

Project # 1

Acharya, Anushka

Determining which Parameter has the Greatest Impact on the Range of Electric Vertical Take-Off and Landing Aircrafts

Completed Project, Science, Physical Science

Electric vertical take-off and landing aircrafts(e-VTOLs) use electric power to take off and land vertically. Their design allows for small-aircraft availability and shorter commute times without the noise and pollution of helicopters or airplanes. However, e-VTOLs are limited because they have a restricted range: the maximum flying distance. The purpose of this project was to determine whether the fuel type, fuel amount, or efficiency of the aircraft has the greatest impact on increasing the range of e-VTOLs. Each of these parameters play an important role in the equation for determining the range of an aircraft. It was hypothesized that the fuel type would have the greatest impact on the range because it affects how much energy aircrafts have. The independent variable was the parameter tested, and the dependent variable was the range of the aircraft. The range equation was programmed into a spreadsheet to do a parametric variation. Appropriate numerical values for each variable were applied to the equation to assess how changes in the parameters affect the range. The mentor provided guidance while the student conducted the experiments. A table and scatter plot was generated and analyzed to understand how the parameters impacted the range of e-VTOLs. This data was then compared to data of airplanes and helicopters to determine how to improve the range of e-VTOLs. Data trends thus far support the hypothesis. This project will recommend which parameter is most important for the future development of e-VTOLs to make this technology more realistic and beneficial.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 2

Acharya, Eesha

Determining the Effects of Gender and Age on the Severity of Nonalcoholic Steatohepatitis

Completed Project, Science, Health and Medical

Nonalcoholic fatty liver disease (NAFLD) is characterized by fat accumulation in the liver. It is currently the leading cause of chronic liver disease worldwide in people with obesity and diabetes. Nonalcoholic steatohepatitis (NASH), the severe form of NAFLD, causes liver tissue scarring and eventual liver failure. Previous research has also shown that men and postmenopausal women have a higher risk of developing NASH compared to premenopausal women. It is thought that estrogen plays a role in protecting the liver, but the impact of gender and age are not understood. It was hypothesized that men would have a higher severity of NASH compared to women of the same age and similar Body Mass Index (BMI), and that younger men and women would have a lower severity compared to older people of similar BMI. Liver biopsies of NASH patients were evaluated for the severity of NASH based on the severity of steatosis, fibrosis, and inflammation. The severity of the disease was also correlated with BMI and a NAFLD activity score (NAS). Data trends thus far support the hypothesis. Currently, there are no treatments for NASH besides losing weight. If estrogen does play a role in preventing NASH, then hormonal therapy could treat those who suffer from this condition. This research could also expand the limited knowledge about NASH and NAFLD by understanding the roles of gender and age in the disease pathogenesis.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 3

Agrawal, Anika

Exploring Germinal Center B-lymphocyte Transcriptional Profile Data Sets to Determine Possible Relationships Between a Particular Subset and Chemotaxation

Completed Project, Science, Health and Medical

The mammalian immune system is a network of cells that consists of both innate and adaptive responses. In adaptive immune responses, activated B-lymphocytes migrate to specific locations in lymphoid tissue forming germinal centers with two major compartments, the light and dark zones. The chemokine system allows movement through these regions by attraction between ligands and chemokine receptors. To answer why cells move to the border between the dark zone and T-cell zone, this project explored germinal center B-lymphocyte transcriptional profiles to determine interactions between B-cells, chemoattractants, and other cells in the follicle. The mentor and student collaborated to interpret single-cell mRNA sequence datasets from the published journal article “Novel Specialized Cell State and Spatial Compartments within the Germinal Center”. Preliminary practice was done with the corresponding programming language, and the student learned how to operate software that utilizes dimensionality reduction to create clusters of cells based on similar profiles. The mentor provided support throughout the data analysis process and with understanding complex material. Resulting gene expression cluster charts and tables were analyzed and sorted into simpler data tables. This study ultimately established that there is a population of cells with the coexpression of unique chemokine receptors CCR7 and CXCR4 at the border between the dark zone and T-cell zone, and that there are indicators of T-cell engagement there. The conclusions of this project can contribute to an overall better understanding of the functions and movement of the cells that compose lymphoid germinal centers in the adaptive immune response.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 4

Ahmed, Aiden

Designing An App for Curating and Promoting Small Video Content Creators

Completed Project, Engineering, Behavioral

The current YouTube algorithm mainly promotes to users channels that already have many subscribers and views. It ranks the videos by analyzing how many views the videos get, how much time people spend watching the video, and how many likes vs. dislikes the video gets. This makes it more difficult for smaller channels to get views and followers as they get less attention and visibility. In addition to reducing the visibility that small channels get, the current algorithm also hurts the user by only showing them popular channels when they may be interested in a new content creator. The purpose of this project was to suggest small content creators to users based on their interests. The initial design was to write a program that takes in user interests and displays a list of channels. The program was written in C# so it could be coded as an app on android devices. A survey was conducted to evaluate how satisfied the participants were with their recommendations, their likelihood of using the app again, and the app's convenience. So far, the data from the survey suggests that the app recommendations needed improvement and the app needed more categories. When the program returned valid channels to the user, phase one was declared a success and phase two began. The UI was improved and more channels were loaded into the app. This app will allow smaller content creators to get more publicity and users to explore newer channels that fit their interests.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 5

Akbar, Faryal

The repercussions of the social effects of COVID-19 on student physical health and wellbeing

Completed Project, Science, Behavioral

The effects of COVID 19 on student mental health have already conveyed themselves. However, sparse to little evidence supports the idea of change on student physical health. The purpose of this experiment is to determine whether there were effects of COVID-19 on student physical health and if so how this has impacted their wellbeing. The method being taken into account for this experiment is surveying the participants by rating their physical health before COVID-19 and then after. The questions asked will be various factors of physical health. Following will be another similar set of questions asked about how the participants feel about those things currently. All questions will later be asked to be explained by the participants. Data trends thus far have supported the hypothesis; several participants have answered with an unhealthy physical activity average as of now in comparison to before Covid-19. With that, it can be analyzed as to see which groups' physical health deteriorated and or improved by the situation created by COVID-19. Using the results, it can be used to see the direct effect on student physical health due to COVID 19.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 6

Armetta, Giovanna

Mispositioned Myonuclei Likely Contribute to Muscle Fatigue

Completed Project, Science, Health and Medical

Muscular dystrophies (MDs), characterized by progressive muscle wasting, are associated with 1 in 2,500 deaths in the United States. Although there are treatments that slow the progression, these disorders lead to early death usually due to cardiac or respiratory failure. Many muscle diseases are characterized by mispositioned nuclei within the muscle fibers that are thought to impair muscle function. It is unclear whether diseased muscles fail to function properly due to the inability of the affected myofibers to exert sufficient force, or if those muscles experience increased muscle fatigue more quickly. To address this question, we used *Drosophila melanogaster*, a model organism that is 60% homologous to humans, to more closely examine the locomotive behavior of mutant larvae. We either overexpressed or knocked down three critical genes known to be required for correct myonuclear positioning, *Bsg25D*, *dmyc*, and *Ran*, in the muscle tissue using the Gal4-UAS expression system to simulate instances of muscle disease. We then assessed the locomotive speed of the larvae and found that the muscle-impaired larvae not only moved slower, but they stopped more frequently than controls, suggesting that muscle fatigue is likely occurring. These data highlight an important distinction that has long eluded researchers and sheds light on the mechanisms that lead to muscle disease. With this information, we can now work towards identifying therapies, both genetic and physical, that specifically address improving muscle endurance instead of merely increasing a patient's range of motion to provide a better quality and prolonged life for affected individuals.

King School

Teacher: Victoria Schulman

Project # 7

Babajanyan, Aaron

Examining the Effects of Marine Plants on pH Levels of Sea Waters for the Mitigation Effort of Ocean Acidification

Completed Project, Science, Environmental

Ocean Acidification (OA) has been a recurring problem over the past 200 years; however, only recently has it become a topic recognized as a threat to ocean life and sustainability. The primary cause of OA is the CO₂ emissions from deforestation, burning of fossil fuels, as well as natural processes such as respiration and volcanic eruptions. The purpose of this project is to determine if the plant species in an area have a profound effect on the pH levels of seawater. The hypothesis is that if waters with specific oceanic plants living in them have higher pH levels, then oceanic plants can raise the pH levels of the ocean waters and mitigate OA. Data pertaining to oceanic plants indigenous in the New England region as well as the pH levels of the bodies of water will be recorded along with the location of the body of water. After this is conducted, a virtual map of the region, as well as the data recorded, will be created on Mapline. Through this project, a mentor will provide peer-reviewed journal articles, aid in data analysis, and the general organization of the project. Data trends thus far illustrate that eelgrass and seaweed lower pH levels of oceanic waters. The implications of this project are to potentially discover a more efficient and effective mitigation effort of ocean acidification to improve the outcome of this recurring problem.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 8

Babajanyan, Edgar

Reinventing the Virtual Voice Assistant to Improve User's Experience and to End User Data Tracking Edgar Babajanyan

Completed Project, Engineering, Physical Science

Every day, millions of people use a virtual assistant to help them throughout the day whether it's placing an order online or turning smart devices on or off through voice commands. User data such as location history, internet history, and even keywords from conversations are taken from users every time virtual voice assistants are used. These virtual assistants are very popular throughout the world and the companies that created these are able to store tremendous amounts of the user's information. Currently, there are no virtual assistants that don't manage user information to sell to other companies like advertisers. The main goal of the project is to create the same voice assistants people have today without any data tracked or logged anywhere. There will be a series of tests that will be done in a specific order. I will begin with the test involving the speed at which the virtual assistant can convert my speech into text regardless of the accuracy. The goal would be to have the virtual voice assistant process speech to text in 4 seconds or less. The next test would be to test the speed I receive an answer based on the command I gave. The goal would be to have the virtual assistant deliver answers in three seconds or less after processing speech. The last test would be to test the accuracy of its speech to text capabilities. The goal would be to have the virtual assistant deliver a high accuracy percentage when understanding the speech which would be ideally approximately 82% or higher.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 9

Bahel, Anchal

Analyzing if Racial Disparities are Present in Medical Device Advertisements for Total Joint Replacement

Completed Project, Science, Behavioral

Annually one million patients undergo total joint arthroplasty (TJA). Minority and obese patients are severely prone to osteoarthritis, but many are not undergoing TJA. The purpose of this project is to determine how medical device companies who produce the implants target their advertisements to specific patient populations. It is hypothesized that in various mediums of advertisements the target audience will not be minority groups. The independent variable is the type of advertisement and the dependent variable is the focus and target group of the advertisement. Data was collected from pamphlets, websites, website banner, and video advertisements of the top four medical device companies in TJA sales. Information on the race, sex, age, and weight of the model portrayed in the advertisement was collected. Pearson likelihood tests were used to compare categorical variables, including advertisement attributes and advertisement type. Of all advertisements collected, there was a lack of overweight patients and a lack of diversifying the advertisements, which are two groups more prone to TJA. Overwhelmingly, models were white, male, and of normal BMI which is not the demographic of those in need of TJA. Despite having high rates of osteoarthritis, TJA remains underutilized in minority communities. It is shown that direct to consumer advertising from US medical device companies do not accurately reflect the population in need of this surgery. This study will facilitate changes in medical companies' to target groups more prone to these treatments, while also motivating them to undergo TJA.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 10

Bahel, Piyush

Developing an Endovascular Construct to Correct Heart Defects in Children

Completed Project, Engineering, Physical Science

According to the CDC, approximately one out of every 2518 children are born with Tetralogy of Fallot (TOF). TOF is a heart condition caused by a combination of four heart defects that are present at birth. Of the defects, the narrowing of the passage to the lungs causes reduced blood flow leading to "blue babies". The only option is to enlarge this passage by a patch enlargement. This procedure requires open-heart surgery. This carries various risks such as bleeding, infections, strokes, and psychological and social challenges given the scar from surgery. Therefore, an endovascular construct that can be used as an alternative to open-heart surgery is desirable. In this project, the endovascular construct was created by manipulating a single unit provided by the mentor. This single unit was imported into a CAD modeling software. The unit was then edited by inserting multiple planes to split the unit into different parts. These parts were then used in an assembly and rearranged in an elliptical fashion. The construct has been developed and initial testing looks promising. The implications of this project is that the construct can be used in place of open-heart surgery, removing all the risks associated with this surgery.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 11

Balamurugan, Vishwa

Creating a System to Alert Pet Owners When Heat and Humidity Levels Increase to a Critical Level in Cars

Completed Project, Engineering, Environmental

From 2018-2019, 78 pets died due to heat stroke in cars (in the US). The reason why this happens is because they have a different way of cooling down. The environment inside a car can reach a point where they are unable to cool down, leading to heat stroke and death. The purpose of this project was to lower the pet deaths in cars through a system of a sensor and an app. The constraints of this project were the short test period for my sensor and my limited coding knowledge. The criteria that I had were that the sensor had to transmit data in real time and the app had to be able to both have a favorable UI and can display the data from the sensors. The app was created using Dart as the programming language plus Flutter being the framework for it. The sensor was created using a Raspberry Pi 3 computer and a DHT22 sensor. The project was tested by comparing it to a pre-existing system and I had let it detect the air temperature and humidity of my dad's car for 15 minutes. This was done for 15 days, and then compared the data to find any discrepancies between them both, and the data trends thus far favors my project. The implications for the project was that pet owners can be alerted of dangerous conditions in their car, which can lead to heat stroke and death to their pets.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 12

Barnett, Abby

Developing an Activated Carbon Cloth Filter to Reduce the Prevalence of Phosphates and Nitrates in the Long Island Sound

Completed Project, Engineering, Environmental

Excess amounts of nutrients enter storm drains and are directly deposited into the Long Island Sound. These pollutants carry harmful levels of nitrates and phosphates, which lead to the increased growth of algae blooms, and lower the dissolved oxygen levels, also known as hypoxia. With limited amounts of dissolved oxygen, marine life is deprived of sufficient oxygen levels, leading to a decrease in fish populations and the killing of ecosystems. It is hypothesized that with the introduction of an activated carbon cloth filter, strategically placed in storm drains, nitrate and phosphate levels will be reduced significantly. The effectiveness of the filter will be determined by measuring the concentration of these pollutants, in stormwater runoff, before and after the use of the carbon cloth filter. Last year a 70% reduction of phosphates and a 43% reduction of nitrates was experienced in my experimentation with simulated run-off. This year will consist of real stormwater runoff samples, and after introducing the cloth on a larger scale, it is expected that nutrient pollution entering the Long Island Sound will be significantly reduced by a factor of about 5%. Implementing this filter in storm drains across my community and beyond will remove nitrates and phosphate from stormwater runoff before they are dumped into the Long Island Sound. Nutrient pollution affects thousands of bodies of water across the country, and finding a solution to combat nitrate and phosphate overflow will create healthier water for marine life as well as humans.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 13

Beaudette, Mason

Designing a Ground Collision Avoidance System to Inhibit Controlled Flight Into Terrain Accidents For Single Engine Aircraft

Completed Project, Engineering, Physical Science

The goal of this project was to design a ground collision avoidance system (GCAS) where CFIT accidents can be identified before they happen as well as an app to provide telemetry data from the device. The GCAS software was flashed onto an Arduino Uno for testing purposes. Last year, to identify that a CFIT accident was impending, the code would do two things. First, it took 3 factors into account. Airspeed (knots), altitude, pitch (positive and negative). The 3 factors were supplied by the accelerometer, to determine airspeed, the barometer/GPS to determine altitude, and the gyroscope, to determine pitch. The data produced from the sensors during flight was fed into a prediction algorithm. This algorithm calculated when to alarm the pilot, if necessary. The existing system containing the Arduino, was added on to this year including Bluetooth compatibility. This Bluetooth allowed for an app to be made to go along with the device. This app included important telemetry such as airspeed, warnings, and altitude. Additionally, the app acted as a secondary flight logger as backup if the system goes down. The coding of the app took place using MIT app inventor and coding of the device took place using the Arduino IDE. Overall, with all of this R&D, the outcome was to provide a system that will be able to decrease CFIT accidents and make it affordable, smaller, and easily retrofitted for the general aviation enthusiast and also allowing for an accompanying app to aid pilots. This projection was proved and the device functions and highlights alarms sufficiently.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 14

Bhattamishra, Aditi

Developing A Smart Fluidic Servo Actuator for Use in Prosthetic Joints

Completed Project, Engineering, Health and Medical

There is a strong requirement for power-efficient, light-weight, low-cost smart actuators as technology advances. One area that requires such actuators are smart prosthetics. Commercial prosthetics are either low-cost, 3D-printed ones with limited functionalities, or are the most advanced bionic limbs, uncommon due to weight, power consumption and cost. A solution is needed to bridge this gap in cost/functionality, and this research is one attempt, by combining the efficiency of servos with the power of fluidic. The actuator was developed in two phases. Phase one involved designing actuators with various configurations and comparing them through models and simulations made/run in SolidWorks. The main data points from phase one were weight and cost. In phase two, a functional model of the most promising design was constructed. Using a generic servo controller, the actuator's torque, power consumption, and position control parameters were determined. This final actuator concept successfully weds the best of both fluidic motion and programmable control through low power usage, and fits the criteria established for a prosthetic, providing the adequate torque at less wattage and weight. It is also estimated to be within budget. This smart fluidic servo actuator technology will fulfill the general requirements for new actuator innovations for numerous applications. Specifically, it will greatly enhance modern-day prosthetics—by providing required joint mobilities with long duration usage capabilities at lower cost—directly improving amputees' daily lives.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 15

Bierowski, Mia

Engineering a Cheap and Effective Microfiber Filter for Washing Machines.

Completed Project, Engineering, Physical Science

Microfibers are synthetic fibers that are finer than one denier or decitex, and have a diameter less than 5 micrometers. They come from fabrics such as polyester, and when they enter our oceans they can have devastating effects. The goal of this project is to design an effective, cheap and simple microfiber filter that can be attached to washing machines. The filter will use a removable filter bag made with 0.5 micron material and different PVC adaptations. The cost of these materials will be under \$45. To test the effectiveness of each prototype, water from washing polyester/cotton fabric in constant loads will be collected and drained through the filter. The filter bag will then be removed and weighed, and the original weight of the filter will be subtracted from that amount to determine how much residue was collected. The data from testing each filter design suggests that the prototype using the PVC 1 ½" compression coupling was most effective. Because of the simple design as well as the slim structure, this prototype seems that it will work best in collecting residue as well as having water flow in and out of the filter without any leaks. Further implications of this filter is to make it fully attachable to the drainage pipes of the washing machine as well as making it applicable to the pressure of the water flow. Doing this will make it accessible to many people and putting an end to microfiber pollution.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 16

Bouton, Abigail

Optogenetic Stimulation of Neurons in the Brain to Treat Parkinson's Disease

Completed Project, Engineering, Physical Science

An estimated 60,000 Americans are diagnosed with Parkinson's Disease (PD) each year and 10 million people suffer from the disease worldwide. The root cause of PD is the degeneration of dopaminergic neurons in the substantia nigra (SN), leading to tremors and slowed movement. In optogenetics, light is used to stimulate or inhibit neurons expressing photosynthetic proteins. A micro-electrode array will be made using EasyEDA and DRGs will grow for several days. Blue and yellow light will then be used to stimulate the DRGs and black rock micro-systems will be used to measure activity. MatLab will be used to average signals and perform frequency analyses. The student hypothesized that optogenetics can be used to stimulate genetically-modified dorsal root ganglia (DRGs), therefore modulating their activity levels. In addition, increasing the pulse rate of the light source will directly correlate with activity levels of neurons. The current treatments of PD have many flaws. For example, electrical stimulation of the subthalamic nucleus through deep brain stimulation is invasive and the administration of the drug L-DOPA can have many negative side effects. However, due to its use of light and genetic methods, optogenetics is more precise and less damaging to tissue. If optogenetic stimulation can increase the activity of DRGs, then the activity of neurons in the SN will likely increase when optogenetically stimulated as well, which will increase dopamine production. If the hypothesis is supported, these findings may lead to better and safer treatments for PD.

Darien High School

Teacher: David Lewis

Project # 17

Boyar, Jacob

The Role of Signal Transducer and Activator of Transcription 3 in Regulating Anaplastic Large Cell Lymphoma

Completed Project, Science, Health and Medical

Anaplastic Large Cell Lymphoma (ALCL) is a rare subtype of T-cell lymphoma, comprising about 1% of all non-hodgkin's lymphomas. Chemotherapy has been found effective against ALK-positive ALCL, though patients with ALK-negative ALCL lymphoma often experience relapses and may need a stem cell transplant after remission. Our study sought to discover a potential method of preventing ALCL lymphoma from occurring through the master regulator protein Signal Transducer and Activator of Transcription 3 (STAT3). ALCL Lymphoma has been consistently correlated with the dysregulation of STAT3; thus, the goal of the project was to find target genes for the transcription factor STAT3 in order to properly understand the relationship between STAT3 and ALCL lymphoma. We first used Chromatin Immunoprecipitation followed by Sequencing (ChIP-seq) to determine where STAT3 binds on DNA. Afterwards, an Assay for Transposase-Accessible Chromatin with high-throughput SEQuencing (ATAC-seq) analysis was performed to discern which epigenetic mechanisms are in use on the DNA. ATAC-seq provides data on the chromatin accessibility in the genome, regardless of cause, and the areas of DNA with more chromatin are those being actively transcribed. Finally, RNA-seq was used to explore the genes whose expression changes due to STAT3 binding. When intersecting these three types of data and searching for Stat3, the potential target genes that are upregulated can be found. Future studies will focus on developing a method to control the production of STAT3 in order to lower the likelihood of developing ALCL lymphoma.

King School

Teacher: Victoria Schulman

Project # 18

Bulsara, Karishma

Comparing Frequency of Pediatric Cancer Survivors That Report Impaired Sleep to the General Population to See if They are at Higher Risk Post Treatment and Therapy

Completed Project, Science, Health and Medical

Despite high cure rates in pediatric cancer patients, high rates of late complications post treatment can also occur. One important complication, often overlooked, is sleep. The purpose of this cross sectional data analysis was to determine if pediatric cancer survivors are at greater risk for sleep disturbance. The hypothesis was that they would be at higher risk for sleep disturbance in comparison to age and sex match in general population. The risk is greater among those that have a BMI \geq 25, and/or had cranial radiation exposure; sex will not affect the risk. The control for this study was a population without cancer. The independent variables were the statistics of a person, including their sex, BMI, age of evaluation, and any history of cranial exposure. The dependent variable was their quality of sleep along with their frequency of sleep based on each of their groups. An important constant in this study was to make sure we are looking at similar types of cancer. Using published studies to gather data, I used that to predict frequencies of impaired sleep stratified by each of the predictor variables. We then compared them through a Chi Square test. My mentor assisted in analyzing data and making conclusions. Results could give a better understanding of how sleep affects survivors after treatment. Next steps are to find a method of intervention that includes routine screening for these complications as part of their clinical care.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 19

Cavallaro, Francis

Creating a Novel Opioid Overdose Detection Algorithm Using Smartwatch and Health Data

Completed Project, Engineering, Health and Medical

Prescription opioids are used to treat high levels of pain and if taken incorrectly, the effects can be devastating. Recently in America the misuse of such drugs has reached epidemic levels. The purpose of this project was to create an algorithm that analyzes a person's health in order to detect, warn of, and stop prescription opioid overdose. Heart rate, respiratory rate, blood oxygen, and sleep time were chosen to be analyzed for symptoms of overdose. Programming began in Python using the PyCharm IDE. The program contained inputs for each piece of health data as mentioned above as well as additional personal information. A set of checks was created to determine whether the person was overdosing, looking at whether the physical health data was set at unhealthy levels. If they were, a phone call containing the personal information was sent to specified phone numbers and the user was told to self-administer NARCAN (naloxene), the overdose reversal agent. A UI was created for Garmin devices as a model of what the app might look like. Data from published overdose cases was put through the algorithm to test accuracy. The algorithm shows promise as a warning system for overdose. Hopefully this research will encourage other projects to be done in this field, to prevent accidental overdose. Additionally, the data collected from smart watches could encourage health monitoring for other diseases, such as heart disease or possibly coronavirus. It could also help doctors better help patients remotely, especially in a new time of social distancing.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 20

Cavallaro, Grace

Determining the Effectiveness of Online Interaction in Providing Social Connection as a Substitute for In-Person Interactions

Completed Project, Science, Behavioral

During the Covid-19 pandemic, many people have been staying home to isolate, forcing them to interact online. The purpose of this experiment was to determine if online interactions can be substitutes for in person interactions while in isolation, and which types of online interactions are most effective. It was hypothesized that if the subject was to use a video call, he would feel a connection that is closest to in-person interaction because he would be able to hear and see the other person. The independent variable was the type of interaction. The dependent variable was the level of connection felt during the interactions. The method behind this experiment was gathering a group of subjects and splitting them into four groups: no interaction (the control), interacting using a video call, audio call, and text message. The participants completed a happiness questionnaire prior to the interaction. The subjects then participated in fifteen minutes of their given interaction. Directly after, they were asked to complete a similar survey to the first. The results were compared, and the interaction that showed the greatest connection shows which interaction is the best substitute for in-person socialization. The results support the hypothesis thus far. Not only will the results be beneficial to the general public, but they could also assist doctors in finding which type of online communication with patients will make the patients feel the most comfortable.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 21

Chalasan, Aditi

Development of a Low-Cost, Expandable Boot Aimed to Adjust to Multiple Sizes and Last Multiple Years

Completed Project, Engineering, Physical Science

783 million people are forced to live off of \$1.90 per day. There are only three expandable footwears currently being sold- all with prices out of the price range of the millions stuck in poverty. Plus, there are no expandable boots being sold for either men or children. This project's purpose is to develop a durable, waterproof boot that is expandable up to four sizes and affordable for those impoverished. In the previous year, a design was created for a full-coverage shoe expandable up to three sizes larger than its original size and with an estimated total material cost of \$23.96. To build upon this past project, this year the student improved last year's model. After determining materials totaling under \$35 and creating a design based off of the previous year's, the boot's outsole was designed. Then, a final technical drawing and 3D model run through a finite element analysis program was made. The student 3D printed (as a cheaper alternative)/got samples of parts of the boot. Design thus far supports the intended goal. These boots will allow those poverty-stricken to safely walk to daily tasks without paved roads. For adults suffering from conditions such as edema this boot can provide them comfort. Also, those unable to afford a college degree and turning to blue-collar jobs, the expandable boots will provide them with greater coverage and durability, allowing them to work safely in work areas often filled with debris, mud, etc.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 22

Chaudhry, Haseeb

Determining the Relationship Between Feedback and Time Perception

Completed Project, Science, Behavioral

Time perception is a fundamental concept and it is heavily under-researched. There are many factors affecting time perception that are not known. Understanding these factors can be beneficial to explore the ways people feel time pass. This study's purpose was to understand how different types of feedback affect the perception of time. I met with each of my participants online and gave them a google form with simple pattern questions. After every question they answered, I gave either positive, negative, or no feedback considering what experimental group they were in. I timed the participants during the task, and after completing it, I asked them to tell me how much time had passed. I then recorded the data and finished the experiment. So far, the data suggests that if someone receives positive feedback, they perceive time as going by quicker. This supports my hypothesis which stated that if the participant received good feedback, they would underestimate the amount of time that passed. The data also thus far suggests that negative feedback causes the participant to overestimate the amount of time passed. Understanding how different types of feedback affect time perception is very beneficial. First, it could contribute to the field of time perception research and we could further understand the factors affecting time perception. Knowledge is very important and gaining new knowledge is how we can progress. In addition, this could be beneficial in school exams, or medical procedures to make someone perceive time as going by faster.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 23

Chen, Cindy

The Effect of Cannabidiol on Metabolic Syndrome in Schizophrenia Patients

Completed Project, Science, Health and Medical

Metabolic syndrome (MetS) is a set of risk factors for heart disease and other issues. Symptoms include a large waist circumference, abnormal cholesterol levels, and high blood pressure and blood sugar. MetS is more prevalent in schizophrenics, and antipsychotics exacerbate the conditions. Cannabidiol (CBD), a non-psychoactive phytocannabinoid with cardiovascular benefits, affects the endocannabinoid system, which controls metabolism. The purpose of this study is to determine whether CBD treatment affects MetS parameters. Data from a previously completed clinical trial (double-blind, randomized cross-over design) was analyzed using within-subject comparison to assess CBD's effect over time. The measurements of metabolism and liver function were collected from schizophrenic participants taking CBD for one four-week period and a placebo for another. In this study, the data was analyzed to determine the magnitude of change and for which patients the study drug had an effect on. The hypothesis was that CBD treatment will result in improvement in metabolic parameters in schizophrenia patients in comparison to a placebo because CBD increases the levels of endogenous cannabinoids in the body, and the endocannabinoid system regulates metabolism. It was also hypothesized that CBD will not significantly affect liver function. MetS is extremely common in patients with schizophrenia, but most current medications worsen its parameters. Therefore, finding new medications that don't exacerbate the symptoms is imperative for the overall health of schizophrenics, as MetS is related to hyperglycemia, type 2 diabetes mellitus, diabetic ketoacidosis, dyslipidemia, sudden cardiac death, and other health problems.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 24

Chen, Evelyn

The Effect of Aspirin vs Salicylic Acid as Osmoprotectants in Plants Undergoing Drought

Completed Project, Science, Environmental

Stress, like drought, can make plants grow smaller, which lowers crop yield. Research has shown that salicylic acid can help the plant regulate osmotic adjustment, and it can improve stress tolerance in plants. Aspirin, when put into water, dissolves into salicylic acid and acetic acid, which means it might have a similar effect. The problem statement was what is the effect of aspirin vs salicylic acid as osmoprotectants in plants undergoing drought? The hypothesis was if bean leaves are sprayed with osmoprotectants, and put through drought, the treated plants will grow to be bigger than the untreated plants. The independent variable was the type of osmoprotectant. The dependent variable was the health of the plants, measured by size and color. There were two control groups: Untreated plants with enough water and untreated plants without enough water. The experimental groups were well watered plants with salicylic acid, plants undergoing drought with salicylic acid, well watered plants with aspirin, and plants undergoing drought with aspirin. The plants were treated with foliar spray containing either salicylic acid or aspirin dissolved in water. The beans were grown in pots with an artificial light source. Once the beans matured, they were measured and the color was noted. So far, data trends support the hypothesis. It is estimated that in the US, abiotic stress reduces the yield of agricultural crops by an average of 22%, so knowing more about how to lower the effect of stress will be important to people growing plants.

