant Growth	<p>An experiment was conducted to determine how electricity affects the growth of plants. Radish seeds were planted in three different pots and pole bean seeds were planted in three different pots. Two radish pots and two bean pots were used as the control group. One radish pot and one bean pot were treated with an electric current. The radish pot and the bean pot were treated with electric current by placing a conductive copper rod into the soil and connected to a DC 9V battery. The rate of plant growth was observed for both the control and experimental group. The plant growth rate for the control and experimental group was compared. The hypothesis was that the experimental group treated with the electric current would grow at a faster rate than the control group.</p>
Environmental Engineering (ENEV)	2112	Laura Johnson	Maglev Trains! Efficient or Not?	<p>In this project "Maglev Trains! Effective or Not?", time is tested based on the angle of a magnet on a train that rests on nothing but the space in between two repelling magnets. This is tested because natural fuel resources used for transportation are slowly disappearing and a solution is needed for this problem. Maglev trains are a possible solution. A hypothesis for this is, if I tilt the magnet attached to the tin to a steep and positive angle, then the train will move faster because there is more magnetic propulsion.</p> <p>To conduct this experiment, a track with evenly spaced magnets with the same polarity facing up was tilted 57.15 cm above the ground. The effect of gravity helped propel the train while a magnet on the train determined how long it would take to reach the bottom of the track. 0 degrees was the constant, while the other angles determined the dependent variable. The most difficult angle to test was -20 degrees because the magnet on the train would start to pull towards the magnets on the track.</p> <p>At the end of testing the 4 magnet angles, 40 degrees produced the best results. Though 0 degrees was the constant, it proved to have little effect on the time it produced. -20 degrees showed that with that magnet angle, travelling would be very time consuming and very inefficient. In conclusion, based on the results found, a maglev train with a magnet tilted at an angle of positive 40 degrees will help people travel faster more efficiently. Though time was only measured by seconds, the differences between magnet angles can affect hours of travel time. A further experiment that could be done is to use magnetic strips instead of individual magnets and to test magnetic propulsion on a horizontal track.</p>

Environmental Engineering (ENEV)	2113	Mina Adabag & Sarah Peterson	Plants to the Rescue: Removal of Lead Through Phytoremediation	Lead contamination in water is an urgent public health crisis which has affected many U.S. communities. Lead exposure causes a variety of adverse health effects including anemia, memory impairment, kidney failure, and death. The Minnesota Department of Health predicts that removing all lead from drinking water in Minnesota alone will cost more than four billion dollars. Previous studies have shown that, through a process called phytoremediation, plants can remove lead from contaminated water and soil. The aim of this project is to assess the efficacy of lead removal by three different aquatic plants: duckweed (<i>Lemna</i>), fanwort (<i>Cabomba</i>), and anacharis (<i>Elodea</i>). It is hypothesized that duckweed will remove the most lead from the contaminated water compared to the other two aquatic plants. Twenty cups of a 0.0015 molar lead nitrate solution will be prepared. There will be five of each species, each in its own container. Five containers without a plant will serve as the controls. The concentration of lead in each container will be measured over two weeks using a spectrophotometer. The average lead concentration in 5 containers of each plant species will be calculated and graphs of the concentrations after the trial period will be made. Statistical methods will be used to determine if the hypothesis is refuted or affirmed. Phytoremediation offers a promising, natural, and affordable method of lead remediation. Future studies could involve further identification of the characteristics that contribute to effective removal of contaminants as well as researching logistics of real world implementation of this method.
Environmental Engineering (ENEV)	2114	Constance Azonwu & Natali Joachin	Pulp it Up! Buckthorn Paper	This experiment was conducted to test the effectiveness of using the invasive species <i>Rhamnus Cathartica</i> , commonly known as buckthorn, as a resource. Buckthorn is an invasive species commonly found in Minnesota and is a restricted noxious weed causing environmental problems. In order to redirect the harmful effect that buckthorn produces, paper from buckthorn was invented through the Kraft pulping process. Testing showed that while buckthorn can make adequate paper, its fibers are short compared to papers made from softwood trees. Short fibers are not as strong and durable as regular paper. It was found that buckthorn can make a positive additive with printing paper because small fibers result in smoother paper. Overall the results had a small yield due to the buckthorn being in small quantities of branches. It was concluded that buckthorn as a source of paper is better off being added with more material, whether that's more invasive species of trees, common wood used today, or recycled material, than as a paper source on its own.
Environmental Engineering (ENEV)	2115	Sydney Therien	Testing <i>Bacillus subtilis</i> for estrogen degrading ability using zebrafish as a model organism	Estrogenic endocrine disruption, if severe enough, can cause irreparable damage to freshwater ecosystems. The previously untested synthetic estrogen degrading bacteria with high potential <i>Bacillus subtilis</i> was investigated for its synthetic estrogen degrading abilities in hopes that it could be added to the wastewater bioremediation process. Zebrafish embryos were exposed to EE2 water and EE2 water remediated with <i>B. subtilis</i> . On average, the <i>B. subtilis</i> embryos lived for two days longer than EE2 embryos, however, due to lack of statistical significance and proper control groups, <i>B. subtilis</i> cannot yet be guaranteed as a safe and productive addition to the wastewater bioremediation process. A trend exists between estrogenic endocrine disruption mitigated and <i>B. subtilis</i> presence that is worth investigating further.
Environmental Engineering (ENEV)	2116	John Cardwell & Byron Jia	Testing the Waters: Engineering an Innovative Method of Water Health Analysis	Although water seems endlessly available, only 2.5% of the Earth's water is fresh, with just 0.26% of that residing on the surface. This water supply is where much of humanity's drinking water comes from. Therefore, clean surface water is essential to the health of humanity and millions of other organisms. As a result of continued human mismanagement of resources, waste, and pollution, one of the most valuable resources on earth is in more danger than ever. It is essential to monitor the health of bodies of water around the globe. However, current methods of water health analysis fall short of being effective due to their cost, comprehensiveness, and consistency. This research addressed these problems by designing a new method of sampling water comprised of two parts: the use of a drone to collect aerial imagery and the use of a remotely operated watercraft to collect physical samples and electronic data. The researchers successfully completed part 1 by creating 3D renders of aerial imagery and overlaying them onto real-time maps to provide new insights on a body of water. Part 2, which will allow the gathering of bathymetric information, temperature data, and water samples, is currently in progress. Combining information from both

				parts, this project will result in a more efficient method of creating a comprehensive set of information on a body of water. More effective and economical water health analysis will allow for better management of the limited freshwater supply, making both the water and surrounding environment healthier.
Environmental Engineering (ENEV)	2117	Jennifer Oettinger	The Last Straw: The Development of an Innovative, Portable, and Reusable Device for Filtering Microplastics in Drinking Water	The purpose of this project was to develop and test a portable and reusable device to filter microplastics (plastics under 5mm in size) from bottled drinking water. This research is important as The World Health Organization estimates that there are microplastics prevalent in 93% of bottled water. Due to the lack of research, firm conclusions cannot be drawn on the toxicity of microplastics in drinking water to humans. This project modified an electrostatic smoke precipitator design to create a straw-like filtration device. A series of 9-volt batteries were used as the power supply for this filter. For this experiment 500 mL of bottled water was poured through the straw while the filter was connected to four different voltages (0V, 9V, 18V, 27V), afterwards microplastic particles were counted. The results showed that the average number of plastic particles was reduced from 61 to 26 when the water was not filtered versus when the 27V filter was used. This 58% reduction was the greatest of any voltage tested, with the 0V filter having a 4% reduction, the 9V filter having a 35% reduction, and the 18V filter having a 44% reduction, in comparison to the non-filtered water. Based on the results, it can be concluded that an electrostatic powered straw is an effective way to filter microplastics from drinking water. Although this research was intended to be used for drinking water, the technology could be easily adapted for both commercial and industrial uses.
Environmental Engineering (ENEV)	2118	Nancy Wang & Justin Draheim	The Wolf Can't Blow This House Down	The goal of this project is to build a safer house with integrated robotics and programable features that would provide residents a disaster-proof home during natural disasters. In addition, this design includes leisure structures found in most traditional homes. This year's project is a continuation of my previous projects in 2017 through 2019. Originally, I focused on the overall round shape with emphasis on tall pillars that lift the base of the house and a cone shaped roof. In 2018-2019, I added a water filtration mechanism that would recycle rain and flood water flowing throughout the unique structural parts of the house. The primary focus of this year's project is to make this house a "smart" house. Smart functions are designed to better assist with the water filtration process by controlling the amount of filtered water and automated safety mechanisms that would disable the leisure parts, such as patios and window glass protectors, during natural disasters. A prototype is built by 3D printing and includes robotics components such as servos, motors, sensors, and a hub. This model is expected to roll the patio under the base of the house and the window glass shield folds up to ensure a smooth surface when the household receives a disaster alert on the phone. The structure will remain in the "Disaster Mode" until the alert has cleared. This design could potentially benefit the reconstruction process, protect the environment using sustainable materials, and provide a safer residence in areas vulnerable to extreme weather hazards.
Environmental Engineering (ENEV)	2119	Minhnhat Le	What water filtration system does Mother Nature love?	Is there a way to filter water cheaper, powerless, be a little greener and can get the use of clay? This project came to life because this project is trying to prove that there can be a natural way to filter water out without machinery. If the filter A(20 grams of sawdust) filters out groundwater, it would be slow but effective. Filter A will filter out most of the iron, hardness, and also acidic pH levels. Not looking for the time waste but looking for the efficiency of the filter. The worst would be C(100 grams of sawdust) because the water is going to go through the filter too fast thus not collecting that much amount of iron, hardness, and acid pH level. The filters were made of clay and mixed with sawdust. During the firing process, the sawdust just burns off creating holes that make the water go through and get iron, hardness, and acid pH level collected in pinholes. All of this concludes that filter A's(20grams of sawdust) power on filtering is pH level and one of the best results. Filter B(50grams of sawdust) is just constant but still does the job. Filter C's(100grams of sawdust) power is on the iron side and one of the best filters as well.

Materials Science (MATS)	2120	Abigail Smith	Analyzing the effect of micro-perforated acoustical tape vs. acoustical tiles on the sound intensity in an art room, using spectral analysis, and three dimensional acoustical modeling software	This study used 3D modeling and spectral analysis to understand the effects of different sound dampening materials/devices (acoustical tape and tiles) in an acoustically challenged middle school art room and to document, study, and reduce the effects of white noise produced by the room's HVAC system. In the art room, sound intensity was measured when different sound dampening methods were in place: dampening tiles, tape, and both installed. The 3D model was found to be capable of modelling the room accurately; However, at the higher frequencies, the tile was less effective at reducing the decibel levels in the art room. Overall, it was determined the tape reduced the sound intensity more than the tiles. But the tape and tile installed at the same time, reduced the decibels more than either dampening treatment. In order to see the causes of white noise, a spectral analysis was performed in MATLAB. Initially, resonance occurred at lower frequencies (65, 125, and 250Hz). However, after researching the specifications of the speaker used, it was determined a higher quality speaker was needed. When the spectral analysis was redone with a higher quality speaker, resonance diminished in lower frequencies. However, resonance occurred in all frequencies around 119Hz. This is thought to be the frequency of the lights/HVAC. In the future, to confirm this theory, audio could be recorded with the lights/HVAC off and a spectral analysis done. If the lights were the cause of this resonance, the resonance would then diminish from the spectrogram.
Materials Science (MATS)	2121	Megan Nicholls	Investigating Insulation	In this experiment I tested different types of insulation in model houses placed in cold outer temperatures. I did this lab to educate others on what type of insulation would maintain the most heat in cold temperatures. I build 3 model houses to conduct my experiment and placed different types of insulation, one trial at a time, then put them in a freezer and measured the temperature change over 30 min intervals, to see how much temperature was lost over a 2 hour time frame. I observed that spray foam insulation maintained heat for the longest period of time and foam board contained the least amount of heat over a 2 hour test. The experiment shows what insulation types would be the most beneficial for cold temperatures, and how R-value can be compared to how much heat was maintained by the insulation. In the future I would like to test more insulation types and also make my model house more realistic, to an actual house with rooms, levels and heating.
Materials Science (MATS)	2122	Trisha Samba & Amira Sinclair	SCOBY-Dooby-Doo, Bioplastics Where Are You?	There were 217.9 million adhesive bandage sales in the US in 2019, all containing various toxic plastics. With the 2017 surge in Kombucha tea sales, the fermented beverage's waste product might be a solution to this dilemma. In this project, a water-resistant, durable, biodegradable alternative to conventional polyethylene materials was constructed using SCOBY, a symbiotic culture of yeast and bacteria. Eight pieces of SCOBY were treated using varying amounts of coconut oil, castor oil, beeswax, and vinegar. It is hypothesized that the SCOBY that is treated with 15mL vinegar, 20 grams (g) of coconut oil, 20 milliliters (mL) of castor oil, and 150g of beeswax will hold the most weight and have the least water damage. The development of this readily accessible, SCOBY bioplastic will mitigate the current plastic waste crisis and help set an economic precedent for renewable alternatives.
Materials Science (MATS)	2123	George Richards & William Sweeney	The Polymer Problem: Creating an Accurate Model of Polymers Using Magnetic Polystyrene Microspheres and Lambda DNA	Polymers are found in nearly everything in the world from clothing to our own bodies, yet not much is known about polymeric properties. Further experimentation on polymers would yield more insight as to how they behave under given circumstances. However, observing the behavior of polymers at a molecular level is extremely difficult. Therefore, we attempted to construct a realistic model of polymers to study the behavior of these complex molecules. Magnetic Polystyrene microspheres were connected by Lambda DNA and magnetic attraction to form a chain of microspheres. The Lambda DNA was prepared to be used in the chain formation via hybridization and ligation. Hybridization and ligation occurred using oligomers of biotin and DIG before being combined with a solution containing the microspheres. The microsphere and DNA solution was viewed using an oil objective immersion lens at a magnification of 60x to observe chain length and flexibility, and through this process, biotin ligated chains were observed to have a consistently longer max length. To allow for removal from the microscope slide and further testing of the model solution, we also designed and tested custom 3D-printed microscope slides. These slides are able to house the solution in the magnetic alignment process without loss of solution to