Amity Regional High School

Teacher: Catharine Piscitelli

Project # 25

Coale, Grace

Testing For the Presence of Antibiotics in Poultry

Completed Project, Science, Health and Medical

Antibiotics have been used in the past for every phase of the chicken-raising process, however, many poultry products today are labeled antibiotic free. The purpose of this study is to determine if the products are indeed antibiotic free. This is significant because antibiotics in poultry can lead to drug resistance in humans. It is hypothesized that at least 40 percent of poultry will contain antibiotics, even if labeled antibiotic free. To test for the presence of antibiotics in poultry, the Premi Test was used in several trials of popular and supermarket brands of poultry. A positive control, the antibiotic penicillin, and a negative control, poultry known not to contain antibiotics, were also tested. The independent variable is the type of poultry product tested, and the dependent variable is the presence of antibiotics. There has been a significant amount of mislabeling detected, meaning antibiotics were found in products that were labeled antibiotic free. Antibiotics were also found in products that did not indicate whether the product contained antibiotics. Overall, 50 percent of the 22 samples tested contained antibiotics, thereby supporting the hypothesis. This study will help raise awareness and help educate consumers when buying different poultry products. There were, in fact, antibiotics present in poultry products that do not have antibiotic information on the label or that were labeled antibiotic free, demonstrating that the consumer needs to be aware of the issue. An avenue of research that could be explored next is how the products that are labeled antibiotic free are contaminated.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 26

Calmon Coelho, Victor

Use of Accelerometers to Determine Gait Irregularity

Completed Project, Engineering, Physical Science

Examining a patient's gait can give more insight into the patient's condition. One method to assess a gait is through accelerometers. Gait assessments can be done with a motion capture camera, but a less invasive approach, such as accelerometers, would allow for broader use. The objective of this study is to differentiate gait irregularity through the use of an accelerometer. It is predicted that variations in step ground force and time between successive steps will identify gait irregularities. A square area will be set up with accelerometers lined up on one side of the square. A subject with no conditions will walk around the square simulating eight gait irregularities. Another trial will be run with natural gait as a control. The accelerometers will record ground force data. The ground force data will be analysed in MATLAB to remove background noise and manipulate the data. The data showed a clear difference between a normal gait's time between successive steps and that of a simulated gait irregularity. The ground force varied depending on each gait, but none closely modeled the natural gait. This will allow accelerometers to be used in a wider range of situations, such as home use. Home use gives more data, resulting in a better gait assessment. With more knowledge about gaits, medical professionals will be able to give better care, such as a physical therapist giving more specific treatments. Additionally, eventually accelerometers can be used to create a wearable gait assessor, allowing for widespread use.

Darien High School

Teacher: Pratt Guy

Project # 27

Connolly, Emma

Surveying Adolescent Public Opinion and Knowledge on Nuclear Energy

Completed Project, Science, Behavioral

Since nuclear energy was first used in the 1940s, the public has been divided in their views of the way it should be used. Today, great advances have been made in the use of nuclear energy, particularly fusion. It was hypothesized that most people surveyed will not know much about nuclear fusion and will show more opposition to nuclear fusion than support. The electronic survey was created and IRB approval was obtained. The survey, using the Likert scale, collected information about people's views on nuclear energy focusing on nuclear fusion. It was administered over Google Forms and was anonymous, asking only general information such as age and gender. The survey was administered to students within the Sacred Heart Network in the United States and approximately 200 students participated. Results demonstrated that most adolescents surveyed lacked knowledge of nuclear fusion. This was indicated by a question that asked if students wanted to know more about nuclear fusion, and 72.8% either agreed or strongly agreed with this statement. Also, a question asked if students felt they had enough knowledge to properly complete the survey, and 59.2% either disagreed or strongly disagreed. This survey updated public opinion on nuclear energy and get specific information on the public's, specifically adolescents', perception of fusion energy. My hypothesis was correct as the survey results demonstrated there was a lack of information. Advances have been made in the use of nuclear energy, particularly with fusion, and greater public awareness and education are needed.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 28

Cooper, Reed

The Effect of Various Ammonium Nitrate Concentrations on Phaseolus lunatus

Completed Project, Science, Environmental

Increasing temperatures in drought-susceptible regions, as a product of climate change, has harmed plants by accelerating rates of transpiration, or the evaporative process of water in plants. The ultimate consequence of increased transpiration in drought areas is the depletion of soil moisture and water in plant tissue, which causes many plants to become dehydrated and die. The experimental response to this issue explores the effectiveness of thermodynamic processes on transpiration in *Phaseolus lunatus* as a means of mitigating the negative effects of climate change. The final experiment utilizes small quantities of ammonium nitrate. Drought conditions are simulated for half of the plants with a heating mat regulated at 32°C. Several trials will be performed testing pH, presence of ammonium and nitrate ions, and rates of transpiration. The increase in concentration is expected to show an inverse relationship with rates of transpiration due to the endothermic reaction caused by the addition with water. Presence of ammonium and nitrate in each sample is expected to remain constant throughout the experiment. These results would provide insight into the development of methods for reducing the effects of climate change by means of allowing plants to gain a resistance to high temperatures and combating the exasperated evaporation of water in drought areas, thus giving plants the ability to survive in rapidly changing climates.

Joel Barlow High School

Teacher: Paul Testa

Project # 29

Correya, Sandra

Determining which Pathophysiological Mechanism of Atrial Fibrillation is Most Affected by Obstructive Sleep Apnea: Diastolic Dysfunction or Atrial Dilation

Completed Project, Science, Health and Medical

Obstructive Sleep Apnea (OSA) is a sleep disorder where the muscles at the back of the throat relax, causing a person to lose the ability to breathe for periods of time. Studies have shown that it has a connection with Atrial Fibrillation (A-Fib). OSA and A-Fib share many pathophysiological mechanisms that impact each other. The purpose of this project is to determine which mechanism of A-Fib is most affected by OSA, specifically focusing on diastolic dysfunction and atrial dilation. If the severity of OSA was analyzed, it was hypothesized that OSA would have a larger impact on diastolic dysfunction. The independent variable was the severity of OSA while the dependent variables were the pathophysiological mechanisms of A-Fib: diastolic dysfunction and atrial dilation. Data was collected from past studies and analyzed through statistical analysis, at home. The student experimenter collected and analyzed data while the mentor aided in finding studies and provided advice on the execution of the project. This project helps to create more awareness among patients about the complexity of the effects of OSA on each pathophysiological mechanism of Atrial Fibrillation. Additionally, this will help medical professionals to create improved treatment plans and provide multiple options for their patients. Studying the complexity of the conditions in mind, they can treat these conditions as well as help prevent them from occurring. As a result, this study has a dual benefit.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 30

Cummings, Audrey

Identification of Epigenomic Biomarkers for Cannabis Use in Humans

Completed Project, Science, Health and Medical

Cannabis use has significant adverse effects in health, however, the mechanisms of cannabis' impact on humans is unknown. Evidence suggests that cannabis may change the epigenome that is defined to regulate gene function without changing DNA sequence. Such alteration may influence gene function, causing DNA methylation, and could result in potential health problems. The purpose of this project was to determine how certain genetic markers react to cannabis use as a method to objectively identify use. The hypothesis was, cannabis users will have significant differences in DNA methylation biomarkers as compared to cannabis non-users. The independent variable was use of cannabis, determined when participants of the study completed an examination. The dependent variable was the change in genetic markers, data of which was collected in the form of DNA extraction with the consent of the participants. Since it was a comparison between users and non-users, there was no control. The raw data was already gathered before the project, so my role in the project was assisting my mentor with data analysis. The hypothesis test code was written as a multiple linear regression model using RStudio. Findings so far show a correlation between smoking and cannabis use. The implications of this project are gaining a better understanding of how cannabis use affects the epigenome and determining biomarkers to be able to identify cannabis users. Because current long-term identification of use relies on subjective measures of self-reported data, objective methods of evaluation will be more valid in analysis of cannabis use.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 31

Dillon, Avery

Making the Handle of a Surgical Stapler Accommodate More Surgeons

Completed Project, Engineering, Health and Medical

The purpose of this project was to design a device that would be attachable and detachable to the laparoscopic surgical stapler. The laparoscopic surgical stapler was proven to ergonomically accommodate only 33% of surgeons while trying to pull the trigger, 54% of surgeons while trying to push and release with the thumb, and 45% of surgeons to pull the articulation head. These data points include both men and women. In order to create this device, there were a few measurements of the articulation head that needed to be taken. This is where the device was designed to attach to. After the measurements were taken, the device was designed on a 3D-printing website. This device had to be modified multiple times in order to fit correctly. Lastly, the device was 3D-printed from TinkerCad and attached to the stapler. After completion, the device was shown to professionals and a survey was given as well. These professionals are surgeons at Griffin Hospital. So far, the data suggests that this device is useful and there weren't any further complications with the deployment of the staples. At the end of this project, a few points had developed. One of these points was that when made, the laparoscopic stapler was designed more for male surgeons than women surgeons. The device created in this project has helped that by making the function of the laparoscopic surgical stapler easier.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 32

Dillon, Taylor

Developing a Program to Increase Breast Cancer Patients' Communication with Caregivers

Completed Project, Engineering, Health and Medical

Millions of oncology patients worldwide suffer with treatment and repercussions of cancer. Breast cancer specifically occurs in one in eight women over the course of her lifetime. Communication between cancer patients and doctors has become increasingly difficult due to COVID-19. This is the second year of this project, designed to increase online communication, continuing research from last year. Last year, a general Cancer Distress Tool was analyzed and modified to fit specifically to breast cancer patients; this included changing five core categories, over both physical and physiological health. The completed tool is now being used at Griffin hospital. The research done this year was to find a way to make this form available to patients mobility. Limitations for this year included cybersecurity restrictions. It was hypothesized that a clearly organized online Distress Tool will result in communication being more efficient and more frequent because of mobile access. First, a program titled Do Forms was found, it already complied with HIPAA requirements. Then, the information in the Breast Cancer Distress Tool was programmed into Do Forms to create an online version of the Distress Tool. Lastly, the form was tested using Dr. Joyce Chung's secured email. Adjustments that needed to be addressed were then modified. This program was proven to be an effective way of online communication by Dr. Chung. In the long run, it will decrease the amount of office visits patients need, saving oncology patients and doctors time and money, providing overall quicker and more efficient cancer treatment.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 33

Fleming, Liliana

The effect of changing the materials of shooting strings in a women's lacrosse stick on velocity

Completed Project, Science, Physical Science

All lacrosse sticks consist of a head and a shaft. The head is strung with various strings. They can be made out of different materials, but typically they are nylon and polyester. The different strings used are shooting strings, sidewall, crosslace, runners, top string, and bottom string. The purpose of this project was to determine how different shooting string materials affected the velocity of a shot. The independent variable was the materials of the shooting string. The dependent variable was the velocity. It was hypothesized that if the material of the shooting string was sidewall it would have the slowest velocity and if the shooting string was hockey lace then it would have the fastest velocity. For the process the shooting string was restrung and three shots were taken. Then the stick was restrung again with a different material and three more shots were taken until this was done with each material. This was done seven times so there was a total of 21 shots for each material. The data was collected by using a velocity/speed gun to determine the velocity of the ball. Once the data was collected the averages of the data were compared to see which material worked best for getting the best velocity. Data trends thus far disprove the hypothesis. This research is important because it can help people determine what material would help them get the best velocity.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 34

Gopal, Alesandro

Creating a Genetic Algorithm to Minimize the Damage of Wildfires

Completed Project, Engineering, Environmental

Forest fires are killing and harming wildlife, altering the cycles of water and soil fertility, threatening the lives of local residents, and impacting the ecosystem in general. Around 64k wildfires and 6.8m acres burned annually (Wildfire Statistics, 2020). A genetic algorithm, which is a computer program, is a search algorithm based on natural selection. There are multiple creatures and each creature is an object, with a set of genes. The project was coded in Unity's C#. The first section created was the wildfire simulation. From there, a genetic algorithm was created and implemented into the simulation to determine the effect a starting condition has on the overall path of the fire. This was done in order to produce accurate simulations with little data. Subsequently, a genetic algorithm produced which trees should be removed in order for the fire to be stopped. To analyze the output data of all the simulations, real-world data was used for comparison. This outputted the tree accuracy for each step of the simulation. The validity of the mitigation genetic algorithms' solutions is based on the accuracy of the wildfire simulation. Furthermore these solutions are the most optimized way of blocking and suppressing a wildfire. All simulation data was recorded to a file that is accessible for study. Overall, the project simulates wildfires and then makes recommendations on how to mitigate them effectively. This project aids in fire management and the safety of people, wildlife, crops, and forest.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 35

Griffith, Isabel

Studying the Behavior of Dogs in Relation to COVID-19

Completed Project, Science, Behavioral

When it comes to dog behavior, it is a common topic of research today. However, a global pandemic recently hit the world, bringing many unknowns into the playing field. It is believed that dogs will mimic the behavior and emotions that their owners show. The question at hand is whether or not during these unprecedented times, dogs have changed their behaviors because of abrupt routine changes or more stressful environments. A google form was created with various questions that people across the state, country, and world had the ability to fill out for a period of time. These questions consisted of ones that asked about observations of their dog's behaviors and any noticeable changes that have occurred since March of 2020. This form was posted to various groups on Facebook and sent out through email. Since it is not uncommon for dogs to be affected by changes in environment, the results reflected the following. The ones with the greatest changes in their daily routines were found to have behavioral deviations such as increased aggression, sleeping for longer periods of time, lack of appetite, etc. Additionally, the dogs with the least amount of change due in part to the pandemic had the fewest shifts in behavior. The research that was performed is important to better understand animals that are prominent in many people's lives today. These findings can also bring change to how dog training works because it can allow for trainers to work with dogs in high stress situations that could be encountered in their environments.

Ridgefield High School

Teacher: Ryan Gleason

Project # 36

Gross, Ava

Comparing Bone Integration From One Dental Implant System to Another by Evaluating Bone Loss Over Time in Healthy Patients

Completed Project, Science, Health and Medical

When a patient loses a tooth, a dental implant, a titanium screw, is needed to replace it and retain the shape of the mouth. The implant osseointegrates with the bone in the mouth. The purpose was evaluating the bone loss over time in two types of implants, 3i and Astra, in healthy patients. Healthy patients do not smoke, have diabetes, or peri-implantitis. Anyone with these conditions was excluded to not skew the data. This is a second year project, so the data from last year was used too. The x-rays were provided by the student's mentor, Dr. Thomas Duplinsky, resident advisor and general dentist at the Yale Dental Residency program. It was hypothesized that the implant brand with the least amount of bone loss in healthy patients was Astra. The independent variable was the implant brand and the dependent variable was the amount of bone loss over time. The constant was the program used to assess the bone loss. To evaluate it, the program Eagle Soft was used and measured by the measuring tool. The tool was calibrated to the length of the implant, specified in the patient's file. The amount of bone loss was divided by the total length of the implant to calculate the percentage of bone loss. The percentage of bone loss over time was compared across both types of implant brands. The data was also run through a Z-test for analysis. The data enables dentists to pick the most effective implant for their patients.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 37

Grosso, Nicole

Determining a timeline for conservation efforts towards ocean acidification in locations in the Atlantic Ocean

Completed Project, Science, Environmental

Since preindustrial times, ocean acidification, the reduction of the pH of oceans, in the planet has increased by about 25%. Ocean acidification(OA) is detrimental to many marine species, namely shellfish. The purpose of this project was to determine which locations conservationists should focus efforts to reduce ocean acidification most immediately. The hypothesis was that if an area is closer to the coast of the US, then it will need more immediate attention to help lower OA levels, because pH is generally lower closer to the shoreline. The independent variable was location and the dependent variable was the time and severity of expected pH change. Controls in this experiment included data analysis methods and data collection methods. Data was analyzed from probes in various locations to determine areas most at risk with increasing OA through the use of pivot tables and other analysis methods. Physical environments of the different locations were taken into account to determine what mitigation methods were most appropriate. As previously mentioned, ocean acidification is on the rise and poses a threat to marine ecosystems as shellfish cannot support the calcification necessary for their shells. Some mitigation strategies have been found successful, such as the introduction of seagrass and other marine plants that use the CO₂ in photosynthesis and iron fertilization (the introduction of iron into the water). This project determined a timeline for conservation efforts in different locations and gave suggestions for which mitigation strategies to use in each given area.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 38

Gu, Emily

Using Alfalfa (*Medicago sativa*) to Remove Heavy Metals from Contaminated or Polluted Soil

Completed Project, Science, Environmental

Heavy metals are elements that have a high atomic weight and are at least 5 times denser than water. They occur naturally in the environment, but anthropogenic activities such as manufacturing, burning fossil fuels, and failure to dispose waste properly has led to greater distribution of heavy metals in the environment. The heavy metals tested for in this experiment were Lead, Mercury, Nickel, Arsenic, Chromium, and Copper. All of them except for Copper are heavy metals that are highly toxic and can cause adverse health effects to any organism who is exposed to them. Copper is vital for life in small amounts, but too much exposure can be harmful. Alfalfa (*Medicago sativa*) is a hardy, fast-growing, perennial plant that can grow in a variety of climates. It has an extensive taproot system that can reach several meters underground, which makes it a plant to consider for soil phytoremediation. The alfalfa was grown in bins of soil from four different locations. The growing conditions of the plants were kept constant. The soil was tested multiple times regularly to track the levels of heavy metals as the plants grew. The data suggests that alfalfa can grow in soils that have been contaminated or polluted by heavy metals and draw out those heavy metals. The determination of whether alfalfa can grow in polluted soil and if the plants can decrease heavy metal levels or not is important because it can show if alfalfa can be used for phytoremediation of polluted and contaminated soil.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 39

Hall, Aidan

Bacterial decomposition and consumption of PET plastics as a sole metabolic energy source

Completed Project, Science, Environmental

The purpose of this experiment is to identify the decomposition of PET (Polyethylene Terephthalate) when exposed to the bacteria *Ideonella Sakaiensis*. Due to the large issue of plastic waste and plastic pollution throughout the world. The goal of this experiment is to provide a possible new insight into new recycling methods. In this experiment, PET plastics will be used as a substrate for the bacteria *Ideonella Sakaiensis*. This bacteria will be used to identify the degradation of the plastic substrate. Degradation will be measured by massing the PET substrate in each trial, prior to applying the bacteria and after each trial has been conducted. The mass of each PET substrate will be the same. It is believed that at the conclusion of conducting research, at a minimum, some of the PET substrate would display degradation. Due to the limited baseline of information pertaining to the degradation of PET from this particular bacteria the expected results have substantial room to vary. However, it would be beneficial if substantial degradation was displayed in order to set up a strong baseline for future research. This research will hopefully be useful in determining alternative methods for recycling and bioremediation. After a cross-analysis of data from this research other methods of recycling PET plastics, we will likely have a better understanding of *Ideonella Sakaiensis*, and will be found a possible long term use for it in plastic waste applications in the future. The use of this bacteria in recycling plants and landfills as a bio remedial measure could be done as future research.

Newtown High School

Teacher: Timothy DeJulio

Project # 40

He, Angela

Examining Risk-Aversion Decision Making in Competitive Environments Throughout Multiple Generations

Completed Project, Science, Behavioral

Different generations in the United States all had different upbringings, as they grew up in different societies that have changed each generation's behaviors. The purpose of this experiment was to determine how societal changes affected each generation's willingness to take risks under the pressure of competition, as at the point of experimentation, not much research had been done on this topic. The initial hypothesis was that this experiment would show Generation Y as the least risk-averse competitively, and the opposite for Generation X. The independent variable was the generation the participants identify with (X, Y, or Z). The dependent variable was risk-aversion decision making, measured through two required tests. The quantitative test required the participant to complete a "choose your own adventure" activity where they were asked to choose between one "safe" and two "risk" options in order to gain more points than their simulated opponent. The "safe" option gave them a guaranteed amount of points, and choosing the correct "risk" option gave them even more. In the qualitative test, participants used a 5-point Likert scale to explain how they felt during the quantitative test as well as how much they relate to their generation's stereotypes. The results from the experiment were made by comparing results between generations, as there was no control group. Data thus far supports the hypothesis. This data allows relationships between behavior and upbringings to be made, creating a safe and efficient work environment. Further, educators and guardians can use these relationships to shape future generations.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 41

Hebbar, Shreya

Effect of different types of Media on Empathetic Behavior

Completed Project, Science, Behavioral

Elements in narrative fiction can foster empathetic development through transportation into a story. Transportation occurs when an individual experiences high imagery, and is emotionally impacted. Components of empathy include affective empathy (capacity to respond with the correct emotion), concern for others, emotional contagion, and perspective taking. The purpose of this experiment is to identify whether viewing a narrative fiction film or reading a short story lead to a greater level of empathy. The film and reading was based on the same story: "The Man Who Planted Trees" by Jean Giono. One group of college students provided by my mentor, received the reading while the other viewed the 30 minute film. Each participant answered some simple comprehension questions to confirm their understanding, and then assessed their empathy using 4 different questionnaires. They played a round of dictator game to assess their prosocial life, completed a narrative engagement scale, a character identification scale, and finally the interpersonal reactivity index which has four subscales, each measuring a separate aspect of empathy. So far data has shown that the fiction reading led to a higher measure of prosocial life, participants were more engaged with the film, and nonfiction scored higher in overall empathy. In today's day and age with more online interactions, it is important for students to be able to connect with others and grow healthy relationships. Film makers and story writers can also continue to develop their characters to encourage empathy through transportation, which can translate into real life behavior.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 42

Hillenmeyer, Samuel

The Electrochemical

Completed Project, Science, Environmental

With carbon emissions of over 36 billion tons per year, the climate change crisis is expected to increase in severity over the coming decades. Methane, an extremely potent natural gas, is emitted into the atmosphere in larger quantities each year. While industries often flare this methane to oxidize it into carbon dioxide (a much less potent gas), these emissions are still harmful to the environment. To ameliorate this issue, this project aims to devise a fuel cell that will convert oxidized methane (CO₂) into non-polluting carbon products such as baking soda (NaHCO₃). Simulations were run using COMSOL v5.5 (modelling software) to determine optimal conditions. The optimal inlet pressure and NaCl inlet concentrations that reduced the overall emission of CO₂ and maintained charge neutrality in the fuel cell were found to be 7000 Pa and 2 mol/m³, respectively. These important conditions identified herein can be used by future scientists to optimize a carbon sequestration fuel cell that will eliminate carbon emissions and generate additional power from the methane oxidation process. This fuel cell will become widely implemented throughout the world. This will in turn significantly mitigate climate change, a pressing issue that our world currently faces.

King School

Teacher: Victoria Schulman

Project # 43

Hisiger, Luke

Analysis of regenerated mouse digit tips following modulation of Amphiregulin expression

Completed Project, Science, Health and Medical

Axolotls, humans, and mice all possess the areg gene. There exists a correlation between increased areg expression and decreased regenerative capabilities in axolotls. Humans and mice do not have the same regenerative capabilities as axolotls. However, mice and human children can both regenerate their digit tips. The purpose of this experiment is to determine the effect of a lack of areg expression on mouse digit tip regeneration. I used ImageJ software to determine the area of the regular and contralateral regenerated triangular digit tip bones in mice both with and without functional areg genes. The area of the regenerated bone was divided by the area of the control bone. The percent changes were compared between the mice with and without functional areg genes to determine the effect of the gene on bone regeneration. A functional areg gene and thus a presence of amphiregulin leads to increased effort and resource devotion to healing rather than regeneration. This means that regenerated digits in mice with a functional areg gene will be more similar in size to the control digit than in mice without functional areg genes. Regeneration in humans is very similar to mice. Additionally, both species have the areg gene with similar functions. This means that an areg gene knockout in humans may increase regenerative ability when necessary. By enabling humans to regenerate themselves, certain tissue damage conditions may be treated or even completely healed.