				<p>evaporation and could be reopened to access the solution after chain formation. This work has the potential to revolutionize the production and uses of polymers. The ability to study the behavior of polymers could lead to drastic improvements in the production and uses of polymers.</p>
Mathematics (MATH)	2124	Nathan Krause	Testing a New Language-Based Method for Human Random Number Generation	<p>Humans are terrible random number generators. The goal of this project was to test a new method for human random number generation which may be performed mentally using words as input. This works by performing an alphanumeric substitution and then summing each number produced by the letters of the word, and then applying the modulo operator to that sum.</p> <p>The effectiveness of this method was tested with several thousand words produced by human participants. The words were entered into a computer file and a variety of statistical tests were performed by a Python program.</p> <p>The initial results showed that the method was effective for a small number of outcomes, but it failed to produce sufficiently random results for a large number of outcomes. This was due to a concentration in the likelihood of the sum of the numbers produced by the alphanumeric substitution. It was decided to modify the method by implementing a six-letter requirement for word length in order to reduce bias. New data was collected, and the statistical tests were performed on that data. The modification failed to yield superior results.</p> <p>Overall, words seem to be an acceptable source of randomness for a small number of possible outcomes, with the acknowledgement of a certain level of inevitable bias. For a large number of outcomes, it was shown to be highly ineffective and is not recommended.</p>
Microbiology (MCRO)	2125	Madelyn Tangen	An Investigation of the Antibiotic Effects of Fish Slime	<p>Fish are in constant contact with their surroundings and the bacteria in it. There is no escape from the bacteria, yet somehow fish are flourishing. Therefore fish must have a strong protective measure against infections. The purpose of this experiment is to see if fish slime has antibiotic properties. The hypotheses for the experiment were as listed below.</p> <p>If <i>Micropterus salmoides</i> slime has antibiotic effects then it will produce a visible zone of inhibition after 24 hours in a petri dish with either <i>Bacillus subtilis</i>, <i>Micrococcus luteus</i>, or <i>Rhodospirillum rubrum</i> bacteria.</p> <p>If <i>Catostomus commersonii</i> slime has antibiotic effects then it will produce a visible zone of inhibition after 24 hours in a petri dish with either <i>Bacillus subtilis</i>, <i>Micrococcus luteus</i>, or <i>Rhodospirillum rubrum</i> bacteria.</p> <p>Using agar plates that were poured prior, the hypotheses were tested by placing paper disks soaked in fish slime into petri dishes that contained one of the three bacteria species. Two slime disks and one blank control disk went into every dish. After 24 hours in the incubator the growth of the unknown bacteria was measured.</p> <p>After performing the experiment it was apparent that there was no zone of inhibition present but there was an unknown bacteria species that had an antibiotic effect. When the slime of <i>Micropterus salmoides</i> and <i>Catostomus commersonii</i> were compared it was found that <i>Micropterus salmoides</i> had more potent unknown bacteria than <i>Catostomus commersonii</i> did.</p>

Microbiology (MCRO)	2126	Sophia Mitchell	Concentration of Bacteria on Shopping Carts	Whenever we go shopping, my dad always stops to use an antibacterial wipe on the basket and handle of the shopping cart, which made me wonder if some store chains had more bacteria on their carts than others. To test this, I swabbed 20 shopping carts at two locations of two different store chains before plating them into a petri dish. I let the bacteria grow for 7 days before analyzing my data. The average number of bacteria colonies for Store A; Location 1 was 97.6, while for Store A; Location 2, the average was 12.9 colonies. Store B; Location 1 had an average of 46.85 colonies, and the average for Store B; Location 2 was 24.15 colonies. The p-value in my experiment was 0.062, which means there was a 6% chance that the differences in data were due to chance, not the store chain. Therefore, I rejected my experimental hypothesis and accepted the null hypothesis
Microbiology (MCRO)	2127	Maya Choi	Degradation of Microplastics: The Efficacy of Various Bacteria in Breaking Down Microplastics in the Environment	Microplastics are everywhere in our ecosystem, and they will only become more abundant as they are directly deposited into the environment from everyday products such as face wash. Microplastics severely damage the marine ecosystem as they affect both the top and bottom of the food chain. However, some types of bacteria including <i>Bacillus subtilis</i> and <i>Vibrio anguillarum</i> are able to degrade microplastics. Accordingly, this experiment sought to determine which non-pathogenic bacteria <i>Bacillus subtilis</i> or <i>Vibrio anguillarum</i> would be able to degrade microplastics faster. To investigate the efficiency of <i>Bacillus subtilis</i> and <i>Vibrio anguillarum</i> 's ability to degrade microplastics, both bacteria types were plated onto agar plates and then microplastics were added. The petri dishes were observed and photographed twice a day for the next two days. After 24 hours the agar plates with <i>Vibrio anguillarum</i> had degraded 100 percent of the microplastics while the plates with <i>Bacillus subtilis</i> had degraded 77 percent of the microplastics. A one-way Anova was run on the trials and a significant p-value of 6.31×10^{-10} was obtained, which means that <i>Vibrio anguillarum</i> is able to degrade microplastics more efficiently, than <i>Bacillus subtilis</i> . <i>Vibrio anguillarum</i> could be used in wastewater treatment facilities to prevent microplastics from entering the water and thus save the marine ecosystem.
Microbiology (MCRO)	2128	Jace Flansburg	Inhibition Potencies of Naturally Derived vs. Synthetically Manufactured Antibiotics: The Effects On The Gut Microbiome	There is an area of active research about the effects of antibiotics on the gut microbiome so if we can find a natural remedy that can do most of the same jobs as antibiotics it can help us stop the destruction of the gut microbiome from antibiotics. In my experiment, I planned to answer the question: How do alternative remedies affect the gut microbiome compared to standard antibiotics? This research is important because we can learn what the least damaging type of antibiotics is for the gut microbiome but the most damaging to bacteria that causes infection in your gut. During my experiment, I grew bacteria in agar and I exposed it to natural remedies and antibiotics by using antibiotic disks and after 2 days I measured the zone of inhibition around each disk. In the end, the <i>E. coli</i> that was exposed to gentamicin had a zone of inhibition average of 17.6 mm compared to <i>E. aerogenes</i> that was exposed to gentamicin that had a zone of inhibition average of 22 mm and the <i>E. coli</i> that was exposed to honey had a zone of inhibition average of 29.2 mm compared to <i>E. aerogenes</i> that was exposed to honey that had a zone of inhibition average of 1.8 mm. Future research could investigate the best probiotics to take while taking antibiotics to keep a balanced microbiome. This research would be particularly important for us to find out how to keep our bacteria balanced while taking antibiotics.

Microbiology (MCRO)	2129	Maxwell Maveus	Isolation, characterization and identification of chlorpyrifos-degrading bacteria from agricultural soil	Chlorpyrifos (C ₉ H ₁₁ Cl ₃ NO ₃ PS) is an organophosphorus (OP) insecticide, belonging to a class of organophosphorus compounds, that is toxic to birds, insects, fish, and moderately toxic to humans (Cuthbert, 2018). Chlorpyrifos is still widely used across America, despite efforts put forth by the Environmental Protection Agency (EPA) to ban commercial use of it, which has led to wide-spread soil contamination. A promising degradation method of chlorpyrifos is through bioremediation, which requires the identification of a chlorpyrifos-degrading bacteria. The concerns about chlorpyrifos pollution have inspired this research, as well as sparked many questions: Is there a bacteria present in chlorpyrifos-polluted soil that is able to biodegrade chlorpyrifos?; If the bacteria is present, can it be isolated?; More specifically, can the bacteria survive in pure chlorpyrifos?; Finally, if the bacteria is able to be isolated, what is its genetic sequence and relation to similar bacteria?. This experiment was designed to isolate, characterize, and identify a bacteria that degrades chlorpyrifos. The experiment was carried out by gathering agricultural soil contaminated with chlorpyrifos, culturing and enriching the bacteria, creating an isolation culture of the bacteria, characterizing and extracting genomic DNA from the bacteria, and finally using a 16S Next-Generation Sequencing (NGS) method of sequencing the bacteria and analyzing the results. It was hypothesized that there would be a bacteria that can survive in pure chlorpyrifos and can use it as its primary nutrient source. If the hypothesis was proven correctly, it was recommended that research into the use of the bacteria as a form of chlorpyrifos bioremediation be carried out.
Microbiology (MCRO)	2130	Aidan lanz	Mycoremediation of Organic Environmental Contaminants	This experiment was a comparative study detailing the remedial properties of two species of white rot fungi, <i>Lentinula edodes</i> and <i>Ganoderma lucidum</i> , so as to determine which is a more likely candidate for use in self-sustaining environmental cleanup procedures. Ligninolytic enzymes present in white rot fungi such as lignin peroxidase, manganese peroxidase, and laccase, have been shown to be able to degrade organic compounds that resemble the naturally-occurring compound lignin. The fungi were exposed to equal concentrations of three different environmental contaminants: crude oil, acetylsalicylic acid, and glyphosate. The fungi were then left for one week and afterwards the contaminants were reisolated and the amount of the contaminant the fungus broke down was calculated. The p-values obtained from a one-way ANOVA for these data were all lower than 0.05: 0.0178 for the crude oil trials, 0.0022 for the acetylsalicylic acid trials, and 0 for the glyphosate trials. In conclusion, the <i>Ganoderma lucidum</i> fungus was able to degrade more than the <i>Lentinula edodes</i> in all three contaminant groups tested. The treatment also proved more effective for acetylsalicylic acid and glyphosate than crude oil. Further experimentation with more fungal species and contaminants can better establish these results and may lead to the discovery of the most efficient fungus to break down chemical contaminants in the environment.
Microbiology (MCRO)	2131	Tessa Wayne	Survival of the Fittest: Bacteria Style	This experiment was performed to find the concentration of alcohol in hand sanitizer which would kill the most bacteria. Since people may use hand sanitizer to replace hand washing, knowing which sanitizer works best, is a common request. Preparations for this experiment are as follows: At home, varying concentrations of hand sanitizers were made using aloe vera and 91% isopropyl alcohol. At school, petri dishes of agar were made and the plates were inoculated with <i>E. coli</i> K12 bacteria and the sanitizers were applied over the bacteria. Plates were sealed and placed in an incubator. Data was collected approximately 24 hours later. The hypothesis was correct, the higher concentrations of alcohol killed more bacteria colonies compared to lower concentrations. Since the recommended concentration of alcohol is 60%, it makes sense that the concentration of 50% averaged 354.3 bacteria colonies remaining. The 60% did better, but the 87.5% concentration killed 1/3 more bacteria, averaging 206 colonies remaining. The results of this experiment were successful. Not only did the results support the hypothesis, but they helped find a solution to a commonly asked question. Hand sanitizers with over 60% alcohol are more likely to kill bacteria compared to those with a lower concentration. Difficulties within the experiment included extra time at school and finding a way to successfully mix the sanitizer. To redo the experiment it would be beneficial to perform all the steps at home to streamline

				observations for data gathering. Some topics to study further include hand and dish soaps using the same process.
Physics and Astronomy (PHYS)	2134	Gabe Germain	Creating a synthetic lightcurve using a python script with a free animation software	The focus of this project is to create an easily accessible tool that creates a synthetic lightcurve for any object based on certain inputs about the spin and phase angle. This will be achieved by creating a python script within a free modeling and animation software named Blender. It is hard to visualize what parameters about the shape and the spin of an asteroid affect the lightcurve and this tool will make it much easier to understand those inputs and corresponding outputs. This tool can be very useful for educators, scientists, and astronomy enthusiasts alike.
Physics and Astronomy (PHYS)	2135	Supriya Roy	Evaluating the Stability of Resonance in Exoplanet Systems	The purpose of this project was to develop a mathematical simulation to determine the stability of resonances that are sometimes observed in exoplanet systems, and how vulnerable they might be to disruption. My hypothesis was that a potential intruding mass passing by a resonant exoplanet system may affect the orbits of the individual planets. A computer program was written in Mathematica to simulate a three-body exoplanet system which was modeled after a stable and resonant exoplanet system, TRAPPIST-1. Data from TRAPPIST-1f, TRAPPIST-1g, and TRAPPIST-1h were used for these three simulated bodies. The baseline resonance (relation between orbital periods) for TRAPPIST-1g and TRAPPIST-1f was 4/3 and the resonance for TRAPPIST-1h and TRAPPIST-1g was 3/2, which fluctuated when cases of disruption were implemented. The maximum distances for the bodies were calculated and demonstrated instability in all three orbits as the mass increased. When the intruder mass was small, there was little gravitational influence on the planetary orbits, but with intermediate masses, the orbits were affected as shown by the changes in period and maximum distance. At the largest intruder masses (approaching the mass of the central star), the period could not be determined because the orbits became non-elliptical and chaotic before the planets were eventually ejected from their orbits. The mass fell into orbit around TRAPPIST-1, forming a binary system. These simulations can assist in determining whether resonance can be reestablished after a disruption. The level of disruption may be so extreme that recovery is not possible under certain circumstances.
Physics and Astronomy (PHYS)	2136	Mina Mandic	Exploring the Wonders of the Early Universe: Green Pea Galaxies and Light Flux	Green Peas are a unique set of galaxies characterized by low mass, low density, and high star formation rate. These properties are shared with Lyman alpha emitters, one of the first types of galaxies that existed in the early universe and played a role in reionization, a phase in the early evolution of the universe that is not well understood. Investigating the properties of Green Peas would help understand the Lyman alpha emitters and their contribution to reionization. This project examines the luminous flux distribution emitted by Green Peas, separating the light from the stars and the surrounding gas. Python code was used to extract images of 80 galaxies from the Sloan Digital Sky Survey database and to create images of the components produced by stars and by oxygen gas. These images were used to make plots of Flux vs Distance from the center of each galaxy to show the regions from which the two components were emitted. The results show that the stars and the oxygen gas emit light from the same locations within the galaxy. Green Pea, galaxy, reionization, Python, flux, universe, lyman alpha, continuum, emission, center of mass
Physics and Astronomy (PHYS)	2137	John Neaderhiser	LIGHT	What is Wave-Particle Duality? Is light a particle or a wave the answer is that it is neither. The double-Slit Theory proves that it shows that light is a wave when it goes through a slit but once it hits the back surface it lands as a particle. If a light was only a particle it would hit the parts that make up the slits and only a certain amount would land on the back surface. If it was only a wave we would see none of the light at all on the back surface.