Ridgefield High School

Teacher: Ryan Gleason

Project # 44

Hofstatter, Gregory

Designing an Automatic Ski Decelerator

Completed Project, Engineering, Physical Science

When many novice skiers begin to ski, many do not know how to stop, especially children. Not knowing how to stop poses a risk to other skiers, bystanders, and the out-of-control skier. Currently, the solutions that exist do nothing to bring the skier to a full stop automatically. The purpose of this project was to design a device that was attached to a ski to decelerate and stop a skier who is unable to stop on their own. The velocity of the ski was measured and recorded by a Raspberry Pi. When the speed of the ski passed the set speed, flaps on the back and sides of the ski flipped down to steadily slow down and eventually stop the ski. The Raspberry Pi was programmed with Python. In addition, a speaker connected to the Raspberry Pi plays a loud beep as an additional safety precaution. The ski was tested on an incline with a weight attached in order to accurately simulate an actual situation. Thus far the data suggests that this device was successful and was able to stop the ski. In the future, these skis could be used to make sure beginner and novice skiers have a positive skiing experience and not be a danger to themselves and others on the ski slope.

Amity Regional High School

Teacher: Nicholas Champ

Project # 45

Huber, Alejandro

Creating a Slim Custom Steering System for Air Launch to Orbit Rockets Utilizing Fin Rotation

Completed Project, Engineering, Physical Science

Air-Launch to orbit is a methodology of launching rockets, which consists of a small rocket attached to the plane. However, a complication when designing an Air-Launch to orbit rocket is the problem of size. When a rocket is too huge, it complicates the separation between the aircraft and itself, sometimes making it unlaunchable, as the aircraft can only be so big. Creating a system to steer the rocket utilizing vertical fin rotation could potentially lessen the weight of the rocket, by removing some of the major components that would be present. This system used three 3D printed trapezoidal fins with servo motors and hinge joints attached. The Arduino UNO held the code, and was linked to a HC-05 which received signals from my android device. All components were held in the rocket body (3D printed). To evaluate my system, I built a wind tunnel to simulate the effect of wind. I placed a camera directed downwards at the rocket, which recorded the distance in a 2 second time frame. By dividing distance by time, I was able to measure the speed of the rocket changing directions, and visually see the effects of vertical rotational fins. Data thus far suggests that the vertical fin change in rockets affects the trajectory of the rocket. The more angled the fin is mid trajectory, the more it changes direction. Implying this into society is relatively easy, because of the need for a small steering system, making Air-Launch to orbit rockets more efficient and reliable.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 46

Jain, Simran

The Effect of GERD on Children in Contrast to Adults

Completed Project, Science, Health and Medical

Gastroesophageal reflux (GER) is one of the most common gastrointestinal disorders in children. In some cases GER can persist, and it becomes Gastroesophageal reflux disease (GERD). 2-8% of 3-18 year olds experience GERD symptoms. Children experience symptoms like a dry cough, asthma symptoms, or trouble swallowing, which are different than those adults experience. The research question was, how does GER affect children differently than GERD does adults? The independent variable was the ages of the patients, and the dependent variables were esophagus thickness, weak LES, and acid concentration in the patient's stomach. The groups were, adults ages 18-60 years old, children ages 3-18 years old, and toddlers 12-24 months old. The adult group was the control, the two children's groups were the experimental groups. The data was taken from endoscopy, esophageal manometry, and pH monitoring results. An ANOVA test was run to determine the relationship between the independent and dependent variables. The mentor helped by providing scientific journal articles and access to that data that will be used, and any other help whenever necessary. The mentee analyzed the data and form conclusions. Children with GER experience different symptoms than adults because they may have thinner esophaguses, weaker lower esophageal sphincters, and higher prevalence of acid in their stomach. The implications of this project are it will establish a relationship between symptoms of GER in children and adults.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 47

Kadimi, Srilekha

The Effect of Genotype of DOT1L On Cell Division

Completed Project, Science, Health and Medical

DOT1L is a gene linked to active gene expression, but its mechanisms in cell division remain unknown. The purpose of the project was to determine what effect the genotype of DOT1L cells has on cell division. The IV was the genotype of DOT1L (wild type vs. mutant). Wild type cells are cells with DOT1L and mutant cells are cells without DOT1L. The DV was the fraction of abnormal cells. It was hypothesized that DOT1L is involved in controlling cell division via expression of pericentromeric repeat sequences. The mentor acquired a series of microscopy images for DOT1L wild type cells and knockout cells. The student examined these images and classified each dividing cell into 'normal' or 'abnormal' appearance. The student then quantitated how many cells were normal vs. abnormal in wild type compared to knockout cells. The student tested if there was a statistically significant difference in the fractions of cells with abnormal mitoses using a Fisher's Exact Test. The data was also separated based on specific types of abnormalities: chromosome breaks, chromosome fusions, and premature centromere separation. Similar statistical analyses were run on these groups. Data thus far has shown that there are more abnormalities in DOT1L knockout than DOT1L wild type. This project will provide new insights into the molecular function of DOT1L. Better understanding how DOT1L functions will help design better drugs targeting DOT1L and also predict which patients will respond best to DOT1L inhibition.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 48

Kim, Youngsu

Determining the Growth of Alyssum When Exposed to Different Fruits That Produce Ethylene Gas

Completed Project, Science, Environmental

Efficient plant growth has become more vital due to the rise of plant care in homes. However, some fruits have shown to have negative effects on the growth of plants. The purpose of this project was to determine the effects of ethylene producing fruits on plant growth. For the experiment, alyssum seeds were placed in a 6 inch pot with soil filled up $\frac{2}{3}$ of the way. The seeds were germinated and took about 3 weeks until the plant was ready for testing. Once the seedlings were formed, each pot was placed with fruits (Apple, pears, bananas, and apricots) in a plastic container. The container (about 8x10 inches) had holes on the top for air flow and prevented exposure of ethylene to another plant. Over the course of 2 months, the plant was taken care of. When the first fruit started to rot, all fruits were replaced with a new one to prevent any other variables. Every 4 days, pictures of the plant were taken and the height of the plant was measured with a 30 cm ruler which was recorded in a data table. The data trend suggested that apples had the most negative effect because too much ethylene can affect regulation of plant growth and damage chlorophyll, thus damaging the plant and causing premature growth. By determining the results, people can be more alerted in order to perform efficient plant growing and provide a better environment in their houses.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 49

Krukar, Jade

Creating a distributed denial-of-service attack mitigation system using SYN cookies to ensure access to crucial election information

Completed Project, Engineering, Physical Science

Websites containing crucial election information such as voting methods and candidate profiles are popular during election season. Because of this, these websites are often targets of cyber attacks that prevent the websites from running correctly in attempt to influence voters. The use of SYN cookies is a strong but overlooked method of mitigating these attacks. The purpose of this project was to create an attack mitigation system using SYN cookies. My solution was to create an Anycast DNS system to spread attack requests throughout multiple IP addresses, using SYN cookies to protect the server queue. The program was written in C++. It replies to SYN requests with SYN-ACKS which prevents the SYN queue from filling up. The mitigation system was tested against an open source DDoS SYN attack and evaluated by how quickly it could recognize and then mitigate attacks. My results show that a mitigation approach using SYN cookies recognizes and mitigates attacks faster than the common mitigation system. The program can be used to strengthen election websites and secure the fairness of the election. It can also be used for many other websites in need of a DDoS attack mitigation system. The program can strengthen the safety of all websites.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 50

Kucher, Nadia

Deep venous intervention surgeries for lower extremities in out-patient offices do not create additional complications compared to hospital setting

Completed Project, Science, Health and Medical

Approximately 30 million Americans suffer from chronic venous insufficiency. Although many may not realize this because of the variety of the symptoms, this means that the blood that flows to one's extremities is unable to travel efficiently. The symptoms can be as mild as some swelling, to as serious as ulcers that can get infected, and in some cases, lead to amputation. Though extreme, there are interventions that can be done to help reverse these effects by restoring proper blood flow. These procedures require a catheter to be inserted into the patient's veins, so that either a balloon can be used to inflate and eliminate the blockage, or so a stent (metal cage) can be used to hold the vein open, allowing the blood to properly flow. Although these are simple procedures, there is persistent fear that it is not safe to have these procedures performed in an outpatient setting and that hospital settings are safer options. However, out of 539 selected patients, we found that there were no hospitalizations within 6 weeks of the procedure in an outpatient setting, indicating that the procedures are safe to be conducted in the outpatient offices, as well as hospitals. Thus, our study shows that patients should now feel comfortable having their procedures done outside of a hospital. With the increased risk of catching a variety of different viruses and infections in hospitals, not only do procedures in an outpatient office remove this risk, but the procedures do not pose additional risks.

King School

Teacher: Victoria Schulman

Project # 51

Kulkarni, Avani

Testing Different Household Spray Solutions On Preventing Fungal Growth On Food

Completed Project, Science, Environmental

Power outages leave thousands of homes without running refrigerators, and causes fungal growth on stored food. Food waste causes excess expenditure and, when dumped into landfills, contributes to global warming. To combat fungal growth, white distilled vinegar, baking soda, citric acid, and 3% hydrogen peroxide, which are all safe to consume (hydrogen peroxide must be diluted) household chemicals, were tested. The independent variable was the solutions sprayed; the dependent variable was amount of fungal growth. Constants were the amount of food ($\frac{1}{4}$ cup) and amount of solution ($\frac{1}{4}$ teaspoon). The control groups were food not sprayed, and sprayed with water. Pasta and lettuce were used as common models of foods wasted. Placed in airtight containers, each was sprayed with one solution, and fungal growth for seven days was measured. Data trends thus far show that hydrogen peroxide was the best solution at preventing fungal growth because it is the most acidic solution. The other solutions, such as citric acid and baking soda were weaker and therefore, making a hydrogen peroxide spray would prevent fungal growth on foods. The implications of designing this spray are less food is thrown out because families can now use their own sprays. Since it is made of household chemicals, most people have access to them. This in turn helps families save money and waste less on food that is wasted due to fungal growth, and the environment benefits from less food releasing methane in landfills causing global warming.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 52

Lapierre, Lucca

Bird Identification Software Using Python and Keras CNN

Completed Project, Engineering, Physical Science

Bird watching is a popular hobby among many but being able to identify birds out in the field or from a picture can be challenging for those with less experience. The goal of this project is to design a bird identification software using a deep learning model called a convolution neural network. This software will allow the user to input a photo of a bird and have the software output the name of that specific bird. The convolution neural network will be designed in Python along with the Keras deep learning library. A dataset of images published by Caltech which has 200 bird species across 11,788 pictures will be used to train, evaluate, and test the software. The training dataset of images is used to create the software and establish certain parameters, while the validation set is used for fine tuning of these parameters as well as accuracy evaluation. Putting the test data through the software will be the last step in the process and provide an unbiased evaluation of the software's accuracy. The hope for this project is to have a bird image identification software that can identify birds with 90% or more accuracy. This software can be used by beginner bird watchers looking to perfect their identification skills. Future work regarding the use of this software will be fabricating a bird feeder with an integrated camera which will record video of a bird then send a still frame of the video to a Raspberry Pi for identification.

Newtown High School

Teacher: Tim Dejulio

Project # 53

Lavi, Ethan

The Role of Gene Expression of Non-Homologous End Joining Pathways in the Progression of Ovarian Cancer

Completed Project, Science, Health and Medical

Double Strand Break DNA Damage is repaired by error-prone NHEJ pathways. In NHEJ, the high level of mutations that can result from these processes serves as a double-edge, both being able to damage the cancer but also giving it potential to further the cancer's resistance to treatment. It is hypothesized that NHEJ gene expression plays a significant role in the tumor's progression. The purpose was to determine how genes involved in NHEJ have an impact on the treatment of ovarian cancer and to what extreme. The independent variable was a complete list of the most significant genes currently known to be involved in NHEJ, compiled by literature research. The dependent variable was the individual patient's tumor progression, classified by the length of survival per patient. Ovarian cancer HTSeq-FPKM files (normalized gene expression data) were extracted from the TCGA database, with the aid of scripts programmed to automate this process. The gene expression and the patient's survival time was recorded into a table. Multiple ways were used to analyze the data. Furthermore, a machine learning approach was utilized for recognizing patterns in gene expression and survival time. It was found the upregulation of NHEJ genes play a significant role in the recurrence of tumors. An analysis of the weights of the machine learning model was used to determine the most impactful genes on the tumor progression. Determining the most significant genes in cancer's progression will aid in creating more effective treatments as well as providing possible biomarkers for predicting resistance.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 54

Lee, Ian

The Effect of Different Species of Isopods on. pH Level of Soil

Completed Project, Science, Environmental

The environment is becoming polluted. There are ways to fix it, and isopods may be a solution to help this process. They could help in making the pH of soil more healthy. Purpose of the project is to see the degree of effectiveness isopods have on the pH of soil. There were 10 isopods from species "White Dwarf," "Zebra," "Powder Oranges," and "Dwarf Purple". 6 quarts Sterilite Containers were used, potting soil, one apple slice and 2 leaves for food. Temperature of each habitat was between 15 to 19 degrees Celsius. Habitats were checked every day for possible consequences. Isopods were disposed of after the experiment concluded. Testing of pH of soil was done with Rapitest Soil Testing Kit. Soil from under the food was taken and used to measure the pH of it. Then, the data was filled in and pictures of the pH were taken for reference. This went on for around 2-3 months. Data trends show that pHs of most soils were relatively similar. There were some differences in the pH of the soil, but nothing significantly different in it. Data suggests that isopods from "Powder Orange" seemed to do slightly better than others due to being most active. These results help see if isopods are viable in upping pH of soil, thus making it more healthy. By this method, the Earth can become healthier.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 55

Lee, Owen

Studying the Effect of the COVID-19 Pandemic on Adolescent (High School) Sleep Schedules

Completed Project, Science, Behavioral

Did the pandemic, if at all, affect adolescent sleep schedules (quantity and quality) both in general and within the differing school days (online and in-person)? The motivation for this study was to see what effects the pandemic made on things that are not as obvious, such as any sleep schedule changes. Consent forms were constructed and distributed. A survey was created that assessed sleep patterns before the pandemic and what their sleep patterns are now. This included their day to day sleep habits depending on whether they are attending school online or in person, and questions on their stress levels throughout the day, to test if this also had an impact on sleep quantity/quality. It was found that the pandemic created a negative effect on both amount of sleep and quality of sleep. The implications of this study are to inform adolescents and their parents about their sleeping habits and how, if a significant impact is found, it may affect their overall health. In doing this, the study can create awareness to adolescents about what their current sleep schedule is, and what it actually should be. And though the sample size is small, this study could give society an idea on how the COVID-19 pandemic and any other potential pandemics affect society's sleep patterns, which could ultimately lead to a larger study.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 56

Levinson, Nicholas

The Landscape of Fear of Squirrels in Urban and Rural Environments

Completed Project, Science, Environmental

Humans are expanding their area of use at a rapid rate that is only increasing. There is little research on the effects of human developments on the Landscape of Fear (how much they fear predation) in foraging animals. The variation in giving-up densities of *Sciurus Carolinensis* in urban and rural environments will be tested. Rural environments should have a higher giving-up density than their urban counterparts. Trays were placed at 0, 10, 20, and 30 meters from a tree line into an open field. The trays were filled with sand and 500 grams of whole corn. The squirrels were allowed to forage from sunrise to sunset for four days at each site. A conditioning period of two days where no sand was added was used to allow the squirrels to become acclimated to trays and food. It was found that rural squirrels had a greater giving up density than urban squirrels. On average, the 30 m tray for the rural population had 486.25 g remaining while the urban population had 310 g remaining. The rural population showed a greater difference in giving up density in between trays. The findings in this experiment show that human developments are having an impact on the foraging behavior of animals. As humans continue to develop, minimizing the impact that our developments have on these behaviors should become a greater priority.

Darien High School

Teacher: Guy Pratt

Project # 57

Li, Jason

The Effects of Various Seagrasses on the pH Level of Saltwater

Completed Project, Science, Environmental

The ocean absorbs carbon dioxide from the atmosphere, and as a result, the pH level increases. Ocean acidification is a major problem in the world, and it harms many organisms. Seagrasses are able to remove the carbon dioxide before it lowers the pH. The purpose of this research was to determine which seagrasses could increase the pH the most. Three experimental groups and one control group were set up. Each experimental group had a different sample of seagrass (turtle grass [*T. testudinum*], shoal grass [*H. wrightii*], and manatee grass [*S. filiforme*]). The control group had no seagrasses. I measured the pH level every 48 hours and took a photo of the qualitative results. Thus far, there have not been any distinguishable trends, and there have been no significant differences between each group. The seawater is currently maintaining a pH level of 7.8. If seagrasses can increase the pH level of saltwater, it could potentially offer a way to deal with ocean acidification, as well as a way to deal with climate change by reducing the amount of carbon dioxide in the atmosphere.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 58

Li, Jennifer

Determining the Effect of Using Percentages or Ratios on the Perceived Quantity of Proportions

Completed Project, Science, Behavioral

How numbers and statistics are communicated can be manipulated to sway or encourage different interpretations. A change in units, such as days to weeks, may make the time period seem longer. Often, techniques like these are used in news, marketing, and activism. The purpose of this experiment was to discover if there was an impact of conveying numbers as percentages (50%) versus ratios (1 out of 2 people) on participants' perceptions of statistics and if so, how. The hypothesis was if a ratio is used to convey statistics then the participant would perceive the amount as greater than a percentage. The independent variable of this experiment was the wording of a statistic. The dependent variable was the participants' perceptions of a part of a whole as greater or smaller. In the experiment, participants were given an online survey with ten questions, each first stating a figure in two formats: percentage and ratio. After each example, they answered a survey question with three options: which was perceived to be greater than the other or neither/not sure. The form data was analyzed and graphed, both for each question and overall. Data trends thus far support the hypothesis. The results of this study can be used to inform people on how the wording of statistics can influence their perceptions as well as be used by those presenting statistics in the aforementioned fields.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 59

Li, Matthew

Effects of RV antifreeze, glass fibers, sugar, and pozzolan on freeze-thaw and expansion resistance of concrete

Completed Project, Science, Physical Science

11.1% of bridges in North-east America are considered structurally deficient. As concrete cracks, its load-bearing capabilities weaken causing bridges to be labeled structurally deficient. The hot summers cause concrete to expand and crack, the cold winters also make concrete undergo multiple freeze-thaw cycles. These two processes cause concrete to crack and weaken. The purpose of this project was to test the effectiveness of additives in concrete at boosting their temperature-related damage resistance. I constructed five concrete prisms using a 0.50 concrete cement ratio adding RV antifreeze, glass fibers, sugar, pozzolan, or nothing into each separately. Glass fibers and pozzolan are common additives in cold weather. While sugar acts as a retardant and strength booster. RV antifreeze lowers the freezing point of water. Each concrete prism was tested via being submerged in water for 1 hour before being placed in the freezer for 1 hour and baked at 200 degrees Fahrenheit for 60 minutes for a total of 3 times each. Qualitative observations were taken on the surface of the prisms along with a measurement of length and weight before the trials began and after each trial. Thus far data trends suggest that glass fibers and pozzolan work best to increase the temperature-related damage resistance of concrete. This data will be used to engineer a new type of concrete which if successful, would be used in bridges to increase their lifespan and preserve their load-bearing capacity and structural integrity in harsh climate conditions.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 60

Lim, Alexander

Using an Automated Drone and Camera System to Improve the Safety of Schools and Other Populated Areas In a Cost Effective Manner

Completed Project, Engineering, Physical Science

The implementation of drones into society has dramatically increased in recent years. One unexplored use for drones is to provide security for public places without placing other lives at risk, especially for areas such as public schools, where, between 1990 and 2012, 215 shootings have occurred across America. To fill this void and reduce the number of shootings, we designed and built a drone using readily purchasable components, such as the ArduPilot Mega 2.8 and an F450 drone frame. Using a camera system we designed, this drone is capable of detecting objects to provide a valid proof-of-concept that such a system can function as intended. Various tests were performed to test the effectiveness of the drone and camera system. The first test measured the drone's battery life and overall flight stability. The camera-and-drone combined system was assessed by recording the consistency of detection for the camera system at varying distances. The tests also examined the overall capabilities of the drone and camera system in clear and windy conditions. They highlighted the drone's minimum and maximum battery life, stability, and the camera system's effectiveness in detecting individuals. The camera had a 100% detection rate up to 4 m, and the drone had a maximum flight time of 22:34 (mins:secs) and 20:21 while using and not using the camera, respectively. This work represents a proof-of-concept that, with additional optimization, will integrate the drone and camera system for the purposes of dramatically improving surveillance and safety on school campuses.

King School

Teacher: Victoria Schulman

Project # 61

Liu, Adam

Studying the Effect of Colored Light On a Student's Focus Using Colored Filters

Completed Project, Science, Behavioral

With online learning curriculums utilized more often, making home environments easier to work in is more important than ever. Online learning allows for procrastination and distraction, which may hinder a student's learning. Studies have shown that stimulating the prefrontal cortex can allow students to focus better and that colors with a low wave-length stimulate the brain and encourage focus. When surrounded by these colors, the brain releases serotonin, a chemical associated with regulating attention. The objective of this project was to test the effect of colored light on a person's focus. My hypothesis was that the green filter would allow for the best focus. The independent variable was the color of the video filter, the dependent variable was the individual's attention span, and the control had no colored filter. The constants were the presentations the individuals watched and how their attention was tested. To fulfill the objective, colored filters were added to a presentation with numbers moving across the screen. Individuals watched the presentations with and without a color filter and recorded the numbers as they appeared. Their attention span was evaluated by determining the number of errors made, as well as answering questions relating to their focus. The information gathered through this experiment can be applied to items used inside and outside of the classroom to increase productivity, which could come in the form of adding a colored tint to glasses, device screens, and projectors.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 62

Liu, Daniel

A Comparative Analysis of Current Solar-thermal and Photovoltaic-powered Desalination Technologies to Determine the Best Performing Technology in Various Geographical Locations In the US

Completed Project, Science, Environmental

As global temperatures rise due to extensive amounts of greenhouse gas, demands for potable water and renewable energy sources are also increasing. Consequently, it is critical that current membrane-based and thermal desalination technologies are analyzed to determine economic feasibility and performance in real-world settings. This study's purpose was to compare the performance of solar-thermal and photovoltaic-powered desalination systems for greater insight into their performance in various geographic locations. It was hypothesized that photovoltaic-power desalination has more geographic applicability when considering economic feasibility and performance values in comparison to solar-thermal desalination. The independent variables included desalination technology, source water type, and geographic location while the dependent variables were performance variables, solar technology, and geographic conditions. The control was the current water costs of large-scale non-renewable desalination when measured against the same criteria. Throughout this study, the student independently collected data and modeled the desalination systems while contacting the mentor to answer questions. First, performance and cost ranges were compiled from journals on each desalination technology, including multi-effect distillation, multistage flash, mechanical vapor compression and reverse osmosis. Next, these data guidelines were utilized to create accompanying photovoltaic models in the system advisor model (SAM). The estimated performances of each model were then analyzed to determine geographic applicability, with current trends indicating that reverse osmosis is generally more efficient. This project provides an overview of the current state of the two most prominent types of desalination with solar power, helping communities in need of potable water decide what technology best suits their needs.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 63

Liu, Maggie

The Effect of Organic Duckweed versus Chemical Fertilizer on the Growth of Lactuca sativa and Ortho-Phosphate Runoff

Completed Project, Science, Environmental

Chemical fertilizers used to enrich soils contribute to nutrient pollution through runoff. By determining if chemical or organic fertilizer contributes more to ortho-phosphate pollution and its effectiveness on plant growth, we can better manage ortho-phosphate pollution. I hypothesized that organic fertilizer, made from plants (duckweed) used to phytoremediate phosphate rich waters, will release less ortho-phosphate in runoff and be as effective at promoting growth compared to chemical fertilizers. The independent variable will be the type of fertilizer organic or chemical (Humboldt Nutrients 0-10-0)] applied to the lettuce (*Lactuca sativa*). The dependent variables will be the ortho-phosphate amount present in the runoff and growth of the lettuce. Each experimental group consisted of 13 circular containers filled with 500 g of soil treated with 5 mLs of Humboldt 0-10-0 or the organic fertilizer once every two weeks and a seed. They were grown indoors and watered 40 ml twice a week. When given fertilizer and water, they were set aside for 6 hours before the plants were watered and another container was placed under it to catch runoff for 5 mins. The Hach 147500 Phosphorus test was used to determine the ortho-phosphate concentration in the runoff and height was measured using a ruler. Data trends thus far show that organic fertilizer releases less ortho-phosphate and is more effective. By determining which type of fertilizer is better at promoting plant growth and how much ortho-phosphate they release in runoff, we can better protect our aquatic environments by redistributing the recycled phosphate.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 64

Liu, Randy

Creating a portable and cost-friendly filtration system capable of effectively collecting and filtering rainwater into drinking water

Completed Project, Engineering, Physical Science

Over the past few decades, there have been immense strides in purification tablets and filtration systems for drinking water. However, systems for harvesting and filtering rainwater are often stationary, bulky, and unportable. The purpose of this project is to create a portable and compact filtration system capable of effectively collecting and filtering rainwater into drinking water. Testing of the prototype occurred in a rainy environment to replicate real-life usage. Testing procedures were limited since the water cannot be drunk. Instead, the purity was measured through a testing meter and rated on observations. The proposed filtration system has a large funnel opening to collect rainwater. The rainwater then travels through the filter before exiting through a spout. The filter component itself was primarily carbon-based with an additional polymeric membrane layer. The funnel opening, exit spout, and body of the system were created through 3-D printing via OnShape CAD modeling software. Water purity was assessed on a scale of one through ten in terms of clarity and visible contaminants for each trial. In addition, pH levels were recorded by a pH testing meter before and after to record change during testing. After the completion of testing, the averages of the ratings and the differences in pH levels were taken for each liquid to draw correlations. So far, data trends do support sufficient filtration. By creating such a filter, consumers will enjoy the benefits of a traditional rainwater collection and filtration system while not neglecting compactness and portability for outdoor use.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 65

Liu, Sophia

Testing the Effect of Various Amounts of Diammonium Phosphate on Lepidium Sativum Plants That Have Undergone Water Deficiency and Surplus

Completed Project, Science, Environmental

Climate change has been causing droughts and floods that negatively affect plants, harming entire ecosystems. Diammonium phosphate is a chemical that is used as a fertilizer for plants to promote health and growth. The purpose of this experiment was to test the effects of phosphate on *Lepidium sativum* (watercress) that have undergone water stress (water deficiency and surplus), to determine if phosphorus can mitigate water stress. The hypothesis was that if phosphorus fertilizer is given to the plants, it would mitigate the effects of water stress. The independent variable was the amount of diammonium phosphorus fertilizer, and the dependent variable was the health of the plant, which was determined by the mass and overall appearance. In the experiment, there were two experimental groups: an experiment with water-deficient plants, and the other with overwatered plants. Both groups had four trials (including a control) in which four plants (that have undergone water stress) were treated with varying amounts of phosphorus. After one month of being treated with phosphorus, the health of the plants was determined. One set of data for each experimental group was graphed, and each element of the dependent variable was recorded to determine the effects phosphorus had on the plants. Data trends thus far have supported the hypothesis. By testing how effective phosphorus is at mitigating water stress on plants, we become one step closer to figuring out an effective way to mitigate the effects of climate change on ecosystems.