Physics and Astronomy (PHYS)	2138	Belinda Neset	Lights, Camera, Action! An Evaluation of Low Cost Infrared , UV, and Visible Light Detectors in the Stratosphere	<p>The sunlight we see on Earth's surface doesn't come close to the true power of the light emanating from the sun. Rather, the atmosphere mutes a majority of sunlight, including infrared, UVA, UVB, and visible light, which means that an increase in altitude can visibly show what the layers of our atmosphere does to sunlight. In order to detect and quantify this variation, scientists use photometers, which are expensive. Finding an accurate, low-cost photometer will make it easier to monitor and study our atmosphere's protective layers.</p> <p>The goal of this research was to conduct a high-altitude balloon flight designed to collect data from three photometers. The author built a payload with an 8-channel Verhage photometer, Neulog and QWIC UVA, UVB, and visible light detectors, and a QWIC infrared sensor. The flight was conducted in February, and gathered data so the light detectors could be compared. The results showed that the Verhage sensor was the most reliable and accurate.</p> <p>The Verhage detector is a low-cost photometer that can function effectively and accurately in stratospheric conditions. With this detector, scientists will be better equipped to monitor each layer of our atmosphere, and understand what precautions need to be taken in order to protect civilian and military pilots, as well as astronauts. Finally, this study will have an impact on the understanding of renewable resources, since harnessing solar energy without the restrictions on light from the Earth's atmosphere could redefine solar-powered technology.</p>
Physics and Astronomy (PHYS)	2139	Hayden Montour	Nerf or Something	<p>My project is on Nerf darts. I am looking for a better alternative than Nerf darts. I used 8 types of darts and I also used 4 types of ball ammo. For each type of ammo dart or ball I used 4 blasters. Half of those blasters were springers which use a spring to fling the ammo. The other half used flywheels which are two plastic wheels that spin then when the foam ammo is pushed into them they compress the foam and fling it. I tested accuracy and velocity. For velocity I shot every ammo type through its four blasters 10 times. I used a ballistic chronograph to measure the velocity. To do accuracy I mounted a target to the wall then did the same amount of shots at the target well recording it on the camera. I recorded it by replaying the video and recording where it hit the target and the total number of points out of 100 is what I used for accuracy. I had very varied results but overall the best dart for velocity was Ekind Suction. The best accuracy for the ball ammo was Rival. Some of the variables that might have happened during the testing was I did not have the blaster mounted to anything and was just holding. Another one was that batteries might have had less power lowering the power for the blaster. Last variable would have been there could be an inconsistency in the chronograph.</p>
Physics and Astronomy (PHYS)	2141	Noel Abraham	The Night Sky of our Intergalactic Neighbors: Creating Star Maps For Exoplanets	<p>In this research project, the star maps of various exoplanets were found. Star maps are used for navigational purposes and for the identification of various astronomical objects. Exoplanets are planets outside of our solar system that humans are looking to expand towards. In this project, data from the GAIA satellite data release 2 were used. The right ascension and declination angles were converted to galactocentric coordinates in order to make the movement of the center of the stars easier. The coordinates were then moved and converted back to right ascension and declination coordinates. The new coordinates were then graphed to make a star map.</p>
Plant Sciences (PLNT)	2142	Abby Fisette	A Study of the Variance in the Hydroponic and Aquaponic Cultivation of Allium cepa	<p>According to dosomething.org, 11.3% of the world's population is undernourished. One way to help this issue would be to find more efficient ways to grow food, and that is exactly what this project will assess. In this project, I will be observing three different farming methods (hydroponics, aquaponics, and traditional gardening) and investigate which of these three methods is the most efficient for growing onions.</p> <p>It was hypothesized that the hydroponics system will be the most efficient method of cultivating Allium cepa, as the essential nutrients in the hydroponics system are more abundant than those in the aquaponics system. I accept this hypothesis as the plants had a greater rate of root regeneration and growth than those grown in the aquaponics system.</p> <p>The information provided in these conclusions is relevant to those who wish to know which farming method is the most efficient for growing onions. Though the hydroponics was more</p>

				efficient for the onion cultivation, the aquaponics may be the most beneficial method of cultivation: not only do you have the onions to consume, but you also have the fish.
Plant Sciences (PLNT)	2143	Isaac Mauch	Bean Boozled: Raising Bean Yield Potential	If orca beans are grown using ridge-till practices then yield potentials will be increased along with the percent of white in the beans because of better soil drainage conditions which cause anthocyanin pigment to shut off due to high stress. The hypothesis was accepted because based on the yield that was harvested both a variant and the base more than doubled their production from being in the raised ridge tilled garden. The black increased a total of 144% and the base 153% which shows how much more yield can be produced when ridge tiling. Both color variants increased their white percentage from the ground to raise. Black may not have had a tremendous white increase but a significant black decrease of 59% and a base increase of 82.9%. The white had a 13.8% increase of white with no black at all. To review the raised beds create dryer and hotter soil conditions while the ground stays wetter and tends to be cooler. Between both, there is about a 1 degree Celsius difference. Therefore because the raised beds are hotter and dryer and that the anthocyanin pigment in the bean under the stress of those conditions cannot create pigment black it was intended to produce. Making the white color you see in the shell of the bean.
Plant Sciences (PLNT)	2144	Cassandra Neumann	Busting Bad Buckthorn The Final Phase: The effect of different germination and temperature on Buckthorn Seed germination	To determine the best germination techniques to enhance germination as well as finding a heat treatment method to reduce germination, buckthorn berries were picked and stratified for four weeks in a refrigerator. To ensure successful germination, enhancing techniques were tested. A set of berries were hand mashed or blended, one set of each was fermented with water and another was let to dry on newspaper. Next, the skins were removed from the berries and the seeds were rinsed. Six trials for each germination enhancing treatment were exposed to different heat treatment methods (0, 170, 190 and 210 degrees Fahrenheit) for thirty minutes. For each heat and germination (mash or blender) treatment, three seeds were placed into containers with a soil mixture of equal amounts of sand, compost and peat moss. Germination success was recorded. The questions were: Q1 What effect do different germination enhancing techniques for buckthorn seeds have on germination success. Q2-What effect do different buckthorn seed heat treatment methods have on retarding germination. The hypotheses were that blended buckthorn seeds would have a higher germination rate and seeds treated to temperatures at and above 190 degrees (F) would have the lowest germination success. My first part of my hypothesis was partially supported, the seeds without treatment were the most successful compared to mash water, mash dry and mash water there was a $p < .009$ with a significant difference. The Second part of my hypothesis was supported, germination rates were lowest at 190 and 210 degrees.
Plant Sciences (PLNT)	2145	Elisa Guo	Creating Auto-luminescent Plants with Fungal Bioluminescence Pathway	Auto-luminescent plants have the potential to become an alternative, self-powered source for indoor and outdoor lighting, saving energy used for electric lighting. However, natural plants cannot generate light because they lack luciferase, the enzyme critical for bioluminescence, and the correct enzymes to produce luciferin substrate. Although some methods for introducing luciferase into plants have been reported, efficient delivery of its substrate remains a challenge. In this study, we describe a unique method to generate bioluminescence in plants: transiently transforming the plants with the Fungal Bioluminescence Pathway (FBP). We observed that in the four plants we used, yellow-flowered Tuberous begonia (<i>Begonia</i>), white-flowered <i>Chrysanthemum morifolium</i> (<i>Chrysanthemum</i>) and <i>Euphorbia pulcherrima</i> (<i>Poinsettia</i>), and white-flowered <i>Rosa rubiginosa</i> (<i>Rose</i>), bioluminescence was generated after FBP agrobacterium transformation. These results provide promising direction for creating practical plant lights in the future.