Amity Regional High School

Teacher: Catherine Picitelli

Project # 66

Liu, Yuqi

Analyzing the impact of social media on youth opinion and advocacy for climate change

Completed Project, Science, Behavioral

Climate change (changes in climate patterns, particularly as caused by human activity) has had significant detrimental effects on the world as a whole, so it is important to disrupt current climate change trends. Youth are especially affected because they will inherit today's world; social media is a critical conductor for information to young adults. This study seeks to determine if and how social media influences adolescents' beliefs towards climate change. The hypothesis is that the perceived negativity of current media will have a negative effect on the enthusiasm of students to act on climate change. The independent variable of this study will be social media, and the dependent variables of this study will be adolescent opinion towards climate change. The study will use a three-part survey, which will be administered to high school students in Connecticut. Thus far, the results of this study show that social media has a notable effect on students' climate change beliefs, but the students surveyed are optimistic about current climate change efforts and are willing to devote their resources towards these efforts. This suggests that the hypothesis was only partially correct. Past studies have shown that most youth are aware of climate change, but a significantly smaller amount are willing to act on the part of the climate. This study is, thus, important because it adds much-needed insight into the best ways to inform and inspire young people about climate change, which is necessary for the mobilization of further environmental advocacy.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 67

Lowder, Bridget

Distance Detection Masks for Prevention of COVID-19 Respiratory Transmission

Completed Project, Engineering, Physical Science

Recently, the COVID-19 pandemic has become a global crisis with over one million deaths worldwide and an ever growing number of cases in the United States. Studies have shown that COVID-19 predominantly spreads from close contact when infectious respiratory droplets can travel up to six feet away and infect healthy people. To prevent transmission, the CDC recommends wearing masks and staying six feet apart from others. While there are some products available for detecting social distancing, like cameras and bracelets, there is nothing embedded within personal protective equipment, such as masks, on the market yet. The purpose of this project was to create masks with transmitters and receivers inside them with identical frequencies that send and receive low-power radio signals to each other. When the masks were within six feet, they detected a signal from the other mask and LED lights turned bright red in warning. The prototype was created utilizing a breadboard, microcontroller, LEDs, and radio transmitters and receivers. The amount of power needed and how bright the LEDs needed to be so they are noticeable but not distracting, were tested. Distraction caused by the LEDs was evaluated by a survey, which compared distraction levels at different brightness settings. Data trends so far suggest that the LEDs are not distracting and minimal power is needed. By warning people when they are closer than the recommended distance, these masks can help prevent respiratory transmission of COVID-19, which will keep people healthy and save lives.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 68

Lowder, Scott

The Manufacture and Performance Evaluation of a Locking Container to Eliminate the Distraction of Phones While Driving

Completed Project, Engineering, Physical Science

With the rise of technological advances in the 21st century resulting in the popularity of cellular devices, car accidents and fatalities associated with distracted driving have become an increasing issue of concern. Additionally, young people are more likely to use their phones compared to older individuals, which makes them a safety concern for their early years as new drivers. To restrain individuals from phones, a prototype for a locking container was developed during freshman year requiring the driver's phone to be stored within the container before driving to prevent attempts of distraction.

Afterward, my sophomore year focused on manufacturing a 3D model and PCB boards for the project. Therefore, for this year, the focus was on implementing and testing the performance of the product in an automobile. The product is finished and ready for implementation into an automobile for real-life application and performance evaluation. During testing to ensure successful performance evaluation, trials such as testing the effectiveness at preventing user tampering, as well as finding the best location for implementation of the product is tested. Concerning the purpose of the product, the main implication is to prevent future teen driving-related car crashes involving the distraction from their cellular device and save lives. Other potential implications for this project can be for personal safety for any driver, or as a business policy for the safety of workers for companies such as FedEx or UPS.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 69

Lu, Brodey

Creating a Smaller and More Portable Vertical Axis Wind Turbine to Increase the Accessibility and Usage of Wind Energy Harvesting Devices

Completed Project, Engineering, Environmental

Wind energy harvesting is a promising form of clean, renewable energy, but its widespread implementation faces some obstacles. Two problems are limited access to wind turbines and the immobile nature of most devices. Both drawbacks are due to the large size of most common turbines. The purpose of this project is to create a smaller wind turbine that is portable and easier to use than existing models. Designs were created for the wind turbine, and built with accessible materials like wood and plastic. The design had to fit limited size and weight parameters, while producing enough power for minor tasks. Using newer vertical axis designs, which are more compact and require less wind than the traditional horizontal turbines, provided an important foundation. A foldable mechanism and methods for the device to be attached to tall objects like trees or rooftops drastically increased the portability. Measured data was power output of the device, in watt hours. The model's efficacy was determined based on whether it generated enough power for certain tasks while remaining a reasonable size and weight. The turbine was tested outdoors in various wind conditions. The immediate implication of the device is access to a convenient power source usable in remote areas, in power outages, or other situations where power isn't easily available. In a broader sense, the smaller device approach used in this project can be a key step towards making wind energy a more widespread and applicable source of power.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 70

Lu, Kevin

Analyzing the Relationship Between Acceptance of Virtual Communication Mediums and Depression Proneness, FOMO, and Social Anxiety

Completed Project, Science, Behavioral

Since March of 2020, a substantial increase in average levels of fear-of-missing-out (FOMO), social anxiety, and depression proneness (all behavioral indicators of negative mental wellbeing) has been noted by psychologists. Recent studies have suggested that prolonged usage of virtual communication mediums (VCM) may be partially responsible. Thus, this study aims to assess the relationship strength between VCM usage and negative-valence psychological factors such as social anxiety, depression proneness, and FOMO. An online survey was distributed to a group of highschoolers and college student participants, containing questionnaire items from the Przybylski FOMO test, the Willoughby Social Anxiety Scale, and the Depression Proneness Inventory, measuring FOMO, SA, and DP, respectively. Participants then received a second survey on their' estimated weekly virtual communications usage alongside a personality-sociability questionnaire from the 16PF. Finally, participants were disbanded and multivariable analysis was conducted on gathered data. The data collected currently suggests a strong positive relationship between VCM usage, social anxiety, FOMO, and depression proneness. Multivariable analysis suggests that all three negative behavioral indicators are additionally co-related in strength/direction. Regression analysis with known confounding variables such as personality valences and pre-pandemic VCM usage did not significantly alter the strength of observed relationships. Data strength thus far is tenuous, with further data collection ongoing. Overall, this study thus far affirms the conjectural hypotheses of previous research articles: that excessive usage of virtual communications are indeed related to negative behavioral indicators. However, the presence of a causal relationship remains uncertain in this naturalistic observational study.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 71

Lu, Melinda

In Vivo DTI Analysis to Investigate the Association of Reduced White Matter Tractography on Synaptic Density in Alzheimer's Disease

Completed Project, Science, Health and Medical

Alzheimer's disease (AD) is a growing health epidemic that causes cognitive decline due to excessive protein buildup in the brain which leads to reduced synaptic density. Because current treatments only target the symptoms, researchers have tried to identify potential tracers. Many studies have indicated that white matter (WM) damage can appear before any symptom onset, and it can potentially be used as a biological tracer for AD. This study evaluates the effect of reduced WM on AD. It was hypothesized that reduced WM would be positively associated with reduced synaptic density in certain brain regions. The independent variable was WM tract integrity which was measured with DTI, diffusion tensor imaging. The dependent variables included synaptic density and the individual's AD stage (cognitively normal (CN), mild cognitive impairment (MCI), early AD). AD/MCI subjects were compared to the control, CN, group, and people with similar ages and sex were compared. The data came from a previous study done by my mentor, and it was processed through Excel with statistical tests. Regions with a significant correlation between WM integrity and the dependent variables were investigated to research underlying biological processes. This project was completed with a group consisting of my mentor, undergraduates, a research assistant, and myself. My mentor acted as a guiding figure while the rest of the group worked to process the data. This study will provide new insights on how WM affects AD pathology and how WM can be used as a biological tracer for treating people with AD.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 72

Luo, Deborah

Creating a Structural Design to Optimize Lighting in Vertical Farming

Completed Project, Engineering, Physical Science

Vertical farming is a type of farming that allows for more crops to be grown in a smaller floor area by utilizing the z dimension, as well as the x and y dimensions. The most common way this is done is for plants to be grown in layers stacked on top of each other. However, this often results in plants in the lower levels being overshadowed and not getting enough sunlight. While artificial lighting systems do exist, they often consume copious amounts of electricity. The purpose of this project was to create a structural design to optimize lighting in vertical farming. The minimum criteria for this project was for the prototype to utilize vertical space, and for higher and lower levels of the prototype to have less variation in light received. The solution was to build the prototype in a pyramid formation, in which lower levels were tilted further outwards with overlap between layers. A 'regular' vertical farming frame was built as the control, and the prototype was also built. Light measurements were taken with light meters. Light levels were compared on the higher and lower layers of both the prototype and the regular frame to determine which one had more light discrepancy. The design is progressing towards success. The success of the prototype means that vertical farming could be both more widely and more easily used, especially in areas where electricity is unreliable.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 73

Luo, Danlin

Comparing the Efficiency of Autonomous and Regular Vehicles With New Requests

Completed Project, Engineering, Physical Science

Autonomous vehicles will become prevalent among the public within a few years, aiding in the reduction of traffic through communication between vehicles. However, properly planning the routes of these vehicles and testing their efficiency has been recently subjected to research. This experiment compares the efficiency of autonomous and regular vehicles with the appearance of new requests. Using Python, a computer model records the total time a regular and autonomous vehicle needs to pick up every location and fulfill new requests. The autonomous vehicle can change its route with the appearance of the new requests while the regular vehicle must make a second trip. An 8x8 grid is used for simplicity. The results show that the efficiency of autonomous cars is higher than that of regular vehicles. This experiment comparing the efficiency of autonomous cars and exploring the potential of rerouting can inspire scientists to pursue the development of a smarter car. The results will help the public understand the potential increase in efficiency of autonomous vehicles,

Ridgefield High School

Teacher: Ryan Gleason

Project # 74

Marin, Audrey

Using RNA Sequencing to Analyze Molecular Pathways in Mutant and Wildtype KRAS gene Colorectal Cancer Cell Lines

Completed Project, Science, Health and Medical

Colorectal cancer, cancer in the colon or rectum, is the fourth highest cause of cancer-related deaths in the United States. Through prior experimentation, it has been determined that the KRAS gene is involved in cell growth regulation, and mutations of this gene are associated with colorectal cancer. The purpose of this study is to determine the mechanism by which the mutated KRAS gene can cause colorectal cancer. It is hypothesized that certain molecular pathways of the KRAS gene are altered as a result of the KRAS mutation, disturbing healthy cell growth. I analyzed RNA Sequencing data from two different colorectal cancer cell lines-- one with wildtype and one with a mutated KRAS gene-- through software called Ingenuity Pathway Analysis (IPA). RNA sequencing can be used to quantify the extent to which a gene is expressed. Ultimately, the purpose was to distinguish significant, enriched molecular pathways in the KRAS mutant cell lines which is a function of IPA. Results thus far indicate that alterations in the kinetochore signaling pathway are statistically significant to the mutated KRAS cell line. This pathway is responsible regulating the centromere of the chromosome during cell division. This indicates that cell growth irregularities responsible for colorectal cancer could be linked to problems with chromosome division. In the future, this research will confirm which pathways manage growth of cancerous cells, identifying targets for the production of a drug that can interrupt altered molecular pathways from the mutated KRAS gene.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 75

May, Katherine

Uncovering Abnormalities in Asteroids Using Asteroid Occultation

Completed Project, Science, Physical Science

It is important to define the shape of asteroids in space to understand the origins of the universe. The purpose of this project is to determine the shape and size of asteroids using occultation analysis to potentially discover abnormalities. It is hypothesized that asteroid occultation can reveal asteroid irregularities because accurately timing and combining the occultation duration from multiple locations can determine the shape and abnormalities of the asteroid. We conducted the occultations with a PlaneWave telescope, a WATEC camera, and a video time inserter, which used GPS satellites. To observe and analyze an occultation, the target star was located. Specialized computer programs were used to accurately measure changes in the brightness of the star during the occultation event. We observed five occultations and we were able to precisely measure two of the asteroids. This data was used to try to discover an abnormality in an asteroid such as an asteroid with a moonlet, a contact binary asteroid, or a double asteroid. Through this study, we discovered no abnormalities, but we were able to accurately create three-dimensional images of the shape of the two positive asteroids. This study creates an opportunity to observe objects in space to discover a characteristic or feature previously unknown by using relatively new techniques in space exploration. While no abnormalities in this group of asteroids were identified, the data collected from occultations produced the first recorded images of the asteroids. In future observations of other asteroids, we can apply occultation techniques to discover more abnormalities.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 76

McLemore, Sammi

Comparing Wood/Plastic Composite & Hemp/PLA Composite to Determine the Best Moisture Resistant Bioplastic

Completed Project, Science, Physical Science

Beginning in 1987, a push for sustainability has led to a societal demand for environment friendly materials. A market emerged for bioplastics, however, not all of them are created equal. This experiment compares wood/plastic composite, hemp/PLA composite, pine, cedar, and teak to determine which bioplastic is the most moisture resistant. 6 samples of each material are cut with a width of 6 mm and a length of 64 mm. Dimensions in millimeters and weight in grams are recorded before water submersion. 3 of the samples are placed in fridge temperature water and the remaining 3 samples are placed in room temperature water. Dimensions in millimeters and weight in grams are recorded after 30 days of water submersion. The expected findings is that Trex will absorb less water than the hemp/PLA filament. Trex's wood particles are distributed very evenly which helps ensure most of the wood fiber is completely coated in water resistant plastic. Also, it is tightly packed which prevents many gaps that provide tunnels for water to travel inward. In contrast, the hemp/PLA filament contains less uniformed fiber distribution indicating some hemp hurd may not be evenly coated in PLA. In addition, the filament is 3D printed which could create additional gaps between each layer allowing water to penetrate the interior. The whole world is more environmentally conscious, creating a demand for bioplastics. Investigation on Trex's and hemp/PLA's water resistance will lead to an increase in the material's range of applications.

Ridgefield High School

Teacher: Ryan Gleason

Project # 77

Mills, Ethan

Effects of Climate Change and Environmental Variability on High Altitude Aspen Degradation

Completed Project, Science, Environmental

Aspen degradation is a growing problem in regions where they grow. This is clear in the appearance and amount of death within the trees. I noticed these effects while in the Gunnison National Forest, which has experienced these changes. As it has potential for economic and environmental effects, towns like Crested Butte, CO worry about a decrease in visitor revenue as a result of the decline and the displacement of the many species which require its protection. I have done a data consolidation study. Through statistical analysis I have been capable of graphing out the independent variables against aspen growth. I have acquired several databases of climatic variables which include precipitation, aspen growth, snow fall, and temperature. The results include a strong correlation between the Aspen trees growth and a significant change of humidity variables. This is expected due to the relationship between these factors and overall plant growth, which gives good reason to the idea of a relationship between the factors and Aspen degradation. Climate change has a high impact on the humidity levels, which I expect has effected current growth patterns. The results of this experimentation could inspire new methods of high altitude plant protection to be instated, especially for organisms like the Aspens which provide many species shelter and add to the economy.

Ridgefield High School

Teacher: Ryan Gleason

Project # 78

Mohammed, Suhail

Determining if Age Affects Willingness to Take the COVID-19 vaccine

Completed Project, Science, Health and Medical

For a year, the COVID 19 pandemic has changed the world. As it continues to make an impact, billions wait for a vaccine, but how many are willing to take it? The purpose of the study was to determine which age group was the most willing to take the COVID 19 vaccine. The independent variable was the age group. The groups being tested were 18-29, 30-49, 50-64, and 65+. The dependent variable was the percentage of people in each group that were willing to take the vaccine. The hypothesis was that the 65+ group would have the highest percentage because they are the most prone to facing complications if contracted with the virus. The method behind the study was to survey as many subjects per age group. The survey was an email survey. The subjects were asked to answer 10 dichotomous questions each assessing their willingness to take the vaccine. To find each group's willingness percentage, I took the responses that showed inclination to get vaccinated from each question, and averaged them by group. There was no control, so the results were made by comparing the percentages of each age group. The constants were the questions asked on the survey, the number of people in each age group, and the number of questions asked. The experiment's results were used to help educate society on the importance of getting vaccinated to protect themselves and others, and to help vaccine companies raise awareness among all ages by advertising the right content.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 79

Napolitano, Andie

The Effect of Abstaining from Using Social Media on the Mood of People from Different Age Groups

Completed Project, Science, Behavioral

Many studies have been conducted showing the correlation between social media usage and the declining mood of teenagers (13-19), though there is less research on the relationship between social media usage and mood of adults (20-65) and seniors (65+). Research has found that social media negatively impacts the mood of teenagers, so the purpose of this study is to discover how social media affects the mood of different age groups. Participants from each age group were recruited and sent the same survey twice (before and after abstaining from using social media for two days). The number of days each person does not use social media and the survey questions were kept constant during this experiment. After the data from each age group was collected, it was compared. At this point, the data trends suggest that teenagers and adults have the greatest difference between their mood while using social media and their mood while not using social media. Not using social media showed participants its effect on their lives. This experiment can be used as a resource to see how social media usage affects adults and senior citizens because limited data exists about the impact of social media on their lives. This research can determine potential negative effects on the mental health of age groups and can be used to create solutions for those individuals.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 80

Nomani, Adam

Thermoelectric heating and cooling of an electric vehicle using phase change material

Completed Project, Engineering, Physical Science

The problem being addressed is the inefficiencies of electric vehicles. EV's are popularizing in today's world and are vital in order to help decrease global warming. Air Conditioning system in EV's use up a significant amount of energy from the battery the vehicle. It is considered the main accessory that extracts power from the battery when it is operating and decreases range of the electric vehicle. We plan on designing a thermal battery that replaces the AC system in an electric vehicle and provides hot and cold air to the cabin. The two main components of the thermal battery are the Peltier modules and PCM. Simulations were run for the thermal battery on ANSYS software, testing the thermal conductivity of the system. The proposed system will decrease the weight of the electric vehicle as the thermal battery weighs less than the traditional AC system. Additionally, the use of a thermal battery will draw less energy from the battery that could be used to accelerate the vehicle. The combination of a lighter vehicle and more efficient use of the battery will in turn increase the driving range of the vehicle. The proposed system will be aimed toward reducing the driving time of the vehicle while being able to keep the cabin of the vehicle heated or cooled. Our proposed system will help reduce one of the drawbacks buying an electric vehicle: The driving range. The result of an increase of EV's will help aid in the problem of global warming.

King School

Teacher: Victoria Schulman

Project # 81

Nomani, Wafa

Feraheme® works synergistically with several ROS-inducing drugs for the treatment of pancreatic cancer

Completed Project, Science, Health and Medical

Pancreatic ductal adenocarcinoma (PDAC) has a 5-year survival rate of less than 3%. Current treatments including chemotherapeutic agents are associated with toxic side effects resulting in a decreased quality of life. In order to mitigate issues associated with administering free chemotherapeutic agents, we loaded them onto iron-oxide nanoparticles as cancer cell-targeting agents. Additionally, we wanted to explore the potential toxicity of the iron-oxide nanoparticles via the generation of reactive oxygen species (ROS). Since cancer cells have higher basal ROS levels than healthy cells, we wanted to overwhelm the cancer cells with ROS which would lead to cell damage. We first synthesized the nanoparticles and non-covalently loaded Brusatol, Erastin, and Parthenolide. We next did an MTS viability assay between loaded and free drugs to determine which treatment groups are most effective in killing the cancer cells. We then did a Western blot for ferritin and ferroportin which are involved in intracellular iron metabolism to determine how iron treatment affects the regulation of these proteins. We also conducted microscopy to visualize nanoparticle uptake. The Feraheme® and Brusatol and Feraheme® and Erastin combinations had a synergistic effect on the ROS levels of the pancreatic cancer cells. Finding targets on the surface proteome of cancer cells and functionalizing the nanoparticles with charge-based, amino-acid-based, and lipid-based coatings would prove to be useful as it would allow better cell entry and exhibit toxic effects on the cancer cells; this is our next step.

King School

Teacher: Victoria Schulman

Project # 82

Novak, Eric

The Impact of Mouth Coverings on Speech Perception

Completed Project, Science, Health and Medical

Due to COVID-19 people are required to wear masks to public areas. Normally masks alter the sound quality and volume of people's voices. Because of this people have trouble communicating with others in important situations. The purpose of this research was to find out the most effective type of mask to use for communication during the COVID-19 crisis. The hypothesis was that out of mask coverings made from plastic, cloth and N-95 masks the cloth masks would be the most effective choice for communication. The independent variables were the 3 different types of mouth coverings. The dependent variable was the effectiveness of communication. The way this was tested was through Speech Perception Measures and through computer recordings. The Speech Perception Task was given to individuals in multiple conditions. There was no control because the research was a comparison project. The mentor had already collected some data. Student collected data through additional testing. Computer recordings were used to tell the acoustic changes that each mask gives. In the Standard Speech Perception Measure Test, the accuracy was evaluated based on different conditions. The computer recording was evaluated through spectrograms. Based on the projected data it was determined the disposable masks were the best choice for speech perception. This was closely followed by cloth masks, then windowed masks. This research will help people decide on what type of mask they would like to wear based on their communicational situation.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 83

Novak, Samantha

Testing for Arsenic Contamination in Well and Municipal Water and Agricultural Food Products

Completed Project, Science, Environmental

Arsenic levels have been present in high levels in soil and water throughout New England due to both natural causes and man-made contamination. It is hypothesized that there will be higher arsenic concentration in agricultural products compared to municipal water and well water because if agricultural products are irrigated with arsenic contaminated water, then it will result in arsenic gathered in the soil and crops. I first used the Hach testing kit to test for arsenic contamination in well vs municipal water. My variables were municipal and well water from New York, Connecticut and Maine. Second, I used the Chemsee testing kit to test for arsenic in agricultural products. My variables were Brown Rice, Apple Cider, Apples (red and golden), and distilled water. It was essential to liquidize each sample before beginning the experiment. This is a completed project. I found that there was no arsenic present in the well and municipal samples. My hypothesis was supported that agricultural products would have the highest level of arsenic because Cortland apples and Uncle Ben's Brown rice had an arsenic level of 10ppb. These results show that the the state permitted level of arsenic (10ppb) and the filters are adequate and effective. Although my samples did not go past the set arsenic level limit, I am curious as to what steps farmers/agricultural food sources can take to ensure that they have a clean irrigation system to facilitate the lowest level of arsenic possible in their crops/products?

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 84

Ochs, Benjamin

Modular Robotic System for Multipurpose Robots

Completed Project, Engineering, Physical Science

Currently there are robotic systems that replace human first responders, but they have only one specific use. This project will design a robotic system that will demonstrate the ability to replace first responders in a dangerous situation, no matter what the situation is by being modular. A possible solution to a modular robot will be designed, developed, and a small scale, 3D printed prototype will be built. It would use very similar electronics to a proper, fully-functional robot, but it will only have basic functionality as its primary goal is to demonstrate modularity. To connect the modules of the robot there will be dedicated high power plugs, using XT90 or XT60 plugs, depending on the voltage going through. The primary plug will be a DB15 plug, this will carry all data and lower voltages 5V. To prove that the modularity works properly, multiple modules will be made, likely an arm, two different manipulators, a camera module, a distance sensor module, a wheel module, and a tread module. These modules should be able to connect anywhere on the central hub. To consider this successful, the core computer will have to be able to recognize and control each module's computer from every port, and that a module can be switched while it is powered off and recognize the change as soon as it is powered on. If this is successful this will lead the way for this technology to be implemented into a more complex robotic system.