Plant Sciences (PLNT)	2146	Grace Finnerty	Does honeybee hive distance affect apple quality as measured by seed count?	Higher seed counts in apples produces higher quality apples with fewer calcium deficiencies. My project investigated the impact of distance from honey bee hives on apple seed count. By discovering if seed count is affected by distance from the hives, growers can better assess where to put their hives in order to reap the most benefits from Honeybees. In this experiment, the number of seeds in Honey crisp apples was counted for 24 apples at each of eight test sites, with three apples collected from each of eight trees at each site. The collection numbers chosen, after consulting an expert in the field, were determined to accurately represent each site and the whole orchard. The test sites were mapped and navigated to, at four distances from the hives at 145, 300, 323, 430 meters, using Google Maps. These distances were plotted twice, once on two different foliar nutrition programs, which are defined by the calcium sprays applied to the foliage of apple trees. This test was performed on trees from the two different nutrition programs so that seed counts could be assessed separately for each nutrition program. After statistical analysis, no significant difference could be shown in seed count at different distances from the location of the hives. Many possible factors could have contributed to this result, but the results of the experiment indicate that the location of the hives during pollination does not have an effect on the seed count of the apples at different locations of the orchard.
Plant Sciences (PLNT)	2147	Ayaan Jamali	Effect of Electricity on Seed Germination and Growth	In the past, experiments have been conducted involving the use of magnetism in plant growth, and magnetism, on occasion, had positive effects on growth. However, this experiment was about electricity and plant growth. This experiment was done in order to see the effect of a current on seed germination and growth, specifically with kidney beans. It was predicted that the beans that received a current would not germinate and grow as much as the untreated beans due to past experiments done and the negative effects of electricity on humans. To run a current through these beans, a gel electrophoresis setup was used at 50 volts for ten minutes. 24 beans were in each group, and they were put into two separate pots. They were grown for four weeks with height measurements taken daily. The results were statistically significant (p-value), with the untreated beans growing more than the experimental beans. While this supported the initial hypothesis, the treated beans appeared to be growing at the same rate as the control beans. The mean of the treated beans was consistently within 4-6 cm of the mean of the untreated group. This suggested that the electricity caused an initial stunt to the beans' growth, but later had no effect, allowing the treated beans to grow at nearly the same rate as the untreated beans.
Plant Sciences (PLNT)	2148	Tania Acevedo Garcia	Grain Strain On Brain: Mechanical Characteristics of Lodging Resistance	Lodging in small grains severely affects producers and processors financially. The cause of lodging is complex, scientists have previously used genetics and management to control lodging. We are going to use physics to identify mechanical traits that differentiate lodging resistance. 16 grain cultivars classified as either lodging resistant or susceptible were measured with a push force meter to obtain biomechanical characteristics of the stems. We quantified four physical factors; force (N), displacement (mm), change in energy (J) and change in power (watts). We found that displacement can predict lodging susceptibility for oats. With force, heading stems of susceptible varieties off all crops are stronger than at grain maturity whereas resistant lines do not change stem strength over time and mature wheat has the biggest change. These findings will allow breeders to make selections to develop cultivars that have higher yield and lower lodging incidents to benefit all who utilize these grains specifically third world countries who depend on it as a main food source.
Plant Sciences (PLNT)	2149	Ivy Ferstan & Fiona Reilly	Ideal Environmental pH for Plants	This project studied the effect of pH level in water supply for jemalong legume plants. Three groups of eighteen plants were watered with three different levels of pH solutions: pH 3, pH 7, and pH 11. The plants were watered with these solutions and as they grew they were measured, then, at the end of the experiment the soil pH was tested and the rhizobia nodules in the roots of the legumes were counted. From our results, we were able to analyze what the ideal pH is for the legumes for them to be healthy. It was hypothesized that the plants watered with a pH of 7 would grow best, but, the plants watered with a pH of 11 showed the most growth.

Plant Sciences (PLNT)	2150	Grace Moeller	Reducing the Environmental Impact of Synthetic Dyes with the Dye of Persea Americana	<p>I would like to learn what different natural elements create different pigments and how the pigments take to silk organza fabric. I know that avocado pits make pink, turmeric makes yellow, beetroot makes red, brown onion skins make orange, coffee makes brown, and black beans make black. I think this research is important because of the environmental benefits natural dyes have, and fast fashion is a leading contributor to big problems like climate change by putting harmful chemicals from artificial dyes into the environment. Fast fashion is responsible for 20% of the world's water pollution. If the pH is changed to be more acidic, the silk will have a more vibrant color. If the pH is changed to be more basic, the silk will have a muddier color. I think that changing the dye bath to have a more acidic pH will purify the tap water and make the color more vibrant, where the alkaline will darken the dye bath.</p> <p>Challenges could be our local water, as water high in iron tends to make the color muddier to start with.</p> <p>The next step is to collect materials: Avocado pits, pot, water, silk, wooden spoon, baking soda, vinegar, iron filings, and jars. After I had gathered the materials, I prepared the dye, and separated it into the separate jars with the different solutions. I then cut the silk into strips and let the fabric sit in the dye for four hours.</p> <p>As I analyzed the dyes, the one with iron filings became a very dark purple, almost black. The vinegar solution turned to more of a peach color, whereas the baking soda solution turned a plum-like color. Compared to the fabric strips, the iron filings created a black fabric, vinegar a plum purple, and the baking soda a dark peach. The fabric and solution colors for baking soda and vinegar seemed to switch.</p>
Plant Sciences (PLNT)	2151	Rebecca Kottke	Selective Breeding: A New Approach to Perennial Flax	<p>Selective Breeding of plants to increase yields, plant hardiness, bloom quality, and many other traits has been prevalent since the first agricultural revolution, but modern scientific methods have streamlined the process. To effectively breed a new genotype of any plant, many factors and traits need to be considered, two of which were explored for <i>Linum usitatissimum</i> in this experiment. In pursuit of perennial flax varieties that lend many benefits to both human and environmental health, two crucial pieces of information are total yield and seed weight, as they have the most direct correlation to seed germination yield and time; important traits for any plant that is to be used as a crop.</p>
Plant Sciences (PLNT)	2152	Anthony Chen	The Effects of Short Term Radiofrequency Electromagnetic Radiation on Diatom Photosynthetic Productivity	<p>With the rise of wireless technology in the 21st century, the presence of unseen electromagnetic radiation (EMR) across the globe has proliferated. While much has been done to develop these systems which we so dearly depend on today, far less is understood about the potentially harmful effects which accompany the proliferation of these waveforms. This experiment sought to quantify the effects of the prospective 5G cellular network frequencies of the radiofrequency (RF) spectrum on the most abundant primary producers on Earth: phytoplankton. To do so, experiments utilized the analog 60GHz frequency band of the WiGig standard, the IEEE 802.11ad protocol, to simulate the radiation parameters of our near future. By measuring the oxygen production of <i>Thalassiosira</i> and <i>Cyclotella</i> diatom genera in two phases under controlled conditions, the photosynthetic productivity of the phytoplankton could be recorded and compared between exposed and control groups. Results supported the alternate hypothesis that short term radiation significantly stimulated productivity, resulting in enhanced oxygen production. While this result can be justified with previous findings, it only provokes further questions: are the effects of RF-EMR on diatoms limited to short term exposure, and if so, how will this change human's relationship with technology?</p>
Plant Sciences (PLNT)	2153	Katrina Roberts	The Investigation of Gall Midge on Soybeans	<p>The purpose for this project is to see the effect gall midge has on soybeans. Gall Midge is a new organism in soybean plants. Gall midge is a very destructive organism that feeds off the nutrients of the soybean plants. This organism destroys plants making farmers lose money in crop production. I hypothesized that if you have uninfected soybean plant, then it will yield more soybean pods than an infected soybean plant. I also hypothesized that if you have a soybean plant infected with gall midge, then it will have thicker stem than the uninfected soybean plant due to the moistness. The last thing I hypothesized If you have an uninfected soybean plant, then it will yield more seeds in a pod than a soybean plant infected with gall midge. The way I tested my</p>

				hypothesis I counted all of the pods on the uninfected and infected plants. I also recorded the thickness of each plant infected or not infected. I took ten random pods on each plant and counted each pod in the infected and non infected plants. The data shows that gall midge has a negative impact on the yield of soybean plant.
Plant Sciences (PLNT)	2154	Vaughn Hughes	Using Environmental Enhancements to Increase Vitamin-C Production in Spinacia oleracea in Varied Agricultural Environments	Vertical Farming (VF) has emerged to feed Earth's growing population. VF grows crops indoors without sunlight or soil. VF produce has less vitamin C and is less nutritious than conventionally-farmed produce because abiotic stress is removed to achieve faster growth times and higher yields. The top twenty vitamin-C producing crops have one thing in common; harsh growing conditions. The ascorbate-glutathione cycle is a plant metabolic pathway that produces vitamin C as a reaction to increased H ₂ O ₂ ; a result of plant stress. It was hypothesized that adding abiotic stress to the VF environment would stimulate the enzymatic pathway, resulting in increased vitamin-C production. Stress in the form of wind, heat and drought was applied to Spinacia oleracea in a VF environment and vitamin C was measured by titration. Thirty samples were taken from each of three plant groups (outdoor farming, VF and VF+stress). The VF groups had statistically significantly lower vitamin-C levels than the outdoor produce (p<0.01). The three stress groups had statistically significantly higher vitamin-C levels than the traditional VF groups but lower levels than the outdoor group (p<0.01). The vitamin-C levels of an interaction group combining wind and heat stress were higher than those of the other stress groups (p<0.01) and were statistically equal to the outdoor group. The addition of abiotic stress to the VF environment can increase vitamin-C levels and, with the addition of both wind and heat stress together, vitamin-C levels can be equal to that of conventionally-farmed produce.
Plant Sciences (PLNT)	2155	Emelyn Beaster	Using Phytoaccumulation to End Mineral Deficiencies: Increasing the iron content of Brassica juncea	Iron is extremely important when it comes to how our bodies function. Although it is considered a trace mineral, a lack of iron can lead to severe cases of anemia, which is the most common blood disorder in the United States. Iron along with many other minerals is able to be easily absorbed in hyperaccumulators such as Brassica juncea through phytoaccumulation. This project was an experiment of the ability of Brassica juncea to absorb and accumulate a substantial amount of iron, which would naturally fortify the plant leaves with this mineral. Samples of Brassica juncea were grown hydroponically in concentrations of 0 (control), 25, 50, 100, 500, 1,000, and 2,000 ppm of FeSO ₄ . The plant samples in concentrations of 2,000, 1,000, and 500 ppm succumbed to extreme toxicity after two days of exposure and were disposed. The rest of the samples (0, 25, 50, and 100 ppm) were monitored for three weeks. After this time period, all of the plant samples were harvested, dehydrated, and tested for iron content using a procedure that involved a reaction with KSCN and a colorimeter. It was found that the samples growing in the highest concentrations of FeSO ₄ (50 and 100 ppm) accumulated enough iron to be well over the RDA when consumed in an amount equivalent to an average serving size of the plant leaves. However, the plant samples growing in a 25 ppm concentration would, when consumed at the average serving size, meet the RDA of iron almost exactly. In conclusion, this method of naturally fortifying plants with essential minerals could be used to help end mineral deficiencies.
Robotics and Intelligent Machines (ROBO)	2156	Pramod Anandarao	A Deep Learning Approach for Diagnosing Diabetic Retinopathy Using Retinal Fundus Images	Diabetic retinopathy (DR), a disease of the eye caused by diabetes, occurs within 21% of patients with diabetes, and often leads to the loss of vision. In its earliest stages, DR often displays little to no symptoms, making it difficult to diagnose without the help of a professional. However, early detection is vital for preventing or delaying the onset of blindness. DR is usually diagnosed through a dilated fundus exam, in which a doctor uses dilation drops to enlarge the pupils. Following this, a "fundus camera" is often used to view the fundus of the eye. However, these cameras are often expensive and are not portable. Deep learning, a subset of machine learning, allows for an efficient and accurate method of identifying and processing images. The aim of this project is to (1) create a deep learning based image classifier capable of diagnosing DR using retinal fundus images, and (2) create a low cost digital fundus camera using the classifier in order to diagnose DR in real time. Roughly 35000 de-identified and anonymous fundus images of varying quality taken from the

				"Kaggle diabetic retinopathy dataset" were used to train and test the classifier. Using this classifier, a low cost fundus camera was designed based on the Raspberry Pi computer with the ability to diagnose DR in real time. The classifier proved to be accurate in diagnosing diabetic retinopathy, making this a successful project.
Robotics and Intelligent Machines (ROBO)	2157	William Sepesi	A Machine Learning Approach To Pokemon Battling	Artificial Intelligence (AI) research in games of incomplete information has increased over the past few years, primarily due to the valuable challenge it provides to new solving techniques and its use as a better model for real-life situations. Pokemon offers a unique game of incomplete information in its high vector space state and stochastic nature, and thus is a worthy task in AI research. Past work in Pokemon has used reinforcement learning as a primary strategy, but the Machine Learning (ML) and game theory techniques used in recent Poker research by Brown and Sandholm offer an intriguing solution to this problem. This project uses a python environment to access and interact with the Pokemon Showdown battling simulator, and will test a series of heuristic modules, as well as abstraction and Counterfactual Regret Minimization (CFR) modeling in pursuit of creating an AI that can outperform basic heuristics and a random agent in a statistically significant manner.
Robotics and Intelligent Machines (ROBO)	2158	Baraa Al-Jasim	Autonomous Firefighting Robot	With the advent of technology, robots are being developed to aid humans in life-threatening events. This paper is based on the construction of a prototype robot aimed to demonstrate its fire extinguishing function. The paper will discuss the design of a fully autonomous robot capable of detecting a simulated fire and sending a warning email to designated people when it detects flames and begins to extinguish it. The robot has a multitude of functions to enhance its application. This includes its GPS tracking system that has the ability to track the robot's location in real-time while saving its previous coordinates, its obstacle avoidance function, and a smoke alarm system that sounds an alarm and sends a warning message if it detects smoke. The robot's ability to extinguish a fire was tested in a maze. The routes the robot would take and how successful it would extinguish the fire with obstacles and barriers in its path were examined. The robot's ability to extinguish the fire was also tested in terms of distance with respect to time. The robots smoke alarm system was tested by creating a smoke environment with different smoke amounts produced to measure the sensors' function and messaging capabilities. The GPS tracking system will be placed on the robot to analyze the robot's path on the web server's map and its use.
Robotics and Intelligent Machines (ROBO)	2159	Stephen Wu & Kajsa Arnold	Mechanized Reading; Using Deep Learning for Document Compression	With so much information on the internet and in physical literature, understanding all of it would take an absurd amount of time. A way of "compressing" a text must be used to act as a summarization tool. To accomplish this, we created a summarization tool that can be used on a body of text of an arbitrary given length, both maintaining the crucial meaning behind the text while greatly reducing the text's length. This was done using machine learning, specifically deep learning, the natural language tool kit, and methods like doc2vec. By utilizing deep learning, the scalability of the algorithm is much better given larger data sets to train on. After running the algorithm on a 10 different web articles, we used the Rouge metric to calculate the accuracy score of the preliminary algorithm with reference to our own human summarization, giving us a score similar to that of some current algorithms, such as the gensim summarizer tool, though not quite at the level of Google Pegasus and other similarly large models. In order to improve our algorithm, it too would need to train on larger datasets, such as the Gigaword dataset. Text summarization algorithm can be used in any field requiring the reading of text, saving time and energy for humans. It would allow for the combing of larger bodies of text, and it would make more complex topics easier to digest.
Robotics and Intelligent Machines (ROBO)	2160	Jai Chadha	Using forearm myoelectric sensing to control an upper-extremity 3D printed prosthetic hand	In 2005, there were 1.6 million people in the United States who were living with limb loss (Ziegler-Graham et.al., 2008). Moreover, about 185,000 amputations occur each year in the United States (Owings and Kozak, 1998). As a result, it is essential that an effective method be developed to make it possible for individuals to complete the task of handwriting using a prosthetic limb, especially for students in schools. For this reason, the focus of this study is the development of a 3D printed prosthetic hand that can write using electromyography sensing (EMG sensing). This project will use EMG sensing to detect the contraction of forearm muscles, resulting in distinct movements with the 3D printed prosthetic hand, allowing for legible