Newtown High School

Teacher: Timothy DeJulio

Project # 85

OConnor, Colby

Determining The Effect Sports Participation Has on the Competitive Nature of High School Students

Completed Project, Science, Behavioral

This project sought to discover whether participating in a sport has an affect on a high school student's overall competitiveness. It was hypothesized that if a student plays a competitive sport, then they will have a higher competitive nature than a high school student who does not. This project was conducted due to the personal belief that sports have a positive impact on one's daily life. Moreover, a consent form was sent out, which was followed by a survey. This survey consisted of questions like grade, whether they play a sport, and what sport they do play either part of school or outside of school. Two surveys were included that tested one's competitive nature using a Likert Scale: the Hypercompetitive Attitude Scale (HAS) and the Personal Development Competitive Attitude Scale (PDCAS). The scores were anonymized and categorized whether they play a sport versus whether they do not. T-tests and linear regressions were run to look for correlations and significant data. Athletes were compared to non-athletes, and competitive athletes were compared to non-competitive athletes in the data tests. Trends thus far suggest that athletes had higher overall competitiveness levels than non-athletes, as well as competitive athletes had higher overall competitiveness levels than non-competitive athletes. However, data has yet to be proven significant between data sets. This study helped to determine whether sports participation affects a high school student's competitiveness. This suggests that high schools students should highly consider participating in a sport, specifically a competitive sport. Additionally, it was concluded that sports participation does lead to a greater sense of competitiveness, therefore, helping assert the value that playing sports promotes adolescent success.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 86

Paglia, Sage

Determining the Relationship Between Subjective Sleep from Patients with Schizophrenia on the Performance of Cognitive Tests

Completed Project, Science, Behavioral

Schizophrenia is a mental disorder that impacts one's ability to process emotions, conduct basic behaviors, and it may cause an inappropriate breakdown of thoughts. Schizophrenia has proven to make people fatigued, and people who are fatigued are often unable to perform optimally on basic tasks. The purpose of this study was to determine the relationship between subjective sleep from patients with schizophrenia on their performance of cognitive tests. The independent variable of this research was the subjective amount of sleep and the dependent variable was the performance on cognitive tasks. The research was conducted by the Yale Psychiatry department with 26 participants; the control group was the 13 healthy patients and the experimental group was the 13 patients with schizophrenia. This project consisted of fully analyzing data that was collected and recognizing trends. Participants volunteered to answer a series of questions about their sleep, and they took a series of various cognitive battery tests. Data that was collected was analyzed by the student to draw conclusions. Composite scores of the cognitive tests were compared to specific sub-groups. Data trends thus far show that the less a patient with schizophrenia sleeps the worse they will perform on cognitive tasks compared to a healthy patient. Future research could explore why schizophrenics may have disrupted sleep. This research could also be used to help manage getting enough sleep, so that people may better function during the day. Finally, this research could be implemented in developing guidelines for better sleep methods for people with and without Schizophrenia.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 87

Patel, Aarav

Creating a Detection System to Aid in the Prevention of Potential Kitchen Fires

Completed Project, Engineering, Physical Science

Most people use kitchen appliances on a regular basis. However, with the rush of daily activities, people can often forget to turn off their kitchen appliances, and this can be detrimental. Unattended cooking appliances cause 47% of kitchen fires and 20% of the civilian deaths. I would like my solution to prevent these deadly fires from even starting by notifying users of unattended kitchen appliances. My idea is to use an infrared camera to send information to a mobile app on the user(s) phone. If the app notices that a kitchen appliance is left on unattended, when appropriate, the app can notify the user. The process will have 3 main steps. The first part is to create a cheap Wi-Fi-enabled infrared camera using a raspberry pi and an infrared camera attachment. This camera can send the information to a database. The second part is to create an algorithm to decide whether kitchen equipment is on and unattended based on the camera and other software. The final part is to create a mobile app through the Flutter framework where users can set up the system, receive notifications, and change default settings if desired. If there is a bug in the system, then the code will be debugged. If the system works and if time allows, then potential optimization could be implemented. With this system, many fires can be prevented before they even have the chance to start. This will save lives as well as houses from being burnt down.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 88

Patel, Armaan

Determining if Nerve Blocks Used During Knee Surgery Affect Patients' Post Operative Pain Levels and Opioid Consumption

Completed Project, Science, Health and Medical

Regional anesthesia has been shown to reduce pain. Nerve blocks are a great form of regional anesthesia. The femoral nerve block is a novel technique to block the pectoral nerves, reducing pain when doing surgeries in that area. Using nerve blocks may decrease the amount of medication a patient may need. It would also likely reduce their pain, indicated by the visual analog scale (VAS). This project sets out to determine if nerve blocks decrease the pain levels and opioid consumption of patients undergoing knee surgery? If nerve blocks are used for patients undergoing knee surgery, then the patients' pain levels and opioid consumption will decrease. Our independent variable was the usage of nerve blocks in patients undergoing knee surgery. Our dependent variable was patients' opioid consumption and pain levels as measured by VAS scores. My mentor Dr. David Maduram MD, did retrospective chart review using published data from various studies. This data included each patient's VAS scores and opioid consumptions. The opioid consumption was measured in morphine milligram equivalents (MME), a scale that compares an opioid dosage's "strength" in relation to one milligram of morphine (if there was an MME score of 50, the dosage strength would be equivalent to 50 milligrams of morphine). I analyzed the data using paired t-tests, appropriate chi-squared tests, Fisher's exact tests, and nonparametric method Wilcoxon two-sample tests, depending on data normality. Data trends thus far support the hypothesis. Findings from this study could help make nerve block usage more common in pacemaker surgeries.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 89

Poddar, Aanchal

Determining the Most Accurate and Robust Machine Learning Algorithm When Used with the Dataset "Early Stage Diabetes Risk Prediction"

Completed Project, Science, Health and Medical

As medical and computing fields become intertwined, machine learning (ML) is often used to assist in diagnoses. Logistic regression, decision trees, naïve Bayes and k-NN classifiers are common ML algorithms, and can each be used as a diagnostic tool based on the symptoms a patient has. The purpose of this project is to find which ML algorithm is most accurate and robust. I wrote Python programs using pre-existing machine learning models from SciKit-Learn. Afterwards, I ran the dataset "Early Stage Diabetes Risk Prediction" (UCI Machine Learning Repository) through each program. 5-fold cross validation was used to see how the model would do with random datasets while using limited data. My mentor remotely guided me through any questions. An ROC curve plots the false positive rate and true positive rate at different classification thresholds, and can be used to compare the rate at which false positives and true positives occur between different ML algorithms. This method will be used to compare accuracy between the ML algorithms being tested. Data trends from previous studies show k-NN classifier will be most accurate and robust. The results of this project will help medical professionals use the most accurate ML algorithm in their diagnoses.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 90

Rai, Aditya

Technical Variables

Completed Project, Science, Physical Science

The stock market is a platform where investors can gain ownership in particular securities and companies, profiting off of a company's success and stock price movement. However, stock price fluctuation does not necessarily depend on the fundamentals, or statistics of a company, rather it can sometimes focus on technical potential. The objective of this study was to analyze a group of technical variables that portray different aspects of stocks and determine relationships between the variables and stock price movement. Establishing a relationship between any of the technical variables and stock price movement can yield an accurate method of predicting price action. The methods of this study began with the selection of multiple stocks based on market capitalization. The second step was collection of data at different time frames for one month of the technical variables and price of stock at each time. Next, the data was analyzed and a model was created for each variable to observe how accurate each technical variable was. It was concluded that the RSI variable exhibited a strong correlation and that not all of the technical variables were equally accurate. The Macd variable did not have as strong of a correlation, and the moving average variables expressed a similar result. Results from this study display an accurate way of foreseeing price action. The success of this study can be the foundation of more complex methods of analyzing price movement involving networks and algorithms.

Darien High School

Teacher: David Lewis

Project # 91

Rathjens, Anton

Creating an Antioxidant Spray to Slow the Browning of a Common Banana

Completed Project, Engineering, Environmental

The browning of a common Banana, or *Musa acuminata*, is caused by the release of ethylene gas when it comes into contact with oxygen. Although anti-ethylene substances have been developed with some success, they can be compounded with antioxidants. The problem with browning is that it causes a lot of food waste. The aim of this project was to create a cost-effective way that one can prevent the oxidation and browning of bananas. My idea for a solution was to create a mixture of antioxidants dissolved into water that can be sprayed onto the bananas. During testing, I experimented with different combinations, ratios, and concentrations of the spray. The experimental methods were, first of all, putting 1 gram of each antioxidant in 50 ml bottles. Then, I cut 7 bananas in half lengthwise and sprayed the solutions on each, leaving 1 as a control. The distance out from the center that the banana browned after 24 hours was how I measured the antioxidant's effectiveness. The projected data so far is that a combination of alpha lipoic acid and vitamins E and C will provide an effective enough mixture, with each preventing browning in different sections. If my design is applied to the real world, it will present a way to reduce the amount of food waste that people produce by allowing them, or the grocery stores they buy from, to spray the solution onto bananas. This would prevent food waste from bananas that were sprayed.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 92

Russell, John

Machine Learning Accelerated Discovery of Catalytic Materials for Energy Applications

Completed Project, Science, Environmental

Roughly 173,000 TW of solar energy reaches Earth's surface as sunlight, thousands of times more than is used worldwide. Moreover, 0.6% of the total land of the U.S. could power the country, and a fraction of the Sahara desert could power the world. Thus, the caveat of solar power is not energy output, but conversion and storage, an issue alleviated in part by photocatalysts such as titanium dioxide (TiO₂). These catalysts are used not only in the absorption of sunlight, but more importantly in water oxidation and reduction. These processes store energy in the chemical bonds of H₂ molecules, posing a possible solution to the current deficiencies associated with storing and transporting solar energy. In our study, we examined thin film TiO₂ in varying preparations. Along with the structure of the material itself, the preparation of these films affects structure and, consequently, catalytic performance. Past studies have leveraged machine learning techniques to predict individual material properties. We used clustering, an unsupervised machine learning technique, to efficiently compare the X-ray absorption spectra of various MnTiO_x samples, requiring fewer parameters and evaluating structure and function on a broader scale. By gaining perspective on the structural implications of preparation techniques, we can evaluate the efficacy of specific combinations in producing optimal photocatalysts, improving the applicability of solar energy in replacing fossil fuels and mitigating the climate crisis.

King School

Teacher: Victoria Schulman

Project # 93

Scheggia, Fatima

The Effects of Vitamin B9 on the Health and Lifespan of Tenebrionidae

Completed Project, Science, Health and Medical

Vitamin B9 or folate is found in foods like legumes and broccoli and in supplements. This vitamin is essential for optimal brain and nerve function but has not been connected to an increased lifespan. This project's purpose is to find out if vitamin B9 can improve overall health and extend lifespan in Tenebrionidae. It is hypothesized that their lifespan will increase with the consumption of vitamin B9-rich foods. Thirty Darkling Beetles were divided into groups of ten and then placed in three containers. The first container held the Darkling Beetles' normal diet, the second container contained vitamin B9 supplements and their normal diet, and the third container contained vitamin B9 foods and their normal diet. The Darkling Beetles were observed and any changes recorded; the number of Darkling Beetles moving and alive were counted as well. Overall, the results showed that the Darkling Beetles benefited from the addition of B9 in their diet. At the end of the first trial, the most beetles alive at the end were in the B9 foods group, followed by the B9 supplementation group, and then lastly, the control diet group. In contrast, the second trial had the most beetles alive in the B9 supplement and the Control group. This research will lead to testing vitamin B9 on other organisms as well as testing other parameters of health in addition to lifespan and movement. In the future, additional nutrients not commonly linked to increased lifespan will also be tested.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 94

Seymour, Anna

The Impact of Location, Nursery vs Reef, on Growth and Survival of Juvenile Coral Species Orbicella Annularis and Acropora Palmata, in St. Croix, USVI.

Completed Project, Science, Environmental

How does the location, off-shore nursery or reef, affect the survival and growth rates of juvenile coral species Orbicella Annularis and Acropora Palmata? Offshore nurseries will have higher survival and growth rates of juvenile coral species Orbicella Annularis and Acropora Palmata, in St. Croix, USVI. The data was collected using photos from multiple months taken of fragged coral from a coral restoration project with the Nature Conservancy in St. Croix. Then using ImageJ, an image processing program, the photos were analyzed to determine the surface area of the coral fragments to calculate the growth rate. To calculate the survival rate each living coral polyp was counted. The results showed that the off-shore nursery had higher rates of survival for both juvenile coral species, Orbicella Annularis and Acropora Palmata. This is most likely due to the protection and adequate condition that the nursery provides compared to the reef. At nurseries, some examples of factors that contribute to the higher rates of growth and survival are better water circulation, decrease in predators and pests, and more genetic diversity. Coral reefs are essential places of high economic and environmental value. Coral reefs are one of the most biodiverse ecosystems on the planet and are homes to a variety of creatures. Right now coral reefs are severely threatened by human impacts and the rising ocean temperatures, we are seeing reefs dying at an alarming rate. So, it is in our best interests to know the most successful methods of coral restoration in order to help aid in their survival.

Darien High School

Teacher: Guy Pratt

Project # 95

Sharonov, Anthony

Thermal Regulation of Perovskite Solar Cells Through Radiative Cooling Using a One Dimensional Photonic Crystal To Increase Stability Time

Completed Project, Engineering, Environmental

Hybrid perovskite solar cells (PSCs) are a renewable energy solution that is cost-effective and efficient. However, the best performing PSCs are not very stable. Radiative cooling can reduce temperatures, increasing stability. This can be achieved through a photonic crystal, which affects photons. The purpose of this project is to design and optimize a one dimensional photonic crystal for efficient radiative cooling of PSCs that will increase stability time. A possible solution to reducing temperature in PSCs is to look for available material selection as components of the photonic crystal. This material selection will have the ability of passive radiative cooling. To accomplish this goal, computer simulations in Matlab will be used to simulate materials tested. A method of analyzing, known as the Transfer Matrix Method, will be used and modified as the simulation. Inputs of materials, number of layers, thicknesses, and more into the simulation were used to gain plots of reflectivity and transmittance vs wavelengths of light. Then, the cooling power can be estimated. The simulations thus far showed that the photonic crystal designed efficiently cooled a PSC. This project will allow for PSCs to stay stable longer, ultimately adding a solution to the insatiable energy demand in this world. PSCs may also replace fossil fuels, helping to reduce global warming.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 96

Sinha, Devansi

Exploring p53 Mutation Status and Clinical Outcome in Ovarian Cancer

Completed Project, Science, Health and Medical

p53 is one of the most vital tumor suppressors in the human body and is responsible for the apoptosis of damaged or mutated cells. In some cases, p53 is mutated so apoptosis cannot occur, eventually leading to the onset of cancer. In High-Grade Serous Ovarian Cancer (HGSOC), 96% of cases have a mutation present in the p53 gene, thus making it a prevalent gene to focus on. Alternative splicing events can be used as biomarkers for the prognosis of ovarian cancer. Specifically, alternative splicing events can be linked with survival rate. The expression levels of p53 isoforms have been shown to be associated with patient survival in several cancers. By looking at the correlation between isoform type, mutation type, and survival rate, p53 isoforms can be used as prognostic markers to determine survival based on specific p53 mutation types. Certain mutation types will cause a better survival rate than others. By determining if p53 isoforms can be used as prognostic markers to determine survival length, it allows patients to gain more information about their disease and plan better for the future. Correlating specific p53 isoforms to mutation types opens possibilities for personalized medicine and treatment. Cancer is not a one size fits all and has many nuances based on the patient. Accounting for this will allow for treatment to be more effective and specific for patients who suffer from ovarian cancer.

Ridgefield High School

Teacher: Ryan Gleason

Project # 97

St Jean, Abby

Exercise Therapy to Treat Anxiety: The Effect of Running on Anxiety Levels

Completed Project, Science, Behavioral

Anxiety is a mental health disorder affecting 31% of US adults at some point in their lives. While pharmacotherapy and psychotherapy are effective in treating Anxiety, neither treatment is accessible to the entire population. Alternative treatments for Anxiety have been recently introduced, including exercise. This study is designed to measure the Anxiety levels of runners before and after their runs to determine whether running has an impact on Anxiety. It was hypothesized that running will have a positive effect on reducing Anxiety levels in runners. To measure this, each participant submitted a survey before and after they ran. The Zung Self-Rating Anxiety Scale (SAS) was utilized to calculate Anxiety levels before and after running. Self-reported data such as age, gender, frequency of exercise, time run, mileage, and pace was also collected. For 4 participants ($n = 7$), running had a positive effect on reducing Anxiety levels ($p < 0.05$). Further, Anxiety level changes are not impacted by age ($p = 0.39$) or frequency of exercise ($p = 0.18$), ($p = 0.7$). This research brings forth a potential for larger scale studies, implicating the possibility for lower income adults without access to expensive treatment, to treat their often debilitating Anxiety. Additionally, little to no research, to my knowledge, has been done focusing on the impact of specific exercises on anxiety.

Darien High School

Teacher: Guy Pratt

Project # 98

Su, Allison

Comparison of Chemical Exposure from Face Mask Materials Before and After Washing Treatments

Completed Project, Science, Physical Science

Face masks slow the spread of COVID-19, but their effectiveness also depends on the material and thickness. Some materials may not be safe for other reasons, like chemical exposure from garment particles that can be breathed in, including dyes. The purpose was to determine what face mask materials posed the most risk in terms of chemical exposure and how different washing treatments affected exposure for polyester and cotton materials. Fourteen materials were placed in separate airtight glass containers with a PDMS sorbent bar to absorb chemicals for 24 hours. Next, the fabrics were washed thrice with cold water in a portable washing machine, dried, and placed in a container again. Then, the polyesters were washed three more times. The washing process was repeated with hot water. The samplers were sent to the mentor to analyze using a mass spectrometer. Projected results are that the most chemical exposure, especially of chemicals classified as dyes, resulted from the unwashed denim. Washing tended to decrease exposure for polyester materials. The hot wash tended to result in a greater decrease in exposure than the cold wash for cotton and polyester materials. The results of this project can be used to improve current recommendations on the safest and most effective face masks by accounting for other dangerous particles people may breathe in based on exposure from mask materials themselves. The results may also be applied to determine the safety of textiles in terms of chemical exposure in other contexts, such as in clothing or bags.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 99

Sundararajan, Pranav

Investigating the Effectiveness of Artificial Neural Networks to Accurately Predict Pollutants in Connecticut

Completed Project, Science, Environmental

Connecticut has some of the worst air pollution in New England according to the 2019 State of the Air Report. These air pollutants, such as ozone and particulate matter (PM), can have a negative impact on the health of citizens. Levels of these pollutants have been predicted with methods such as linear regression and recently, artificial neural networks (ANNs). This project aimed to compare their effectiveness in predicting air pollutants. Data for the project was downloaded from the EPA and NOAA, which included PM2.5 and PM10, ozone, and other weather factors. Then, both linear regression and ANN methods were applied to the dataset using Weka, an open source machine learning software. To calculate the accuracy of the algorithms' predictions, cross-validation evaluation and root mean square error (tests the accuracy of a model against recorded values) were used. Data trends thus far have shown that the artificial neural network is typically more accurate and reliable in predicting the ozone and PM levels in comparison to linear regression, which is the standard model. This has also been suggested by previous studies that utilized artificial neural networks and found that they were more effective. The main implication of this study is furthering knowledge in the field of machine learning and air pollutant prediction, which is still relatively new. Being able to accurately predict levels of air pollution will also help policy makers or citizens who are more prone to respiratory problems to know about increased pollution in advance.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 100

Sweeney, Edwin

Measuring the Effects of the USDA Extended Summer Lunch Program on Students' Perception and Intake of Food post Covid-19

Completed Project, Science, Behavioral

After schools shut down due to Covid-19, the U.S. The Department of Agriculture (USDA) ensured that all kids could receive free meals during the Covid-19 pandemic. Subsequently, more students now have access to federally mandated school lunches, regardless of their previous eligibility for free/reduced lunch. At a regional high school in Connecticut, this has resulted in a grab and go style lunch with certain nutritional requirements. These requirements are in place to provide students with healthy and nutritious food. It is not known, however, if including highly nutritious foods in school lunches is effective in getting students, attending this specific high school, to eat more nutritiously. This research assesses the student perceptions and recommendations of current school lunches and the association between student consumption and perception of the school lunch. The hypothesis is that there is no association between student perception of school lunches and their school lunch intake. In this study, a cross-sectional survey was conducted on students attending a high school in Connecticut. The survey administered to participants consisted of 3 parts, asking participants about eating habits pertaining to the school lunch and perceptions of the school lunch. Data trends thus far show that the majority of participants rated the appeal of food and food quality lower where variety of options and amount of food scored higher. Because eating habits in teenagers vary greatly, the data from this survey can be used to provide insight into better solutions for school lunch content.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 101

Tang, Luhai

The Effect of the Satiation Principle on Student Habits and Views on Video Calls Amid the Coronavirus Pandemic

Completed Project, Science, Behavioral

The satiation principle is a disciplinary method, where one allows for someone to commit an action or force them to do it over and over, until a person deems it annoying and is tired of that certain actions, and wants to stop. The satiation principle may have changed this habit or liking of making use of video calls amid the pandemic. The purpose of this research was to find out if and how the satiation principle has taken an effect on student habits and views concerning their video call habits and likings. The hypothesis was, considering the satiation principle, students may have changed their views and eagerness to use things such as video calls with friends, families, as a result of the satiation principle taking a toll on their habits. The independent and dependent variables are the amount of time a student spends in online classes, and the amount of change a student has towards using video calls, respectively. Participants were given a survey, asking about their habits before and after the pandemic. Every month, participants will be asked to update their habits, getting a view of how it changes over the course of the year, making a correlation between the change. The data trends thus far support the hypothesis. This project provided more insight into students' points of view on a constant number of online meetings, and gave ideas as to how this can be alleviated.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 102

Tischer, Aiden

The Biofilm Promoting Nature of Bacteriophages in In-Vitro Escherichia coli. Biofilms

Completed Project, Science, Health and Medical

The Biofilm Promoting Nature of Bacteriophages in In-Vitro Escherichia coli Biofilms

Antibiotic-resistant bacteria are a growing threat to many healthcare institutions throughout the world. Escherichia coli (E. coli) is a bacteria that often develops antibiotic-resistance and is a common catheter-associated antibiotic-resistant urinary tract infection (CAUTI) causing bacteria. Due to E. coli's ability to survive antibiotic administration and form biofilms, there has been a renewed interest to develop new treatments. The use of bacteriophages (viruses that only infect bacteria) as a potential treatment for antibiotic-resistant infections, such as E. coli CAUTI, are a promising alternative to conventional antibiotics. This study seeks to determine the efficacy of bacteriophages when breaking down E. coli. biofilms. It is hypothesized that the bacteriophages will be able to break down E. coli biofilms and destroy all or significantly reduce viable cells within the biofilm. The independent variable is the bacteriophage treatment and the dependent variable is the amount of E. coli. lysis. The control is the E. coli. Biofilms that are not treated with bacteriophages. Each trial will be tested in triplicate and grown in pooled human urine. After a set incubation period, bacteriophages are added to the experimental trials. All trials then go through a MTT assay to enumerate the amount of viable cells within the biofilms. The results are analyzed to determine the cell viability from the MTT assay. Current data trends do not support the hypothesis. The results of this study, if shown to have a high efficacy, will provide a new treatment for E. coli CAUTI.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 103

Tullo, Bowen

Creating Artificial Plant Roots to Prevent Coastal Sediment Erosion

Completed Project, Engineering, Environmental

Erosion is a natural process by which soil is removed from its location and transported elsewhere. This process, unfortunately, can harm many ecosystems on the coast. Many man-made structures to prevent erosion create more problems than they prevent. I intended to create a artificial root design replicating fibrous roots systems to maximize soil security while also permitting free growth of natural ecosystems. The prototype underwent 9 separate tests to replicate three types of erosion. The prototype was placed in a container along with a large amount of soil, and experienced artificial rain and wind in an attempt to dislodge the soil. The dislodged soil was weighed to figure out how effective the prototype was at preventing erosion compared to the control, and was replaced to continue the next trial. Data trends show that the prototype displayed a noticeable improvement in holding soil from both rill and streambank erosion. The water streams from the hose that create rill erosion were displaced by the mesh, minimizing damage, and the soil during the streambank erosion tests was held in place and prevented from sliding. Interrill erosion wasn't affected much by the prototype. This prototype has the capability to bring a new age of erosion prevention, remaining effective while minimizing the negative effects of commercially available erosion prevention. While designed for coastal use due to its high risk from erosion, it has application in many other areas, such as riverbanks and farmland.

Amity Regional High School

Teacher: Nicholas Shamp

Project # 104

Vakacherla, Sanjana

Python Cybersecurity Functions

Completed Project, Engineering, Physical Science

The problem that is being addressed through this project is whether different computer programs can be used to help defend users against cyber-attacks or if these functions can be used to identify a possible attack. As the world moves towards a more digital future, it will be necessary for everyone to defend themselves against cyber attacks. With my knowledge of the programming language Python, I plan to write different programs with different purposes (checking passwords, generating sample passwords, decoding URLs, calling APIs, decoding and encoding to and from base64) using all the different Python resources. After coding all these individual functions, I will put them all together in a UI (user interface) so that it is easier to use. After completing these different functions, the functions will be tested for their individual purposes. For example, if there is a URL, the URL decoding function will be used on it, if there is malicious code in base64, the decoder/encoder will be used to determine the "secret message". If these all work as intended, then the conclusion would be that these do work for nonprofessionals and that is their intended purpose. The implications of this project would be that anyone who would be able to access this application would have a method of defense against malicious cyber attacks. They would be able to ensure a safe password, check where links are really leading, and also decode any malicious messages being sent to the computer, or any suspicious code.

Newtown High School

Teacher: Timothy Dejulio

Project # 105

Viswanathan, Shyam

Designing a Novel Social Distancing Device

Completed Project, Engineering, Health and Medical

Throughout the COVID-19 pandemic, the CDC has told the American people that it is important to stay 6ft away from others whenever it is possible. The purpose of this project was to create a small device and an app that would help people properly social distancing. Phase one of this project was creating a small device that would alert the user if they were within 6ft of another user. Phase two of this project which is still in progress is creating an app that works alongside the device to collect names of users that the user has come into contact with. This may be easier to distinguish from the many alerts a cell phone gives. Phase one was deemed successful because it was able to alert the user when another user came within 6ft. Phase two is still in progress so its efficacy has not been tested fully. The implications of this project are that it could potentially reduce the rapid spread of COVID-19 throughout the country and help identify those who may potentially be infected. Even if there is a vaccine very soon, not all people will be able to receive it immediately, there will likely be a need for social distancing for the next year.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 106

Wei, William

Algorithm For Object Detection and Avoidance for Drone Swarming

Completed Project, Engineering, Physical Science

In recent years, the development of UAV or drones are becoming more popular with more applications including in military, industry, and entertainment. One application of a drone is drone swarming which is when multiple drones operate in a cohesive manner and communicating to reach an end goal. Last year, I applied an A* algorithm on the drone swarm in unity that was somewhat effective but would still collide with other drones. This project is a continuation project from last year. The purpose of this project is to find an effective method in order to determine and orderly avoid an object ahead of the drone swarm so drone swarms can navigate through more situations and locations than just in open air. The minimum requirements for this project is for the drones to be able to identify objects, coordinate paths around the object in simulations, and ensure the drones won't collide. The limitations to this project is that the algorithm can't be tested in a real life environment. The solution used was to apply a multi-agent pathfinding algorithm to the drone swarm. The algorithm was created in a program called ardupilot which was provided by my mentor Professor Tolga Kaya. The drone swarm algorithm was applied in the simulation. With the application of this algorithm, drone swarms can go into more terrains and locations to reach its goal, which will increase the areas which the drone swarms can be useful.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 107

Wijesekera, Aadya

Creating a Mobile Application to Help Oral Immunotherapy Users Track Their Symptoms, Incidence of Allergic Reactions, and Progress

Completed Project, Engineering, Health and Medical

As food allergies become a more prominent issue around the globe, a form of treatment called Oral Immunotherapy(OIT) has emerged. In this type of treatment, the patient consumes doses of their allergen, which gradually increase from a very small dose, in order to increase the threshold for allergic reactions. This will continue until the patient reaches a maintenance dose. An important part of this process is monitoring patient progress and symptoms after dosing. The purpose of this project is to create a personalized allergy application to allow oral immunotherapy users track their symptoms after taking a dose, the overall incidence of allergic reactions and overall progress. In this experiment, I created a mobile application that allows the user to log their symptoms after taking a dose and personalize the app to fit their allergy. The application was developed using Xcode. Phase 1 of testing was proof of concept, which showed that the app worked correctly and met the criteria. In Phase 2, a survey was given in order to receive feedback and an overall rating out of 10 using a google form. In the future, this app could be used to help a user confirm that they are having an allergic reaction before administering epinephrine. It could also be geared towards other diseases, such as asthma.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 108

Wijsekera, Adithi

The Effect of pH Level on Osteoclast Health

Research Proposal, Science, Health and Medical

Osteoclasts are cells that dissolve bone while osteoblasts are cells that produce bone. Thus, decreasing the amount of osteoclasts in a bone would help individuals with inadequate bone density. The project's purpose was to determine if altering the pH level of osteoclasts can induce apoptosis. It was hypothesized that as the pH level of a solution that an osteoclast was submerged in decreased, there would be greater loss of osteoclasts. The independent variable was the pH of the solution and the dependent variable was the health of the osteoclast. The control group was the solution with a neutral pH of seven. There were five pH levels tested including the control group. Vega ZZ, an online software program, was utilized to complete this project. The osteoclast cell structure was created on the program and various simulations involving the pH level solutions were tested on the cell structure. Because the osteoclast health was not measured quantitatively, they were given a ranking one through five to indicate how healthy it was. Categories examined in the ranking system included size and color to rank the health status of the osteoclasts. Results thus far demonstrate that the hypothesis was correct. By learning about the effect of pH level on osteoclast health, those suffering with bone density and formation conditions could be helped. A decrease in osteoclasts in bones would help struggling with bone recovery, giving them time to strengthen. It has the possibility of correcting the imbalance of osteoclasts and osteoblasts.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 109