				handwriting. In doing so, this project aims to create the possibility for students with upper limb amputations to be able to write legibly using a 3D printed prosthetic hand, enhancing their education career and opening up possibilities once thought to be impossible.
Systems Software (SOFT)	2161	Milan Jostes	Developing FourS 2.0 A Web Hosting Software That Uses Encrypted Quick Response Code to Reduce Violence in Schools	<p>In 2018 a total of 39 school shootings took place in the United States. An overwhelming percentage of these attacks were a result of the estimated 962,300 violent incidents in schools. The objective of this project is to create a security system that protects schools from violent acts by using QR code generation. The primary concept is to develop an access system, titled FourS (School Safety and Security System). This system will create encrypted QR codes, for both students and staff, that are required upon entering the building. These QR codes contain a randomly generated password that changes whenever an individual enters or exits the school and is voided once used.</p> <p>In July 2018, the United States Secret Service released “An Operational Guide for Preventing Targeted School Violence” to the public. This document introduces the use of a new threat assessment model, based on the knowledge that in 93% of the school shootings, the shooter showed behavioral warning signs recognized by fellow students or teachers prior to the incident. These warning signs would be used in FourS for a five-level flagging system. If students show warning signs, the flagging level would be adjusted accordingly. Higher warning levels increase the chance of having a bag check, as well as alert counselors in order to help the student. Using FourS, a large school of 2,500 students would be able to check in all of their students in less than fifteen minutes for the cost equivalent of two vending machines.</p>
Systems Software (SOFT)	2162	Mani Chadaga & Akshay Nambudiripad	Development of WALTER: A Route Planning System That Analyzes Accident Data to Determine Safer Driving Routes in Saint Paul, Minnesota	<p>Car accidents cause injury, death, and economic damage. As some roads are inherently safer than others due to structural differences, accident risk can be reduced by deliberately planning routes to avoid high-risk areas. Existing route planning systems either neglect route safety, drastically sacrifice route speed/simplicity, or use an abstract measure to determine safety. We developed a system (in JavaScript using ArcGIS) that uses an empirical statistic to determine safer routes while maintaining the routes’ speed and simplicity. Our prototype works in Saint Paul, Minnesota. Accident data from the Saint Paul Police Department allowed for the creation of this system (named WALTER). To generate potentially safer—yet still fast/simple—routes, alternate routes avoid one high-volume accident cluster (determined via k-means clustering in R) at a time. Then, route options are ranked on safety via determination of risk scores equal to the estimated number of accidents per route traversal. An interactive map GUI allows users to access WALTER, browse potential routes, view/print directions, and export their chosen route to a real-time navigation application. When tested, WALTER found a safer alternative to the fastest route 52.9% of the time; otherwise, the fastest route was the safest. Safe routes on average had 27.8% lower risk yet only 14.2% higher drive time and 1.61 more turns. Due to high usability and mitigated route inconvenience, WALTER is both accessible and practical for the average Saint Paul driver. Furthermore, WALTER is easily implemented in any city with accident data, allowing for improved road safety across the developed world.</p>
Systems Software (SOFT)	2163	Nick Zander	Expediting the School Check-in Process	<p>The purpose of my project is to create an application that goes on a device that makes the school check-in, check-out, and lunch count processes go faster. I think this is important because at schools like mine administrators have to manually take information from a sheet of paper and transfer it over to the computer. This would save them time to do different tasks for the school. My goal is to create an application that can make the check-in process automated by having the students enter information on a device, and that information automatically goes into the database. First, I brainstormed possible tasks that this program could do. Then, I made diagrams mapping out how I wanted my application to work. After I made diagrams, I created the database and the code for my application. I then tested it to see if it worked how I wanted. I also got feedback from both students and administrators on my program. In the future, I could add more to my application, expanding what it can do and making the attendance process even faster. I plan to add a feature where the system prints out a pass for the student automatically based on the information they</p>

				input. I know that this project will be very beneficial to schools, the attendance process, and lunch count process.
Systems Software (SOFT)	2164	Jack McCarty & Addison Olstad	The Assessment of Instagram's Algorithm	<p>The purpose of this science experiment was to identify if Instagram's recommendations held stereotypical tendencies within its account recommendations. This means women being recommended distinct types of accounts and males being recommended other accounts. An example being, women being recommended more make up accounts and men getting more sports related content. These results were determined using several Instagram accounts, 5 female and 5 male, to list the first 10 types of accounts recommended for each account made. Each account would have remarkably similar usernames in order to keep some consistency in the experiment. A graph was then made directly comparing the two results, which allowed me and my partner to come to the conclusion that there wasn't any significant difference between the two results, but there was some small variations, there were more promotional/business accounts recommended to males than females, and the same was for sports, but the opposite for travel. This would most likely mean that this was up to natural variation of the platform since the most recommended account type was celebrities for both women and men. We then took a survey of a few females and males and learned if they believed if this result was accurate to what their experience is. Overall, we learned a lot about how Instagram perceives new accounts just based on the gender in their profile. That Instagram doesn't tend to make judgements just off your gender and tends to just focus on what you search and follow in the future.</p>
Translational Medical Science (TMED)	2165	Daniel Fleury & Manasa Yerriboyina	Deployment of a ShufflenetV2 Network with Atrous Convolutions for the Real-time Semantic Segmentation and Diagnosis of Intracranial Hemorrhage Scans	<p>The emergence of ischemic strokes and acute/subarachnoid intracranial hemorrhages account for a critical 11.1 million and 1.9 million spontaneous cases per year respectively. Initial stroke incidences culminate in 5 million global deaths and 5 million permanently disabled victims due to variable diagnostic efficacy and treatment outcomes. With acute intracranial hemorrhages corresponding to 10% of strokes in the U.S and being the leading cause of death with an escalating 30-day mortality rate of ~45%, urgent, low-latency diagnostic protocols are critical. Although large-consensus teams of neuroradiologists triage and assess clinical data in conjunction with CT visualizations, the process is complicated and time-sensitive due to minute pixel-level anomalies on conventional CT scans. Consistent and scalable diagnostic protocols that eliminate problematic human false negatives/positives are essential in preventative clinical and neuroradiologic measures. The advent of Convolutional Neural Network (CNN)-driven object detection and segmentation tasks in the previous ~2-3 years has provided a new field of manipulation for sensitive radiographic visualization and detection. This project investigates the potential of a low-latency mobile Shufflenetv2 architecture with dilated convolutions for the real-time localization, segmentation, and classification of high-priority intracranial hemorrhage scans.</p> <p>A dataset of ~313,418 CT images across subarachnoid and acute subclasses was derived from the Radiologic Society of North America (RSNA), NIH clinical data, and the CQ500 batch repository to train and deploy a compressed frozen inference model on both a standard Android device and cloud-based web application. Data analysis employed varying confidence thresholds on Receiver Operating Characteristic Curves (ROC), regularized and converged localization-classification loss, weight and bias distributions in the neural network, and total loss values to frame parameters of sensitivity, specificity, progressive learning, and performance on diverse preidentified NIH validation datasets. Following a mini sample size validation of 200 randomized CT scans, Shufflenet attained an Area Under the Curve (AUC) of >0.93 with a high threshold sensitivity of >94% and a specificity rating of >82% on a standard real-time Android video capture. More importantly, following objective validation on mask datasets, Shufflenet produces an Intersection Over the Union (IOU) score of >0.75 in complex semantic segmentation processes. The scalable, low-memory nature of the shufflenet architecture proves viable in real-time intracranial segmentation due to atrous convolutions and an optimized memory vs. performance tradeoff. Moreover, our re-engineered shufflenet model demonstrates application in the underdeveloped world.</p>