Xu, Alice

The Effect of Liquid Fertilizer versus Granular Fertilizer on the Growth and Health of Gold Nugget Tomatoes

Completed Project, Science, Environmental

Fertilizer is typically delivered in one of two forms: liquid or granular. Two main points differentiate them: the speed they deliver nutrients and the distribution of those nutrients within the fertilizer. The purpose of this project was to determine which form most benefits plant growth and health. I hypothesized that the plants given liquid fertilizer would thrive better than those given granular fertilizer. The independent variable was the fertilizer form applied to the soil. The dependent variable was the plants' growth (height in centimeters) and health (color, leaf texture, number of fruits). The control was the plants given no fertilizer. This experiment consisted of three groups (plants given liquid fertilizer, plants given granular fertilizer, plants given no fertilizer). 30 Gold Nugget Tomato seeds were planted in three seed trays. After germinating, they were transferred to pots, and the respective fertilizers were equally distributed around the soil. Each pot was watered daily and remained in the same indoor, sunlit location, rotating positions. If instructed by the packaging, additional fertilizer was given. Weekly measurements were taken and compiled into a graph to compare the plants' growth rates and overall end heights. Weekly pictures were also taken and compared to analyze plant health. Data trends thus far support the hypothesis. The results of this experiment could be used to help in choosing a fertilizer for a certain plant's needs, to improve plant growth indoors, and to steer consumers away from the more common but possibly less effective granular fertilizers to liquid fertilizers.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 110

Yan, Iris

Creating an Algorithm that Automatically Scores Tissue Images Like a Pathologist

Completed Project, Engineering, Physical Science

Cancer is the second leading cause of death globally. Finding and treating cancer at an early stage can save many lives. Pathologists have to look at tissue microarray (TMA) images manually to identify tumors, which can be time-consuming and inconsistent. Researchers have developed algorithms that automatically detect tumors, but they haven't achieved the accuracy of a pathologist so far, so they aren't used widely. Learning subtle tumor patterns requires an exponentially large number of images, but these images are very limited because of privacy concerns and regulations. Many TMA images from different cancer types have common characteristics which could provide valuable prior information for the algorithm. The proposal was to use transfer learning to extract information from tissue images of different cancer types and use it in the algorithm. The algorithm assigned a score from zero to three to each tissue image based on the severity of tumors in the image. Images used in developing and testing the algorithm were taken from the Stanford Tissue Microarray Database. The score given by the algorithm was compared to the score given by pathologists when calculating the accuracy. Data trends thus far show that using transfer learning makes the algorithm more accurate. The goal was to achieve the accuracy level of pathologists or higher, which would enable pathologists to recognize tumors in tissues consistently at a faster speed with higher accuracy.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 111

Yang, Haoyue

Developing a Program to Automate the Process of Searching for Discounts Among E-Commerce Products³

Completed Project, Engineering, Physical Science

Amid the coronavirus pandemic, many people became unemployed with excess financial strain. There are forums and extensions where users can post deals from various retailers. These interfaces introduce inconsistencies, as deals take time to find and posted onto forums. Thus, the purpose of this project was to create a program that tracks, filters, and alerts users of specific products when they've been discounted past a certain threshold on e-commerce websites. By using the eBay API as the source, data would be collected and the pricing data filtered, where it'd be stored in databases. A Python program would be used to update this database based on the API output and to monitor said database. After 2-4 weeks, with weekly updates, the price change would be recorded and communicated to the user, where products discounted past a threshold would be filtered. Results thus far showed the eBay API was capable of retrieving pricing information and being used under a Python console to be called. However, thus far, no results were concluded regarding the use of a Python database and data monitoring over long periods of time. Such a program could be used alongside existing forms and extensions to facilitate people in searching for deals. Furthermore, with increasing reliability over humans, such a program could implement AI to further facilitate monitoring and predict price changes. Because major industries and companies already receive discounts for bulk purchases, this would level the playing field for individuals and smaller, non-individual consumers.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 112

Yun, Annika

Engineering an Artificial Multilayer Perceptron that can Detect and Decrease Catastrophic Failure

Completed Project, Engineering, Physical Science

Artificial Intelligence (AI) is an expanding field and can benefit our society, but failure can lead to detrimental effects. Sometimes certain types of failure have different consequences than others. The purpose of this project was to design an artificial multilayer perceptron (MLP) that implemented techniques to avoid or limit catastrophic failure. The requirements for the MLP included the minimization of the catastrophic failure rate by altering the training process. The MLP was engineered using Python and Keras, a Python library catered to engineering artificial neural networks. The MLP was trained to be accurate at the primary function, which was Tic-Tac-Toe. Catastrophic failure was defined as inaccuracy caused by new situations. The catastrophic failure was caused by feeding new inputs into the MLP, which caused inaccuracy. Techniques were then implemented into the training process that solved this failure. The effectiveness of my MLP was measured by how well the neural network could minimize catastrophic failure while maintaining a reasonable accuracy. The data thus far shows progress toward a successful model. The techniques used in this project could be applied to other AIs where decreasing catastrophic failure is extremely important. As society becomes more dependent on AI, safety will become critical. Developing effective ways of preventing catastrophic failure will lead to safety on a societal level.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 113

Zhan, Annie

Determining the Antimicrobial Effect of *Pseudomonas koreensis* and Their Secondary Metabolites to Inhibit Pathogenic Microbes and Improve Plant Health

Completed Project, Science, Environmental

Pseudomonas is a bacteria that is typically found in soil, water, and tissue. Almost all strains of *Pseudomonas* carry secondary metabolites, which are compounds produced by certain bacteria that serve no specific purpose. It has been shown that secondary metabolites of certain *Pseudomonas* bacteria carry antimicrobial properties that can benefit plant health. This project focused on *P. koreensis*, a less-studied type of *Pseudomonas*, and sought to determine its ability to inhibit pathogens and improve plant health. It was hypothesized that if *P. koreensis* was tested for its antimicrobial activity against pathogenic microbes in plant soil, then it would have a significant effect on plant health. Two experiments were conducted: one to test antimicrobial ability, and another to determine effect on plant health. No physical experiments were performed by me, and most data was collected by my mentor. For the first experiment, soil samples containing *P. koreensis* were collected and diluted onto Petri dishes and tested against multiple different pathogenic microbes. Visuals of the zones of inhibition were given to me and a computer program was utilized to measure the dimensions of them. To test plant health, three groups of tomato plants treated with *Fusarium* were used: one containing no added bacteria, one with biosurfactant; and one containing *P. koreensis*. Data showed that *P. koreensis* was able to effectively inhibit pathogenic activity and significantly improve plant health. The results of this study may provide a better understanding of whether *P. koreensis* has the capability to potentially be used as an antibiotic in the future.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 114

Zhang, Mason

Using Deep Learning to Efficiently Quantify the Impact of Road Salt Runoff on the Swim Performance of Wood Frog Tadpoles

Completed Project, Science, Environmental

Global environmental change is perhaps best underscored by America's road networks spanning 20 million kilometers. Specifically, roads have irreversible effects on natural habitats, hotspots of amphibian diversity, being conduits of fragmentation and pollution where road salt invades the surrounding landscape and salinizes freshwater. Thus, this study's purpose was to quantify how road salt affects wood frog tadpole swim performance, a vital locomotor function of predator evasion. It was hypothesized that tadpoles in habitats with higher salinity would have faster swimming speeds because of the adaptive need of increased fitness to maintain survival in harsh environments. The independent variable was habitat location, where the difference between woodland and salinized roadside groups were examined. The dependent variable was maximum burst speed, measured via pixels over time since the data was video-based. The control was the tadpoles raised in natural woodland ponds. This project worked with pre-existing video data filmed from a downward vertical angle. Using OpenShot Video Editor, 600 videos were made a constant two seconds and analyzed using the Python package DeepLabCut which trains deep neural networks by running iterations. These outputs of tadpole velocity were then plotted in R. Preliminarily, the data suggests that swimming speed is impaired to an extent to road salt. Overall, deep neural networks are extremely efficient and versatile compared to traditional techniques. By understanding how adaptation acts as a natural counteractant against invasive contaminants like salts, conservationists can better grasp the complex influences of roads to find realistic solutions.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 115

Zhang, Wendy

Analyzing the Role of Sonic Hedgehog Signaling in Germinal Center B-cell Differentiation by Single-Cell RNA Sequencing

Completed Project, Science, Health and Medical

The Sonic Hedgehog (SHH) signaling pathway is a molecular process that creates a transcriptional change in cells. In my research project from last year, SHH was found to be present in intermediary steps of germinal center B-cells, a type of white blood cell, with high expression in germinal centers. The purpose of this project is to continue to analyze SHH and its role on germinal center B-cell fate. It was hypothesized that SHH encourages B-cells to differentiate into an intermediary step, preparing B-cells to be ready for change. The independent variable is SHH signaling receipt, measured by the presence of Gli-1, the end product of SHH signaling. The dependent variables were the specific types of cells and the genes they express. The data for this project was from the research paper "Novel specialized cell state and spatial compartments within the germinal center", which included single cell RNA-sequencing for 5,159 germinal center B-cells using the Drop-Seq method. Because of this, the data was not limited by a few reagents in immunofluorescence imaging. Using the Broad Institute Gene Set Enrichment set, genes specific to the SHH signaling pathway and cell types can be specifically identified. This allowed for clusters of cells grouped by similar characteristics and pseudotime, which provided models for differentiation. Preliminary reports provide an indication of successful clustering with unclear results. If this project is successful, it can further the knowledge of b-cell fate and differentiation, which can be used to improve the precision of treatment and drugs.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 116

Zhang, Ethan

Robotic Pancreatoduodenectomy (PD) vs. Open PD: A Meta-analysis-driven Algorithm to Enhance Surgical Decision Making

Completed Project, Science, Physical Science

Besides the \$3000-6000 difference between robotic and open surgery, past studies have shown the inferiority of robotic pancreaticoduodenectomy (PD) as compared to open PD. However, a study with an adequate sample size remains unperformed in the current era. The present study seeks to fulfill two objectives: (1) to compare the efficacy of robotic and open PD, and (2) to create an algorithm to facilitate the selection of optimal PD approach. A meta-analysis was implemented, and five databases were searched. All clinical studies comparing robotic to open PD for benign and/or malignant disease were eligible for inclusion. There were six primary endpoints of this study: length of hospitalization, surgical site infection (SSI) rate, margin involvement rate, operating time, reoperation rate, and number of lymph nodes harvested. This meta-analysis concluded that robotic PD is at least comparable to its open counterpart: Five primary endpoints (length of hospitalization, incisional SSI, margin involvement rate, reoperation rate, and lymph nodes harvested) favored robotic PD, and one primary endpoint (operating time) favored open PD. The second conclusion comes in the form of an algorithm that gives surgeons and patients insight into the favorable PD approach on a case-by-case basis. These results will improve postoperative quality of life, as surgeons and patients will be able to select the PD procedure that has a greater chance to yield desired surgical outcomes. This will translate into more individualized treatments for different patients.

Darien High School

Teacher: Christine Leventhal

Project # 117

Team: Brady, Ainsley; Daugherty, Emma

The Effect of Age and Duration of Routine Exercise on the Development and Risk of Dementia

Completed Project, Science, Health and Medical

Global dementia cases are on the rise. Dementia affects the brain through neurodegeneration, which often leads to memory loss. There is no medicinal cure for most types of dementia. One factor that has been shown to help slow down disease progression and potentially decrease risk is exercise. A simple lifestyle change has the potential to decrease the amount of people with Dementia. Approximately fifteen eligible journal articles were collected to conduct a meta-analysis. All articles met the same criteria and addressed the following: age, intensity, and cognition. Authors were emailed to ensure there were no objections to their research being included. The data from the journal articles was analyzed for trends and compared for differences. Findings were communicated through a journal article review. The analysis is currently being conducted so results are still being finalized. Results gathered up to this point suggests that exercise has the most substantial positive impact on life long cognition when performed during childhood. The cognitive benefit of adolescent exercise continues into adulthood even if the exercise is stopped, however it is most beneficial to continue at least moderate exercise throughout one's lifetime. Dementia's multifaceted nature makes many forms difficult to treat. By identifying exercise as an impactful method to preserve cognition, more emphasis can be put on its importance. Physicians can advise exercise for not only its physical but cognitive benefits. These findings further stress the importance of healthy living and point to increased sedentary life as a contributor to the growth in dementia cases.

Ridgefield High School

Teacher: Patrick Hughes

Project # 118

Team: Chang, Eugene; Silbert, Jacob;

Removal of Phenol from Drinking Water utilizing Food-Derived Activated Carbon (AC) Combined with Nickel (II) Oxide

Completed Project, Engineering, Environmental

Phenol is a highly toxic aromatic compound frequently released into the environment via various anthropogenic sources. Activated carbon and Nickel (II) oxide have both been shown to be effective phenol adsorbents. AC is also a very sustainable material, as it can be sourced from biomass like food waste, making it a desirable sorbent. This project aimed to utilize food-derived AC combined with NiO to detoxify phenolic water. The mentor conducted batch experiments by placing the AC/NiO sorbent into phenolic solutions of varying concentrations over varying periods of time. These experiments yielded data about the capacity and adsorption rate of the sorbent. The students used this data to create thermodynamic and kinetic models of the tested adsorption process. These models were then employed to propose the design of an AC/NiO-based filter for removing phenol from water. Findings thus far have been inconclusive. The findings of this project may lead to innovations that more effectively purify water and, therefore, support public health. Additionally, by utilizing biomass in a sustainable manner, less will need to be placed in landfills, thereby lowering the demand for deforestation and excavation. Decreased environmental damage will, in turn, leave more trees standing to absorb atmospheric carbon and lessen the global greenhouse effect.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 119

Team: Chen, Caroline; Chen, Christian;

Determining the Trend of Nitrogen Deposition Over Time Near Lake Erie and Its Influence on Lake Eutrophication

Completed Project, Science, Environmental

Harmful algal blooms (HABs) are in desperate need of a solution. They use up valuable resources in freshwater systems and coastal waters. Lake Erie experienced its largest, yet unexpected, harmful algal bloom in 2011. A machine learning model that utilizes simulated data from various modeling systems to predict eutrophication in Lake Erie is under development, but one major uncertainty is the relative importance of atmospheric nitrogen deposition (reduced/oxidized forms) in determining the occurrence and severity of HABs. The purpose of this project was to conduct an assessment of atmospheric nitrogen deposition levels near Lake Erie from 2002 to 2012 using outputs from EPA's air quality modeling system (CMAQ) and comparing them to observed nitrogen deposition measurements from the National Atmospheric Deposition Program (NADP) to better understand the change of atmospheric nitrogen compounds and assess their influence on HAB occurrence. The trend of nitrogen deposition over time near Lake Erie from 2002-2012 was determined using data from the NADP for 15 sites. These trends were compared with the modeled data predicted by the CMAQ modeling system. It was projected that levels of certain nitrogen compounds, namely nitrate, decreased while levels of other nitrogen compounds, specifically ammonium, increased from 2002-2012 near Lake Erie. Determining nitrogen trends and comparing them to CMAQ predictions will allow for the refinement of the current machine learning model for chlorophyll-a prediction (a proxy for eutrophication) under development, making predictions of HABs more accurate and potentially allowing for methods to control eutrophication and HABs before they occur.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 120

Team: Daugherty, Emma; Brady, Ainsley;

The Effect of Age and Duration of Routine Exercise on the Development and Risk of Dementia

Completed Project, Science, Health and Medical

An increasing number of people are developing various forms of dementia. Dementia affects the brain through neurodegeneration, which often leads to memory loss. There is no medicinal cure for the many types of dementia. One factor that has been shown to help slow down the progression of the disease and potentially decrease risk is exercise. A simple lifestyle change has the potential to decrease the amount of people with Dementia. Approximately fifteen eligible journal articles were collected to conduct a meta-analysis. All articles met the same criteria and covered the following variables: age, intensity, and cognition. Authors were emailed to ensure there were no objections to their research being included. The data from the journal articles was analyzed for trends and compared for differences. Finally, the findings were communicated through a journal article review. The analysis is currently being conducted so results are still being finalized. Information gathered from the analysis up to this point suggests that exercise has the most substantial positive impact on life long cognition when performed during childhood. The cognitive benefit of adolescent exercise continues into adulthood even if the exercise is stopped, however it is most beneficial to continue at least moderate exercise throughout one's lifetime to maximize benefits. Dementia's multifaceted nature makes many forms difficult to treat. By identifying exercise as an impactful method to preserve cognition and delay or prevent dementia, more emphasis can be put on its importance. Physicians can advise exercise not only for its physical benefits but also cognitive. These findings further stress the importance of healthy living and points to increased sedentary life as a contributor to the growth in dementia cases.

Ridgefield High School

Teacher: Ryan Gleason

Project # 121

Team: Dunphy, Megan; Wilkenloh, Kelsi;

Analyzing the Ability of the SCiO Spectrometer to Detect the Presence of Nutrients in Soil

Completed Project, Science, Environmental

The SCiO spectrometer offers gardeners and farmers a quicker, more cost effective way to analyze the contents of soil. The SCiO, a pocket sized spectrometer is normally associated with the analysis of food, however this experiment seeks to expand the use of the SCiO spectrometer to the agricultural field. This poses the question: does the SCiO spectrometer have the ability to accurately analyze the presence of phosphorus in soil? In the first phase of the methodology, soil samples with unknown phosphorus concentrations were collected from 5 different sites. Next, the samples were scanned using the SCiO and uploaded to the developers forum for analysis. In the final phase, the scans were compared with results from a soil test kit and soil fertility lab to determine if different concentrations of phosphorus are accurately differentiated by the scans. The scans of the soil samples are clearly differentiable in the developer's forum and when assigned a classification of phosphorus content as low, medium, or high they are situated with the scans of their classification. Consequently, the results convey the ability of the SCiO to accurately determine levels of phosphorus in soil. The experiment serves as an example of the SCiO's capabilities beyond its traditional uses in the food industry. The SCiO can be extremely useful to gardeners and farmers who seek to determine the health of their soil in terms of nutrients and now have access to a reusable soil testing device that can analyze a variety of different things about soil.

Ridgefield High School

Teacher: Ryan Gleason

Project # 122

Team: Feuerstein, Joshua; Scully, Peter;

Creating a Platform Capable of Conveying News Article Bias

Completed Project, Engineering, Physical Science

Today, people of differing political ideologies tend to get their information from different sources and often have very different opinions of bias. Fortunately, computer science already has potential for more objectively analyzing media bias. The purpose of this project was to take advantage of this and create a platform capable of dissecting articles in the context of bias and factual integrity, conveniently and succinctly conveying this information to a user. The constraints of this project were limited time, lack of extensive knowledge or experience in design and application programming, and a lack of money to buy expensive design software. The criteria were that the platform accurately assesses bias and has a functional and user-friendly user interface. The application was programmed modularly, such that features will be sequentially programmed and integrated upon readiness. The application was programmed in Expo, an open source app development platform, utilizing the React Native typescript library. Bias is assessed utilizing NLP and test cases of manually, professionally assessed articles. All source code is hosted in a GitHub repository, and all UI/UX design was done in Figma. All work with the mentor will be in code reviews and advice -- no direct progress will be made by the mentor. If effective, this application will have the potential to aid in reducing the divisiveness of current politics and social issues, possibly leading to a more educated and civil future.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 123

Team: Grey, Julia; Clifford, Caroline;

The Socio-economic Implications of COVID-19 on the Ridgefield, Connecticut Community

Completed Project, Science, Behavioral

In the wake of the COVID-19 pandemic, researchers are exploring the socio-economic implications of the virus both nationally and internationally. Ridgefield, Connecticut is an extremely affluent town and it is important that its inhabitants recognize how socioeconomically privileged they are compared to much of the rest of the country. Participants will be asked to fill out a short ten-question survey. Questions are modeled off of data provided by Marketplace's Economic Anxiety Index. The survey will take each participant 5-10 minutes to complete. Identifying information will not be collected. The data will be collected anonymously through a Google Form. We will compare results with Marketplace's public data, and public data from Statista to reach a larger conclusion about the town. We expect to deduce that the COVID-19 pandemic has not fostered significant socioeconomic blows to the Ridgefield, Connecticut community as a whole. It is foreseen that most of the received responses will indicate that the community overall is economically comfortable, and is not struggling with expenses or spending in general. It is important that our community realize how fortunate we are to remain economically comfortable in the wake of a global pandemic. COVID-19 has taken over one million lives, and forced many to remain stagnant in their homes or communities for months, unable to work, enjoy leisure time, or see loved ones. Ridgefield, Connecticut has experienced these drawbacks, yet it is essential that constituents understand how lucky they truly are.

Ridgefield High School

Teacher: Patrick Hughes

Project # 124

Team: Griffin, Claire; Voellmicke, Isabel;

A Simple Model of guideRNA for CRISPR-Cas9

Completed Project, Science, Health and Medical

The purpose of our research is to create a model that allows for easier and more efficient guideRNA design for CRISPR-Cas9 genome engineering technology. Our motivation to complete such a project was to ensure that students and scientists using CRISPR for the first time will have a more concise way to design, order, and clone their RNA oligonucleotides. This will make CRISPR technology more accessible. First, we researched the criteria for guideRNAs in CRISPR-Cas9 and also how to most efficiently clone these oligonucleotides into a CRISPR plasmid. Then, we found the restriction enzymes that were used in Golden Gate cloning and included the restriction sites needed. Finally, we fused these various elements to create our guideRNA model. This procedure produced an accurate and efficient model for sgRNA design. This model includes restriction enzymes and will allow for the oligonucleotides to be easily transitioned to the appropriate orientation for purchase. This model is very clear and visually appealing, as well as very accessible to users of CRISPR technology. This model benefits younger scientists in navigating through the sgRNA portion of the CRISPR process, which we have identified as being slightly complicated. Further, this model will ensure that there are less errors being made in the sgRNA portion, preventing loss of materials and lab time. Overall, this model is very beneficial to the accuracy of CRISPR experiments and is an excellent guides to newer users in the CRISPR field.

Ridgefield High School

Teacher: Patrick Hughes

Project # 125

Team: Kim, Andrew; Paliwal, Arnav;

The Extent of Universal Grammar Theory in Assisting English Grammar Acquisition for Post-Puberty Second Language Learners

Completed Project, Science, Behavioral

The Universal Grammar (UG) theory implies that all humans should have an equal ability to learn a language and its grammar. The purpose of this study was to determine the extent to which UG assists post-puberty second language English grammar acquisition. It was hypothesized that post-puberty second language English learners will be able to access, to some extent, UG when understanding English grammar because humans are born with access to it. Participants' background language knowledge was acquired through a language history questionnaire. Participants were then separated into pre- and post-puberty English learners. Participants then took a 10 question 30 minute grammar test to assess the extent of their acquisition. A paired t-test was run to determine the extent to which UG assisted the grammar acquisition. Also, a Fisher Exact Test was done on case study groups to differentiate the effect based on primary language. Based on the data collected thus far, no conclusive statement on the effect of UG on grammar acquisition in second language learners can be made. If the hypothesis is valid, it would help support the claim that UG exists and is applicable to language acquisition for all ages, not just young children. This could lead to better understanding on how language acquisition works and design language classes around this information to assist second language learners in integrating into new countries.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 126

Team: Kongani, Adarsh; London, Philip;

Creating an Optical Fiber Daylighting System for Hydroponics With Raspberry Pi Active Dual Axis Solar Tracking

Completed Project, Engineering, Physical Science

Hydroponic farming, an indoor farming method, has demonstrated potential to be the future of the agriculture and food production industry. Hydroponic farming reaps massive benefits, however, installing hydroponic lighting systems or greenhouse environments is expensive and requires resources like electricity, making hydroponics inaccessible for many. The purpose of this project is to create an adaptable, low cost, and maintenance optical fiber daylighting system for hydroponics that can be easily installed in a variety of physical spaces and environments. This project used a fresnel lens and fiber optic cable to focus, transport, and diffuse light over a given area.

Development of the system was split between partners. One student created a solar tracking program using Raspberry Pi and electronic hardware. A Python program used light dependent resistors as input and adjusted servo motors accordingly to accurately track the sun. The other student constructed a dual axis solar collection rig that provided a frame and mobility for the lens, solar panel, and optical cable. Throughout development, the mentor provided oversight and guidance virtually. After assembling the combined system, we analyzed its effectiveness by comparing it to LED illumination, direct sunlight and comparing costs and light intensity. Results thus far show that our daylighting system is more efficient than LED. As expected, direct sunlight had a higher intensity, but was more expensive. Promoting the use of hydroponics with our design will allow for more efficient, environmentally-friendly farming and improve agriculture in areas where typical farming methods are not as effective.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 127

Team: Kongani, Keerthi; Luo, Margaret;

Determining the specific number or set of mutations occurring in mtDNA that is associated with Diabetes Mellitus.

Completed Project, Science, Health and Medical

Mitochondrial DNA encodes for proteins essential for mitochondria energy producing functions. Previous studies observed abnormal mitochondria morphology and function in patients with diabetes mellitus, likely caused by the chronic increases in blood glucose levels as well as other factors increasing oxidative stress. Mitochondrial DNA (mtDNA) can mutate as a result of oxidative stressors as found to be the case in patients with diabetes mellitus. Our research aims to determine whether there is a specific amount or set of mitochondrial DNA mutations that is consistently found in individuals with diabetes mellitus. We hypothesized that the mitochondrial genome is more susceptible to mutations in diabetic patients, and such mutations are located in specific places on the genome. The independent variable is whether a mtDNA sequence came from a diabetic or non-diabetic person. The dependent variable is the differences between the sequences. This study used human mtDNA sequences found in the NCBI database. Percent identities of diabetic and non-diabetic sequences to the reference genome were compared to determine whether diabetic mtDNA is more unstable and prone to mutagenesis. Qualitative analysis was done by determining the locations of consistent mutations in diabetic genomes. All this was done by the student researchers. Data trends thus far indicate different average percent identities between diabetic and non-diabetic genomes, as well as certain locations that are consistently more mutated in diabetic mtDNA. This study may provide insights into mitochondrial dysfunction in diabetes mellitus and may contribute towards our understanding on the effects of mitochondrial genetics in diabetes mellitus.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 128

Team: Liu, Allen; Munim, Sheehan;

Development of a WatchOS Application that uses HRV and Vibrational Pulses to Reduce Stress

Completed Project, Engineering, Behavioral

Stress is a reaction that can negatively affect many people, and it has a strong correlation to Heart Rate Variability (HRV), a measure of the variation in time between each heartbeat. Research shows that vibrational pulses can reduce stress and increase HRV. The application that was created helps reduce this stress and increase HRV for people that are negatively affected. To test the application, participants were split into 2 groups, A and B, who remotely completed a stressful task of summarizing an article in the time span of 10 minutes. During the task, Group A did not run the application whereas Group B did. Before and after the task, a SCARED test was given to measure anxiety and stress levels. HRV was also measured before, during, and after the task. Analyzing the SCARED test, HRV averages, and task scores, the preliminary data suggests that Group B, which had received the vibrational pulses had a higher HRV and task score, while maintaining a lower result on the SCARED test. A lower score on the SCARED test signifies less stress. Greater implications of this application are to add features such as custom haptic responses, night time vibrations to enhance REM sleep, and to send vibrations when it detects irregular HRV. A separate device can be created using HRV and vibrational pulses to make the technology more affordable as well. These implications intend to increase HRV and reduce stress, with the aspiration of improving wellbeing for people across the world.

Amity Regional High School

Teacher: Catherine Piscitelli

Project # 129

This project has been withdrawn.

Project # 130

This project has been withdrawn.

Project # 131

Aflalo, Sophie

The Effect of Deep Breathing, Meditation, and Extended Breaks on Practice SAT scores

Research Proposal, science, Behavioral

Anxiety is a prominent issue for highschool students in the United States when taking SAT tests, and the accuracy of their knowledge is altered by generalized anxiety disorder; Different anxiety relieving tools will be used to increase accuracy and decrease anxiety for students. The objective of this study is to find tools that ease individuals anxiety levels and allow the SATs to depict an accurate representation of student's cumulative knowledge. This investigation will compare deep breathing, meditation, and extended breaks on each portion of a practice SAT in subjects diagnosed with GAD, Generalized Anxiety Disorder. Effectiveness will be evaluated by comparing prior test scores to scores achieved when using anxiety relieving tools mentioned prior. In addition, subjects will self-evaluate anxiety using theThe Westside Test Anxiety Score which assesses a person's anxiety at a given moment using ten questions with a 5 point grading scale. If each subject takes a practice SAT test using the anxiety relieving tools, it is expected that the self-assessments will display a decrease in anxiety that directly correlates to an increase in practice SAT test scores compared to the control (no tools used). If the hypothesis proves correct, these tools may be implemented in highschool where students are required to take the SAT in order to graduate.United States take both the SAT and ACT.

Staples High School

Teacher: Amy Parent

Project # 132

Alexander, Alena

3D-Printing Programmed Ferromagnetic Domains for Fast-Transforming Soft Artery Stents

Research Proposal, Engineering, Physical Science

Are there safer ways to magnetically manipulate devices in the human body? Magnetic energy is an efficient technique because of its capabilities in delivering forces of propulsion/steering without a local device-bound power source. Here, ferromagnetic domains and soft materials are combined to make a robot with fast transformations between complex 3D shapes to find whether magnetic dipole moments are efficient actuation methods for soft artery stents. Manipulate a 3D printer by adding an electromagnet nozzle to the dispenser to embed silica nanoparticles into the silica-rubber elastomer matrix. The magnetic polarities of the deposited inks will be tuned to our desire by switching the field or printing direction. With this, microparticles are programmed for the desired expansion properties, allowing us to code 3D structures. The actuation abilities will be tested in a faux artery model. As this experiment comes to a close, our expected results will be that 3D-printing the device will work, Magnetic Dipole Movements will be an efficient actuation method for the artery stent, and that the stent will be able to expand and collapse efficiently based on the exerted magnetic field. My research could advance reconfigurable soft electronics, programmable domains, & rational designs of customized programmable matter. The composite ink used to 3D print the robot opens plenty of possibilities behind constructing different sizes and shapes with ease. It advances the idea that magnetic fields can be used for safe and effective manipulation methods for biomedical applications. Remote magnetized manipulation enables actuation of tethered and untethered materials without the need of a power supply.

Ridgefield High School

Teacher: Patrick Hughes

Project # 133

Amara, Jake

Design Study: Downsizing Nuclear Fusion Devices to a More Manageable Scale

Research Proposal, Science, Physical Science

Current fusion reactor designs require immense amounts of space, complicated and custom made components, and specialized housing facilities that take years to construct. At this rate, nuclear fusion will not be able to replace current power needs to mitigate the effects of traditional power generation methods. Create a design for a nuclear fusion reactor that utilizes a Deuterium-Deuterium fuel system to fuse hydrogen into helium creating energy. This design will be significantly smaller than other reactor designs such as the JET reactor and ITER reactor. The design will be made using a 3D modelling program such as Autodesk Inventor, Blender, or Fusion 360. So far it is certain that the method used for fusion will be based on the same process that JET and ITER use with electromagnets which heat the gas into plasma. The plasma will then cause the deuterium particles to fuse into helium and give off excess heat which will be used to generate power. With the reactor design that is anticipated to result from this research, it can be used to create fusion reactors that are easily manufactured, transported and operated without the need of specialized facilities. Power can be produced anywhere in the world and given the method, will not contribute to climate change unlike traditional power generation methods.

Ridgefield High School

Teacher: Patrick Hughes

Project # 134

Amlicke, Lucas

Implementing Modified OCR and Concurrent Solving to Create a Math Scanner that Surpasses Commercial Speed and Accuracy.

Research Proposal, Science, Physical

The final setback to modern commercial math scanner software is the inability to solve multiple equations without requiring significant user input. The Amlicke program (Amlicke, 2020) will be tested against commercial math scanner software and be shown to override the limitations of commercial math scan software to reduce the time to solve multiple equations and increase the accuracy of the solutions. The accuracy of the program's solutions will decrease as the complexity of the equations increase because giving the math solver more numbers and symbols may cause it to return an erroneous solution. The proposed research will explore the possibilities of modifying modern optical character recognition and provide the world with the next fastest way to solve complex formulae. People have been trying to improve the speed of their apps by increasing the efficiency of the OCR and machine learning software, however the simpler solution is minimizing human input dependencies and programming computers to do more of the decision making so that humans spend less time taking pictures. If the increase in equation complexity does significantly decrease the accuracy of the solutions and the amount of OCR errors, then it is implied that the modified OCR will need more training sets or that the math solver of the program needs to be improved.

Staples High School

Teacher: Amy Parent

Project # 135

Anderson, Ava

The Efficacy of Nootkatone Compared to Existing Insect Repellents

Research Proposal, Science, Health and Medical

Lyme disease is the most commonly transmitted vector disease. An important method of reducing cases is the use of repellents. Nootkatone is a chemical found in grapefruits and is very effective at repelling ticks. My research will compare the efficacy of Nootkatone with current plant-based repellents and DEET. The standard method of testing repellents involves placing ticks on a subject's forearm. However, ticks are shown to flock to dry ice, so I will use this as an alternative. I will treat the testing surfaces with 20% DEET, 20% Nootkatone, and 20% oil of lemon eucalyptus. I will place black-legged ticks on the surface and test efficacy at intervals of 30 minutes for a total of six hours. I expect that at these concentrations, Nootkatone will last as long and be as effective as DEET, while being significantly more effective and longer-lasting than the oil of lemon eucalyptus. I expect these results because it has been shown that Nootkatone can last for 3 days when used as an acaricide, with no encapsulation or modification, and I expect this to apply to its repellency as well. Diligent use of repellents is extremely important in reducing Lyme disease cases. However, people have concerns about chemical repellents, such as DEET, and current plant-based repellents only last an hour. By having an effective, long-lasting alternative to current repellents, that consumers are comfortable using, we are taking a step to reduce Lyme disease transmission. My research will demonstrate if nootkatone is a viable replacement for DEET.

Ridgefield High School

Teacher: Ryan Gleason

Project # 136

Team: Augustine, Sarah; Berkery, Isabelle;

Comparison of Dog and Wolf Behavior and Ability to Complete Cooperative Tasks

Research Proposal, Science, Behavioral

This project compares the effect of domestication of dogs and wolves by observing each species' behavior while participating in a specially designed task. Through this experiment, we expect to gain more insight into the effect of domestication on intra-specie cooperation and play behavior between wolves and humans. We hypothesize that wolves will be less likely to cooperate with humans compared to dogs. We will recruit 4 dogs from local owners and work with 4 wolves from the Wolf Conservation Center in CT. We will conduct four tests over five days: tug of war with a human resulting in a treat, tug of war with an object resulting in a treat, tug of war with a human resulting in praise, tug of war with an object resulting in praise. Average playtime with humans versus objects and with praise vs treats will be recorded. We expect that the dogs will play longer with the human while the wolves will play longer with the object instead. We expect dogs to play longer than the wolves for a treat rather than praise. In conclusion, the evolution and domestication of dogs resulted in them being more cooperative with working with humans compared to the wolves' level of cooperation. We expect our results to reflect the effect of domestication of the wolves versus the dogs. This experiment will most likely lead us to more testing to prove our hypothesis that the wolves will be the aggressors while the dogs will follow.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 137

Axel, Brooke

The Effects of Specific Neuropeptides on Cluster B Personality Disorders

Research Proposal, Science, Behavioral

Individuals with cluster B personality disorders, which includes Antisocial, Borderline, Narcissistic, and Histrionic personality disorders, experience symptoms that cause them to have a limited, or in some cases non-existent, capacity for empathy towards others. This inability is harmful to both those with these disorders and those around them; leading to suicide, self-harm, and a plethora of violent crimes. Through a systematic review of studies on the effects of added oxytocin and vasopressin, as well as their antagonists, on people with these disorders as well as healthy people with a below-average capacity for empathy, I will create a proposed treatment plan for each of these disorders. The data will be sorted and analyzed based on the studies' participants, methodology, and results. Patterns and discrepancies will both be noted and examined for value and reasoning. Through my research, I expect to find a correlation between changed levels of one or more of these neuropeptides and increased empathy in people with these disorders. I also expect to find significant changes in other behaviors such as affiliation, anxiety, and aggression. Treating these disorders will help to make individuals with them happier, more productive, members of society. It will also help all those around people with these disorders by lessening crime and domestic trauma. While there is a genetic component, these disorders are triggered by early childhood trauma, often from having a parent with a cluster B disorder. This research will therefore help to cure everyday people and to reform prisoners.

Ridgefield High School

Teacher: Ryan Gleason

Project # 138

Banks, Claire

Engineering a Chemical Inhibitor in Methicillin-Resistant Staphylococcus aureus (MRSA) using Nanoparticles as Antibiotic-delivery Vehicles (ADV's)

Research Proposal, Science, Health and Medical

Staphylococcus aureus kills more people than Parkinson's disease, HIV/AIDS, emphysema, and homicides combined. Over time, the bacteria have mutated and become resistant to engineered inhibitors; the result is a strain known as Methicillin-Resistant Staphylococcus aureus (MRSA). MRSA uses a communication complex called quorum sensing (QS), which is a density-dependent process and, at high cell levels, allows for bacteria to trigger the production of biofilm and express QS-dependent virulence factors. A multitude of bacterial pathogens use QS systems and agr-like genes, which code for the expression of virulence factors. In order to reach such stages, signaling molecules called autoinducers (AIs) act as chemical messengers that bind to receptors on nearby cells. An inhibitor has been engineered to replace the AIs, by blocking the receptors and preventing expressive traits. Research has been conducted using inhibitors, namely β -Lactam Penicillin G (PenG), and has been successful in the prevention of the agr gene. This experiment will track the fluorescent chemical inhibitor to determine its effectiveness in halting the bacteria's growth and also engineer a common AI inhibitor by combining a vancomycin cocktail that continues to be the drug of choice for traditional MRSA treatment. The cocktail will then be transported using the fluorescent nanoparticles as antibiotic-delivery vehicles. It is expected that the PenG and vancomycin cocktail will be partially or wholly able to inhibit virulence factors and biofilm development in MRSA. Results could be used to transform vaccinations and the traditional approach to attacking a bacterial infection.

Darien High School

Teacher: David Lewis

Project # 139

Barlow, Samantha

Peanut Sublingual Immunotherapy

Research Proposal, Science, Health and Medical

Peanut allergies are the most common cause of fatal food-induced anaphylaxis, and there is currently no approved treatment. This study will track the progress of continued desensitization and efficacy of peanut sublingual immunotherapy (SLIT). The moderate increase of dosing administration of peanut SLIT will serve as a viable alternative for the treatment of a peanut allergy. 100 patients will be recruited aged infant to toddler, who have a moderate to severe reaction to peanuts. A previous study performed peanut SLIT using children age 1 to 11 years, for only 5 years. Additionally there was no increase of dosing, remaining at 2 mg/d. In this experiment the subjects will undergo extended maintenance SLIT beginning with 2.5 mg/d peanut protein. Then, gradually increasing by 0.25 mg/d every 2 months, for up to 5 years. Subjects with peanut skin test wheals of less than 3 mm would be allowed to discontinue therapy early. Desensitization will be assessed through biomarkers that can reliably predict the response to the treatment. It will be proven through subjects who show no sign of reaction with up to 10,000 mg of peanut protein after completion of SLIT dosing. As peanut allergies affect over 1.2 million children, and the likelihood of it being outgrown is very low, the success of this experiment could have astronomical effects. It is predicted that a gradual increase of the peanut protein, and a long amount of time, will greatly improve the subjects desensitization to peanuts.

Darien High School

Teacher: David Lewis

Project # 140

Bates, Elizabeth

nonoperative treatment of appendicitis with antibiotics in the progression to peritonitis

Research Proposal, Science, Health and Medical

Appendicitis is a common disease with 250,000 diagnosed people in the US alone. It is a painful infection of the appendix which in some cases can be fatal. There are many ways to treat this disease, most commonly a laparoscopic appendectomy, but recent studies have taken the use of antibiotics into place. The question is, how does the progression of the appendicitis change the outcome of nonoperative treatment. This study should include children under the age of 18 who have shown symptoms of peritonitis such as fever, pain in the abdomen, shortness of breath and rapid breathing etc. these symptoms can be confirmed with the use of an ultrasound to see if the appendix has ruptured spreading the infection. The trial will be randomized doses of antibiotics of the use of an appendectomy. If symptoms get too severe the use of an interval appendectomy will be used. In a study by Roxani Georgiou et al. the study of treatment acute appendicitis without appendectomy, they treated acute appendicitis with the use of antibiotics rather than an appendectomy. The results of the treatment were 97% successful with only 17 people of the 413 needing an appendectomy. There were no adverse effects and all of the children in the study were treated. The implications of this study are that the children will be treated without the stresses and adverse effects of surgery. As well as avoiding general anesthesia and being treated for a highly painful disease with a noninvasive treatment.

Darien High School

Teacher: Guy Pratt

Project # 141

Bernal, Martina

Assessing the Effect of Two Species of Seagrass on Acidity in a Model of Ocean Water

Research Proposal, Science, Environmental

Our entire world is connected to the ocean making the health of the ocean a priority when maintaining the health of our planet. The focus of this research is studying the effect of different species of seagrass on ocean acidification. It is hypothesized that both of the species of seagrass will reduce acidification in the water. All three tanks will have 1 liter of water each. The starting pH level of the water would be 8 and 6 would be the acidified. The independent variable is the species of seagrass, and the dependent variable is the level of acidity in the water, measured using pH paper. The constants are the type of water used, the amount of water, and the amount of time exposed to sunlight. It is predicted that seagrass will reduce acidification in water via the process of photosynthesis probably increasing pH by one or two. It is also predicted that the most widespread seagrass is to be the most effective at alleviating the carbon in the ocean. This study will demonstrate that studying the prevalence of those seagrasses in different parts of the ocean, should be an important priority to sustain the overall health of the planet. A follow up study to this could include adding a marine life variable to this experiment and analyzing the effect of acidification on active marine life.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 142

Biolsi, George

Use of Intra-Workout Creatine Supplementation in Individuals Recovering from Lower Body Limb Immobilization

Research Proposal, Science, Health and Medical

There has been a lack of research investigating the effects of creatine supplementation in patients recovering from limb immobilization in order to recover from a lower-body injury. Immobilization often results in muscle atrophy, meaning muscle is lost over time, which can be prohibitively difficult to recover. It is hypothesized that the supplementation of creatine after resistance training will increase the rate of recovery from lower body immobilization. Sixteen participants who have had a lower body immobilization for two weeks prior to the study will participate in a resistance training program consisting of training 3 days per week. Both males and females will be randomly assigned to two groups; one consuming 5 grams of creatine per training day, and another consuming an equal amount of Maltodextrin, which has no known interactions on resistance training. It is predicted that the group consuming creatine will experience greater average increases in strength compared to the placebo group, demonstrating creatine's greater effectiveness in increasing muscle strength. Graphical analysis using box plots and standard error bars will be used to highlight changes from the beginning to the conclusion of the study. Creatine's ability to increase strength more rapidly than placebo suggests that creatine has the potential to be used in conjunction with other treatments to allow people with lower-body injuries to gain muscle strength lost during immobilization. These results suggest researching the effects of creatine consumption during other times relative to resistance training in the same population to find the optimal time for supplementation.

Darien High School

Teacher: Guy Pratt

Project # 143

Blackman, Drew

Vitamin B1 on Alcohol-Related Dementia

Research Proposal, Science, Health and Medical

Dementia related to alcohol causes 10% of cases of dementia globally. However, an increase in Vitamin B1 (Thiamine) intake can lead to a stronger brain-blood barrier in the brain. Therefore, the barrier can prevent excess iron from entering the pathways within a human brain. This would cause fewer amyloid-beta plaques and tau proteins to form in the brain, limiting the main cause of dementia, globally. The procedure would be to look at the pathophysiological pathways of an individual with Vitamin B1/thiamine deficiency, compared to an individual without a lack of Vitamin B1. Dissect and compare the levels of amyloid-beta plaques, tau proteins, and excess irons in both brains. Observe and record the levels of all three things. I would expect to find that the individual who consumed an ample amount of Vitamin B1 through foods such as legumes, meats, eggs, and seeds, will have less iron, and therefore, fewer amyloid-beta plaques or tau proteins than those who did not. This is because the blood brain barrier is stronger with more thiamine. The blood brain barrier prevents excess iron from entering the brain, which leads to tangles and plaques in the brain. As a result a stronger barrier means fewer plaques and proteins, which results in a lower chance of dementia. If proven true, Vitamin B1 can be a pivotal factor in preventing alcohol-related dementia due to its ability to help keep iron out of the brain. A new pill/cure could be developed which includes thiamine. This would keep the blood brain barrier stronger and prevent plaques/tau proteins from forming for as long as possible. Therefore, cases of alcohol-related dementia would be significantly lower.

Ridgefield High School

Teacher: Patrick Hughes

Project # 144

Brinck, Gabriela

Effects of Elevated CO2 levels on Plants

Research Proposal, Science, Environmental

Climate change is a pressing issue that needs to be studied further to understand its effects on plants (Beerling 2019). Without knowing what could happen to human's crops in the future, current rises in CO2 levels could jeopardize food security. Varying levels of elevated CO2 on different plant types (C3, C4, CAM) will be evaluated over time by measuring height, yield, root length and root health. Based on plant type and method of carbon fixation, it is anticipated that CAM plants will thrive the least in this environment and C3 plants will thrive the most. If CAM plants don't thrive in higher and anticipated future CO2 levels, scientists must be prepared to find a solution to optimally grow these critical plants.

Staples High School

Teacher: Amy Parent

Project # 145

Caruso, Olivia

A Retrospective Study of the Deficiency of Vitamins in Patients with Aortic Aneurysms and Periodontitis

Research Proposal, Science, Health and Medical

Aortic aneurysm (AA) rupture is a common cause of death in adults. Periodontitis is a chronic inflammatory disease caused by pathogenic bacteria and is correlated with cardiovascular diseases, such as atherosclerosis and AA. Vitamin deficiency is common in patients who are diagnosed with AA and Periodontitis. The purpose of this study is to explore the association between vitamin deficiency and patients with both Periodontitis and AA. Previously collected data on patients with AA and/or Periodontitis will be used to assess the association between vitamin deficiency (Alpha-Tocopherol, Menaquinone, and Calciferol) and AA-periodontitis comorbidity. Participants will be divided into four different categories: those with both diseases, those with AA only, those with periodontitis only, and those with neither disease. Statistically significant differences in vitamin deficiency among the groups will be identified. It is expected that the group with both AA and Periodontitis will have significantly lower levels of all vitamins listed, as previous research indicates that both diseases are strongly associated with vitamin deficiency. These results show that patients who have both AA and Periodontitis are also more likely to have more severe vitamin deficiency. Future research should investigate whether vitamin deficiency is a possible underlying cause of these diseases. These findings will also remind patients and doctors of the importance of maintaining healthy vitamin levels.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 146

Catalano, Lucille

The Effect of Potato Brine as a Deicer Alternative to Road Salt Plant Survival and a Simulated Pond Environment

Research Proposal, Science, Environmental

Traditional road salt has many negative impacts on the environment including harming plants and animals, polluting water, and harming infrastructure. Tennessee began using potato deicer alternative, but there is no research on its environmental impact. Potato brine was selected due to prior research demonstrating its effectiveness. It is hypothesized potato brine will have few negative effects and will be less harmful than traditional and other natural deicers. The effect of potato brine deicer on road ice will be assessed by measuring ice melting time. Its impact on plants and organisms will be tested by creating a simulated plant and pond environment and exposing both to potato and traditional deicers. Impacts on the plant environment will be assessed by recording plant height and survival. Impacts on the pond environment will be measured by salinity and algal growth. NaCl, calcium chloride, pickle brine, and beet juice will also be compared. It is expected that potato brine will be less effective than NaCl deicer, but will result in less plant death and lower water salinity compared to traditional deicers. Potato brine is also expected to be associated with less algal growth compared with natural deicers. This experiment will help solve an environmental issue that is widespread. Potato brine deicer will prevent further damage to water, organisms, and roads. Finally, the use of potatoes will reduce food waste, thus making even more of an environmental impact as 4.4 million potatoes are discarded every day in the UK.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 147

Cavicchia, Liam

The Effectiveness of Prayer Plants at Reducing CO₂ from Engine Exhaust Emissions

Research Proposal, Science, Environmental

In 2010 it was estimated that worldwide greenhouse gas emissions from human activities totaled nearly 46 billion metric tons. My motivation for this project and eventual experimentation is to address the issue of greenhouse gas emissions that we so frequently hear about and construct a way that may be able to remediate CO₂ emissions from fossil fuels. My approach to lower the amount of gaseous CO₂ as a result of the combustion of fossil fuels is to construct a greenhouse chamber filled with hardy and effective plants. Exhaust fumes from a four cycle engine will then be pumped into this chamber and left there to be absorbed by the plants that are present thus reducing the gaseous CO₂ emissions and releasing that air back into the atmosphere. An article titled Effectiveness of Indoor Plant to Reduce CO₂ in Indoor Environment found that out of the seven houseplants tested, the Prayer Plant was the most effective at reducing gaseous CO₂ in a greenhouse chamber. This greenhouse chamber mentioned in the experiment inspired the layout of the one I plan on constructing. If my data came back as supporting my hypothesis and CO₂ levels in the greenhouse chamber were to decrease significantly after a short amount of time then I would move forward with more testing and experimentation. I would try to apply this same principle on a larger scale to see if something like this could be scaled up for industrial applications and try other types or remediation like aquatic plants.

Weston High School

Teacher: Stacey Greenberg

Project # 148

Cerbin, Benjamin

The Effects of Polyethylene, Biodegradable, and Compostable Microplastics on the Growth of Common Earthworms

Research Proposal, Science, Physical Science

With non-biodegradable plastic waste being generated in the hundreds of millions of metric tons per year, populations such as the *Eisenia fetida*, otherwise known as the redworm, are being threatened by the toxic effects of soil contamination. These essential members of the soil ecosystem feed on decaying organic matter; thus, biodegradable and compostable plastics may provide an eco-friendly alternative to polyethylene. To simulate natural conditions, four separate soil habitats will be mixed with their respective microplastics (excluding control) at a proportion of 0.10 g microplastic to every 10.0 g of soil, and left to incubate for two weeks. Six distinct earthworms (per habitat) will then be measured, introduced into their habitat, and given two months to feed and reproduce. After two months, the worms will be weighed and analyzed. The polyethylene-contaminated worms will most likely see the largest stunt in growth, as polyethylene often causes intestinal blockages. Worms compostable plastic habitat will likely see the smallest stunt in growth, possibly even a boost-- compostable materials decay quickly and provide a great food source for the worms. As for biodegradable plastic, its vague timeframe and ability to decay will likely yield growth stunts in between polyethylene and compostable plastics. If the biodegradable plastic data is similar to the compostable plastic data, then biodegradable plastics are viable, eco-friendly alternatives to polyethylene. However, if the biodegradable plastic data is instead similar to the polyethylene data, then bioplastics may not be as eco-friendly as advertised.

Joel Barlow High School

Teacher: Paul Testa

Project # 149

Civale, Alexa

Research Proposal, Science, Health and Medical

Ridgefield High School

Teacher: Ryan Gleason

Project # 150

Clough, Madeleine

The effects of stropharia rugosoannulata, clitocybe nuda, and hypsizygyus ulmarius spores on the rate of decomposition in household compost bins.

Research Proposal, Science, Environmental

The purpose of this experiment is to determine if three varying species of mushroom, stropharia rugosoannulata, clitocybe nuda, and hypsizygyus ulmarius spores, accelerates the process of food waste decomposition within a typical compost bin. This will be tested by replicating a consistent environment for composting and comparing the data from all compost bins after the three trials are complete in order to understand the most efficient mushroom for composting. Methane, which is released from decomposing food waste in landfills, is 25 times more potent than CO₂, and controlling the decomposition process with household composts reduces the release of methane from food decomposition. Sterile mason jars will be used to test the variable groups in my experiment. "Brown" waste (dry leaves and grasses, newspaper, dead plant clippings, wood branches) and household food waste will be decomposing. Three jars will have the various aforementioned species of mushroom spores and to measure the efficiency of decomposition, every three days, the size of the contexts in the compost will be measured and compared to its initial dimensions. If my data suggests that a species of mushroom correlates to a faster rate of decomposition, compared to the other various groups, I will be able to conclude that the addition of specific species of mushroom spores accelerate the rate of decomposition in composts. If I can accelerate decomposition, households around the world will be incentivized to begin composting, preventing millions of tonnes of methane from being released from landfills every year. The next issue would be distribution of the mushroom spore!

Weston High School

Teacher: Stacey Greenberg

Project # 151

Coakley, Emma

The Effect of Influenza B on Varying Socioeconomic Environments

Research Proposal, Science, Health and Medical

Influenza treatment specialization based on socioeconomic factors is an important topic of study. Even more important is making predictions about the impact of influenza on varying socioeconomic regions. My goal is to analyze the patterns of Influenza B in six different socioeconomic communities in the United States and use my findings to predict the impact Influenza will have on different communities in the future. I will use influenza data collected from the CDC influenza B database from six different regions of the United States two of high income: New Jersey) and Maryland two average income states Wisconsin and Minnesota and two low-income states: Louisiana and Mississippi. After gathering this data I will create a comprehensible and condensed data chart. I then plan to input this data into predictive analytics software and create a model of what influenza rates in these locations will look like in the future. Based on my past research and in keeping up with journal articles I believe that in Lower Class communities influenza B will be more prevalent because lower-income areas and the jobs in these areas often do not receive health benefits additionally the number of people with high-risk conditions is greater in low-income areas making them more susceptible to the virus. Additionally, people working in low-income areas statistically take fewer sick days even when they may be contagious. Once complete, my research will allow for a better understanding of how influenza B affects different socioeconomic communities throughout the United States. In using predictive analytics I will be able to use the data about influenza B in different socioeconomic communities to create a predictive model for the rate of influenza B in different socioeconomic environments. Having a predictive model will allow for public health workers and vaccine distributors to better understand where the influenza vaccine should be distributed first.

Ridgefield High School

Teacher: Patrick Hughes

Project # 152

Colman, Alexander

How and Why Creating Maximum Contaminant PFAS Levels in Drinking Water is Essential: A Connecticut Case Study

Research Proposal, Science, Environmental

Per- and polyfluoroalkyl substances accumulate over time causing dangerous, and sometimes terminal, health effects. Despite the growing list of dangers of PFAS exposure, there are no nationwide Maximum Contamination Levels (MCL) for drinking water. PFAS can only be tested by a certified lab due to the dangerous nature of the substance and the number of variables that can go wrong in the testing process. I will collect samples using the equipment provided by the lab, such as using High-density polyethylene (HDPE) bottles fitted with polypropylene; appropriate blanks and transport bottles with ice and appropriate labeling, a reach extender, methanol for cleaning reusable sampling equipment, etc.. I will follow the guidelines for sterile and safe sample collection. Experts predict that PFAS contamination can be found in the water of more than 100 million Americans. I will test four drinking water sources and expect to find levels of PFAS in 3 of the 4 due to location and previous findings. My sites include 1) Weston High School, 2) Norwalk Kellogg-Deering Well Field (low levels of PFAS previously detected) 3) Pond adjacent to Transfer Station 4.) River adjacent to the Fire Station. PFAS is dangerous and builds in our bodies as we consume it unknowingly. The more information we have, the better the chance to remediate it. My research will inform and educate the local community about the presence of these contaminants and make a case for remediation.

Weston High School

Teacher: Stacey Greenberg

Project # 153

Corneck, Sarah

Effect of Age at Weaning on Cortisol Levels up to One Year of Age in Beef Calves

Research Proposal, Science, Environmental

Weaning, the process of transitioning from a mother's milk to an independent food source, is a very stressful process for cows. This stress can diminish the overall health of the calves. Although it is known how the age at weaning initially affects a cow's stress, the long term effects on the calves remain unstudied. It is anticipated that the cows weaned the earliest will have the highest stress levels 1 year after birth, and that the stress levels will decrease with each later weaning period. Seeing as more farmers are opting to subject their calves to early weaning, this research will help inform whether that decision may lead to an increased long term stress for their calves. Increased chronic stress levels would result in a lowered immune system and decreased beef quality, so this research would determine if the trend of early weaning will result in heightened anxiety for the cows and, thus, monetary damages to the farmers.

Staples High School

Teacher: Amy Parent

Project # 154

Costello, Isobel

Assessing Effect of Excessive cardio and strength Training on short term Lateral Prefrontal Cortex Function

Research Proposal, Science, Health and Medical

The study of the effect of excessive training on cognition is important because studies have shown that excessive training directly impacts short term executive functioning. However, little is known about the effect of different types of exercise on short term cognitive function. The purpose of this study is to compare the effect of different types of training on the short term functioning of the lateral prefrontal cortex. It is hypothesized that cardio-based exercise will have a larger impact on cognition than strength-based exercise. High school students will be divided into three groups, each given a different exercise regimen over a two week period (cardiovascular, strength, no exercise). A cognitive exam, which targets attention, perception and memory skills, will be taken before and after the training. Exam performance will be compared among the three groups. It is predicted that excessive exercise will have a negative impact on functions controlled by the prefrontal cortex. The group performing the cardio exercises will score lower on the exam than the strength-based group because cardiovascular exercise involves oxygen deficit in the body and the brain, which may be detrimental to the functioning of the lateral prefrontal cortex. The induced fatigue of two weeks of cardiovascular exercise affects the lateral prefrontal cortex negatively and this allows cardio-based athletes to rethink and make better decisions regarding how their training is affecting their cognition. Future studies should, over the course of a couple years, focus on how the type of excessive exercise affects athletes and the long-term effects on cognition.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 155

Crist, Molly

Analyzing the impact of COVID-19 on how people find happiness

Research Proposal, Science, Behavioral

COVID-19 has greatly changed how people find happiness because many people are not able to see friends and family, travel, or go to school or work. These are things people would normally find happiness in but are not able to with the restrictions of COVID-19. The purpose of this study is to help determine how the ways in which people find happiness has been impacted by COVID-19. A social media analysis will be conducted to assess how the ways people found happiness may have changed because of COVID-19. The tags on social media photos will be identified to see what experiences people associated with happiness from before the pandemic and since the pandemic. The change in types of experiences that bring happiness and the amount of experiences will both be measured. This experiment has not been conducted so there are no results. However, the expected outcome is that people associated happiness more with unique experiences before COVID-19, and people will associate happiness and fun more with daily activities during COVID-19. This research will further our understanding of the impacts of COVID-19 on social-emotional wellbeing. Much is still not known about how COVID-19 has affected the world and the lives of individual people. This research will also give us a better understanding of how much social media represents our lives. People often put what they are thinking on social media and it is a very good indicator of how they feel.

Ridgefield High School

Teacher: Patrick Hughes

Project # 156

Crowley, Isabella

The effect of exercise on memory

Research Proposal, Science, Health and Medical

Memory functions are used in everyday tasks and are vital to basic human functioning. Acute sessions of aerobic exercise have the ability to improve memory function. The purpose of this research will be to find which of the three main memory types an acute session of aerobic exercise will have the most beneficial effect on, working memory, long term memory, or short term memory. Volunteers, 18 and older, will perform an acute session of aerobic exercise. Within a set time of completing the exercise they will perform different memory tasks measuring each type of memory. These tasks include recalling numbers back and the N-back test. To compile control data, the volunteers will perform the same memory tasks at a different time after a rest period. The results will provide information regarding the benefits of exercise on the memory types. It is expected that the results will show a positive correlation between aerobic exercise and each memory type. However, the results will show that one area of memory benefits more from aerobic exercise. It is also expected that the results will show improved cognitive abilities with the memory tasks, as shown in other studies. This research furthers the understanding of the impact of exercise on different memory functions which could be beneficial in aspects of daily life and to treating individuals with degenerative memory conditions. Exercise impacts short-term, long-term and working memory differently, and a further understanding of these impacts can help in developing these functions and preventative measures for those with diseases such as Alzheimers.

Ridgefield High School

Teacher: Ryan Gleason

Project # 157

Dallemule, Angie

Localized abnormalities in the cingulum bundle in women with schizophrenia: A Diffusion Tensor tractography study

Research Proposal, Science, Health and Medical

The CB, or the cingulum bundle, is an area of the brain forming connections between the frontal, temporal, and parietal lobes. The CB also has been found to have connections with the etiology of schizophrenia. An increasing amount of evidence suggests that the CB is organized in discrete sub-connections. Using Diffusion Tensor tractography, the aim is to subdivide and look into the structural integrity of the CB. The CB has 5 sub-connections (I1-I5), and patients with schizophrenia are thought to exhibit subnormal activity in I1 and I4. An important note is how increased estrogen in women may increase the activity in I4. Since adjunctive estrogen is a vital component in possible medication for schizophrenia, this study consists of women- 24 patients diagnosed with chronic schizophrenia and 26 matched healthy controls. The findings concluded that there is a correlation between I1 and I4 and schizophrenia. I1 is where the fibers connect the rostral and caudal gyri and is attributed to learning and behavior. I1 is correlated with positive schizophrenia symptoms, such as delusions. I4 is the parahippocampal gyrus and is attributed to memory. This subsection is correlated with negative schizophrenia symptoms, such as anhedonia, or lack of pleasure. These findings suggest that not only is the CB subdivided, but also that CB sub-connections may help understand schizophrenia's neurobiological foundation, thus helping determine possible causes. Along with that, it can also help understand how estrogen can play a role in schizophrenia and how it may lead to effective medications.

Darien High School

Teacher: David Lewis

Project # 158

Daly, Maura

Effectiveness of treating stress and anxiety digitally through apps and wearable technology.

Research Proposal, Science, Behavioral

The purpose of this study is to discover the advantages and disadvantages of treating anxiety of stress through technology. This will aid people in treating their mental health in times of this pandemic, where it might not be as safe to have in person therapy sessions. My method for obtaining data will be through comparing how people's mental health has improved through in person therapy sessions and people who solely use wearable technology and apps to improve their mental health. I will create a survey for participants to take after receiving treatment to discover which treatment works best. My expected result for this experiment is that in person therapy will help people struggling with stress and anxiety. It has been proven that human touch has calming effects and could be hard to replicate. However, as technology advances in the future in person therapy could be eliminated and replaced by apps, wearable devices, video calls, etc. The findings of this study could be potentially useful to people struggling with stress and anxiety in our covid consumed world. Technology could be more accessible to people rather than paying someone for a therapy session. Decreasing contact between people, creating a way to "flatten the curve". Knowing the disadvantages and advantages to treating stress and anxiety through technology will help us improve technology to better assist people.

Newtown High School

Teacher: Tim Dejulio

Project # 159

Darby, Lindsey

Reading textbooks on screens versus paper when focusing on the cognitive map and medium materiality mechanisms.

Research Proposal, Science, Behavioral

As learning online becomes more prevalent in our lives, it's important to know the differences reading on screen and paper can have when a student is learning. Few studies have tested this idea when focusing on two different mechanisms that can be affected by a screen; one being medium materiality and the other the cognitive map mechanism. The goal of this experiment is to find, if compared, which mechanism will be more affected by reading textbooks digitally. If the two mechanisms are compared the cognitive map mechanism will be affected more by reading off screens. The study will use tests of reading comprehension and self-reported reports on eye fatigue and the patient's perceived immersion in the text. These will all be conducted before and after reading from their assigned medium, with the exception of the comprehension test. Then the findings will be statistically analyzed using the Mann-Whitney U and Kolmogorov-Smirnov tests to make sure there is enough statistical difference in the data. After the data is collected, it is expected that there will be a significant difference between reading from a screen versus a hard copy book, in favor of the paper when it comes to the cognitive map mechanism. It may also reveal a difference between the digital and paper counterparts in terms of the medium materiality mechanism. These results will allow for a better understanding and ability to make reading plans for digital texts.

Darien High School

Teacher: David Lewis

Project # 160

Davenport, Katherine

The role of Species Sociology and Evolutionary Domestication in Comparison to Performance in Communication-Based Tasks

Research Proposal, Science, Behavioral

Finding out how the difference in sociology of a species effects performance in communication-based tasks is crucial in understanding how evolutionary domestication has played a role in pack dynamic. By understanding the interaction between members of a species, humans can better observe the effects of evolutionary domestication- specifically when examining the differences between wolves and canines. To carry out this experiment, I will administer the same trial to both wolves and dogs, testing the retrieval speed of a treat in a partnership-based task from a testing apparatus. The testing apparatus will be located outside of an enclosure, and made up of a tray of treats, which can be pulled into the enclosure by two rope pulls, only when pulled jointly. This tests the species ability to cooperatively figure out a task, analyzing their communication and teamwork skills. I hypothesize that the wolves will significantly outperform the canines as their lack of human evolution allows them to have far more collaborative skills within their pack. Through this research, scientists can better understand the relationship between evolutionary domestication and sociology, which can be applied to determining the brains' changes through the taming process. Once we understand the changes canine cognition through in evolutionary domestication, scientists can specifically target the skills canines have adapted in order to most efficiently train working canines.

Darien High School

Teacher: Christine Leventhal

Project # 161

Di Capua, Jennifer

Facilitating Health Care Access for Latinx Undocumented Immigrants Using a Novel Smartphone Application

Research Proposal, Science, Behavioral

As many as 11 million immigrants are undocumented in the United States. This population has limited choices when seeking healthcare, particularly during the Covid-19 pandemic. The purpose of this study is to develop a smartphone app aimed at connecting healthcare providers with the Latinx undocumented immigrant population. It is hypothesized that undocumented immigrants will be more likely to access healthcare when provided with information through an app. This study will focus on the Latinx undocumented immigrant population in New Rochelle, New York. A small group of undocumented immigrants will be interviewed at sanctuary sites to uncover barriers and evaluate how they access healthcare. Based on this information, I will deploy a survey in multiple languages to a larger group. I will use the data from the survey to create an application that addresses the main barriers identified. Another survey will be deployed to the same group of participants to gather feedback and assess their likelihood of utilizing the application to access healthcare in the future. I expect the survey will show that the main barriers to healthcare include cost, legal status, fear of deportation, and language. It is expected that undocumented immigrants using the app will be more likely to access healthcare. The possible results of this project could help me prioritize addressing specific barriers undocumented immigrants face during Covid-19 in future research. In addition, the results can help inform policy decisions about widening access to healthcare.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 162

Doman, Alexander

The Green House Gas efficiency of Nuclear Energy versus other alternative energies

Research Proposal, Science, Environmental

To combat the potential damage that could be caused by climate change, it is important to turn to alternative energy. Not only that, but it is important to find which specific form of alternative energy is the most efficient as well as safe for the environment, which was my motivation for testing if nuclear energy was cleaner than any other form of alternative energy. The approach I'm going to take is to analyze data from a selection of countries across the globe. For each country I observe, I must find a trend in the production of alternative energy sources and nuclear power plants and whether or not they have increased or decreased over time in that country. Second, I will find whether that same country has increased or decreased their greenhouse gas emissions over that same time. I will finish by finding an overall trend between the two pieces. I expect my results to be in favor of nuclear energy. I believe that the data will support that with the increase of nuclear energy technology, there has been a decrease in greenhouse gas emissions. When compared to other alternative energies, I assume that nuclear energy will be vastly more efficient than those as well in terms of limiting greenhouse gas emissions. Assuming my estimated findings are true, this research could be useful for proving that nuclear energy is a vastly more efficient and clean form of alternative energy than any other source, and should be examined for the near future.

Ridgefield High School

Teacher: Ryan Gleason

Project # 163

Donovan, Chelsea

Yin Yang 1 (YY1) in correspondence with glucose transporter GLUT3 promotes tumor growth and angiogenesis in vivo

Research Proposal, Science, Health and Medical

The goal is to find out if oncogene Yin Yang 1 (YY1) significantly affects the presence of glucose transporter GLUT3, aiming to find a correlation between them and their effects on tumor growth and angiogenesis. This study can provide key information to identify a target for drug therapies to combat cancer, the second leading cause of death in the U.S. YY1 is a transcription factor and protein coding gene that has also been linked to proliferation in tumor cells. Glucose transporter GLUT3 facilitates the transport of glucose across the plasma membrane. In this experiment, mouse models will be used to look for correlations between YY1 and GLUT3, plus their effect on tumor growth and angiogenesis. Tamoxifen injected mice (tamoxifen-inducible EC-specific YY1-deficient (YY1i Δ EC) mice) and wild type mice (WT), will be tested similar to current experiments. It is expected that direct correlations between YY1 and GLUT3 to promote tumor growth and angiogenesis will occur. Knowledge of the role of this pathway in tumor growth and an introduction to how the pathway functions will be obtained. Data will be obtained using immunofluorescence analysis, immunostaining, and analysis of tumor tissues for size and weight. This research could open up the possibility of a new target for cancer interventions and the development of drugs preventing growth and angiogenesis. The research would also be able to provide an introduction to how this specific oncogene promotes growth, and allow for further research into its functions and flaws to target.

Darien High School

Teacher: David Lewis

Project # 164

Donzeiser, Lily

Evolutionary Adaptability of the Scarlet Tanager to Climate Change

Research Proposal, Science, Environmental

In today's world, our generation faces fast-paced warming of our planet as a result of global climate change. In contrast, evolution is a slow process dependent on time, a factor that climate change does not account for. As temperatures continue to drastically increase in their summer environments, many migratory bird species, such as the Scarlet Tanager, are faced with extinction. The Tanager's breeding periods in eastern North America are being altered by rising temperatures, leaving them with a smaller window for reproduction. This decreases the chance for evolutionary adaptation, as with less reproduction comes less genetic diversity and variation for natural selection to act upon. In this experiment, the surveying of the Tanager's phenotypic changes and habitat range will be compared to their life history data to track its evolution. To track current conditions and project the presence of the Scarlet Tanager under future conditions, Species Distribution Models (SDMs) can be utilized to project geographical dispersion of phenotypic changes, and thus their susceptibility to changing climatic conditions. Though the Scarlet Tanager will show signs of biogeographical shifts and phenotypic changes, the species will prove to have a high vulnerability towards climate change. The Species Distribution Models will show that the species will need to shift its habitat range and evolve genetically to survive under future climate conditions.

Darien High School

Teacher: David Lewis

Project # 165

Drake, Ethan

The Effect of Hangboard Training on Climbers' Muscular Strength

Research Proposal, Science, Health and Medical

The effectiveness of hangboarding in the climbing community has been questioned and refuted by many. Hangboarding and risk of injury are closely related in the minds of many climbers, for good reason. Hangboarding has been tested in the past by researchers for the effect on muscular endurance. This study proposes to determine whether or not hangboarding has an impact on muscular strength. This will be tested over a period of 42 days with six seven-day long hangboarding cycles of work. Muscular strength will be recorded in overall force exerted in a static pull-up. This recorded force will be analyzed in relation to a given participant's body weight. The static pull-ups will be on holds sized 13 mm, 19 mm, on pinches, and on jugs. With the strict routine outlined in the hangboard workout implemented, it is predicted that less experienced climbers will build pulling force on smaller holds, while more experienced climbers will build overall pull force and confidence on smaller holds. Pinch strength will not alter. Younger climbers will also increase pull force more than older climbers, with the most growth being seen in pubescent participants. The application of this training could help coaches, as well as competitive and professional climbers determine if hangboard training will provide training, or if they would be better off using another, generally safer method. It will also provide data for climbers to track growth and determine what strength aspects need more training.

Darien High School

Teacher: Christine Leventhal

Project # 166

Easterbrook, Kayla

Competitive Inhibition to Prevent Communication of PhrG peptides in Breast Cancer

Research Proposal, Science, Health and Medical

Quorum sensing (QS) is cell to cell communication that allows groups of bacteria to perform actions that individually would not be possible. This communication is not always beneficial in which case, the goal is to inhibit the autoinducer proteins from binding with their receptor proteins to perform an action. Breast cancer behavior is influenced by these autoinducing peptides, specifically PhrG from *B. Subtilis*. By using a competitive inhibitor to the receptor of PhrG, the communication and tumor metastasis can be inhibited. If a competitive inhibitor is introduced, the active site of the receptor will be filled, preventing the real substrate from binding. This will prevent cell invasion and angiogenesis which both encourage tumor metastasis. These inhibitors would be used in breast tissue cells, *in vivo*, and collagen type 1 and chick chorioallantoic membrane (CAM) assays would be performed. These tests show if cell invasion is occurring and the degree of angiogenesis in the tissue cells. The control, letting the PhrG function uninhibited, is expected to show cell invasion, angiogenesis, and signs of cell morphology. In the trial where the communication is inhibited, the cells would show less irregularities and would not promote tumor growth. There are other peptides that contribute to the creation of tumors but by inhibiting one, tumor communication and spread would slow. Using this method to prevent communication is a much more targeted therapy in comparison to chemotherapy, allowing a more effective therapy for breast cancer.

Darien High School

Teacher: David Lewis

Project # 167

Ebrahimi, Kiran

Analysis of Microbiota and Microbial Metabolites in Patients with Pancreatic Adenocarcinoma Undergoing Immunotherapy Treatments

Research Proposal, Science, Health and Medical

Pancreatic adenocarcinoma is one of the deadliest forms of cancer with an 8% five year survival rate. A number of studies over the past 5 years have demonstrated the significant effect of the microbiome and microbial metabolites on cancer proliferation and immune system dynamics. By understanding the metabolism of cancer cells, through analysis of microbial metabolites, researchers may develop more precise therapies that target tumor metabolism through the augmentation of microbiota or microbial metabolites. This proposal seeks to understand the difference in metabolites between responders and non-responders to the immunotherapy drug Pembrolizumab in patients with non-resectable pancreatic tumors, as well as the potential effect of a metabolite transfusion on mice with replicated microbiota populations from the responding and non-responding groups. In order to sample the microbiome, fecal samples will be collected from 30 patients in the study. Stool samples will be analyzed through a combination of 16S Rrna gene sequencing, metagenomic shotgun sequencing, and qualitative PCR. Responder and non-responder microbiota will be replicated in germ-free mice in order to confirm microbiota have a direct impact on patient response. Based on previous studies, it is predicted that the prominent metabolites that will be detected are Phenylalanylphenylalanine, Dehydroepiandrosterone sulfate, Androsterone sulfate, 4-oxo-Retinoic acid and glucose. Microbiota species may include *P. Gingivalis* and *A. Actinomycetomyocomitans*. By developing a deeper understanding of pancreatic cancer metabolite concentrations and microbial populations, researchers will be able to identify key metabolites, metabolic pathways and microbiota, as therapeutic targets that could increase the survival rate of pancreatic cancer.

Darien High School

Teacher: Guy Pratt

Project # 168

Eiger, Haran

The Effect of Midsoles EVA Content in Basketball Shoes on Ankle Sprains

Research Proposal, Science, Physical

Ankle sprains are the most common injury in basketball and occur most often when a player is landing after a rebound. This experiment will involve the participant standing on an inverting platform that when triggered will rotate inwards 35 degrees which is well under the injury threshold of 40 degrees. The platform will invert when triggered by a trap door that is perpendicularly and on the lateral side in relation to the platform. When the trap door is triggered by a wire, the platform will fall invertedly. The platform will be stopped by a block pictured in figure 3 at a 35 degree angle. While the platform is inverting a high speed camera will be recording the motion of the subject at a sufficient frame rate to avoid blurring of the images. This camera will be located 4.5 meters behind the subject and 60 centimeters off of the ground. On the inverting platform there is a sidebar on the lateral border, when standing on the platform the subjects will be told to position their foot so its lateral surface will touch this bar. Then all of their weight will be put onto their right foot and the left will simply be used for balance. If the concentration of vinyl acetate in an EVA midsole increases then the midsole will soften resulting in a decreased angle of inversion, a decreased probability of an ankle sprain, and greater ankle stability. This study will determine which vinyl acetate concentration in EVA midsoles will result in the lowest angle of inversion and therefore a lower likelihood of a sprained ankle.

Staples High School

Teacher: Amy Parent

Project # 169

Elbaqi, Fatimazahra

Treatment Combining CD200 Immune Checkpoint Inhibitor and Tumor-Lysate
Vaccination after Surgery for Pet Dogs with High-Grade Tumors

Research Proposal, Science, Health and Medical

My project is testing the effectiveness of treating dogs with the CD200AR-L receptor before tumor lysate vaccines when treating cancer. The Cancer Genome Atlas Analysis, Peptide synthesis

Darien High School

Teacher: Christine Leventhal

Project # 170

El-masry, Claudia

Predicting the Increase of Vaping Among Youth Using Machine Learning.

Research Proposal, Science, Health and Medical

The data collected from the Severe Acute Respiratory Syndrome (SARS) epidemic in China showed an increase in depression during that period of time. The coronavirus pandemic has likely created a similar effect. Depression can lead to vaping, especially among youth. I hypothesize that there will be an increase in depression and anxiety rates among youth in America that will lead to an increase in vaping among high school students. I am using data taken in China during the SARS epidemic regarding the increase in depression, and the data taken by the Center for Disease Control (CDC) regarding depression rates in youth and vaping. I will then use machine learning and deep learning to determine by what percentage depression increases the risk of vaping. I predict that I will see an increase in the depression rates similar to what was recorded in China. I predict that due to this increase I will see a spike in vaping across every state in the U.S. Vaping is extremely harmful to a person's health, but even more so to youth. Predicting which areas will be hit the hardest by depression will help organizations that educate against vaping, to pinpoint where they should distribute their resources.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 171

Enters, Alison

The effect of microplastics with chemicals at various concentrations sorbed on the surface on zebrafish

Research Proposal, Science, Environmental

Waste that enters the ocean typically contains microplastics, a form of plastic smaller than 5 mm, that may be consumed by species lower on the food chain, reaching apex predators through trophic transfer; humans may also be at risk. The toxicological effects of microplastics on marine organisms is an area deprived of conclusive research. The purpose of this experiment is to determine toxicological effects that microplastics with sorbed chemicals have on zebrafish at various concentrations. In this experiment, *Danio rerio* will be tested on, and the chemicals used will be those frequently found in marine environments. The zebrafish will be fed microplastics in their diets for 3 weeks, later used to perform histopathological analysis on organs, chemical analysis on homogenized samples, and gene expression analysis using RNA. It is expected that as the concentration of the chemicals sorbed on the surface of microplastics increases, the number and severity of toxicological effects will increase because there will be a greater concentration of chemicals released into the organism's body. The data will be analyzed using images for histopathological analysis and graphs for chemical and gene expression analysis, comparing the concentrations. If the hypothesis is supported, this research will provide an adequate way for researchers to determine how certain populations are affected by waste entering their environment locally, which will allow them to estimate the health of particular organisms based on the environmental pollution in the surrounding area. This will also harvest experiments in varying species to observe if the trend persists.

Darien High School

Teacher: David Lewis

Project # 172

Finn, Regina

The Effect of Applied Glucose on Moisture Retention and Growth of Saplings After Simulated Forest Fires.

Research Proposal, Science, Environmental

Forest Fires are a serious threat to wildlife, leading to lasting changes in ecosystems by burning trees and soil and affecting soils' water retention properties. Seedlings require moist soil, a solution is crucial to their survival. It is hypothesized that introducing glucose to burnt soil will improve water retention and subsequently increase the growth rate and survival of seedlings. To prepare for this study, eight groups of soil will be separated in terracotta pots. The seven remaining pots of soil will be burned to simulate a forest fire. All of the pots will receive a boxwood seedling. One pot will be a control with no glucose treatment. The remaining six pots will receive different amounts of glucose (ranging from 0.5mg/g of soil to 5mg/g) One group of plants will receive glucose once, and another group will receive glucose every two weeks. It is expected a medium amount of glucose added will increase the growth and survival rate of the boxwood trees because too much glucose will prevent water from filling the nanopores and too little glucose will prevent water from attracting to the nanopore. Furthermore, it is expected that the testing with multiple treatments will be more effective as it will reinforce the glucose in the nanopores. The information from this study can be used to test larger trees that are native to the Western United States, an area that is largely affected by these fires. This will protect large areas from never recovering from intense deforestation.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 173

Fitzgerald, Cora

Using Lipid Nanoparticles to deliver CRISPR-Cas9 to breast cancer cells.

Research Proposal, Science, Health and Medical

Using CRISPR-Cas9 for cancer treatment has been hindered by low efficiency in the tumors, and the potential toxicity of delivery systems. I propose using lipid nanoparticles to make a safe way to deliver CRISPR-Cas9 mRNA and sgRNA in cancer cells. Lipid nanoparticles are clinically approved nonviral nucleic acid delivery systems. The use of LNPs into Melanomas to deliver CRISPR-Cas9 will successfully and safely deliver the CRISPR. My method is to use lipid nanoparticles to deliver the CRISPR. We prepare the lipid nanoparticle using nucleic acids. We put in the CRISPR technology and insert it into the melanoma cells. The nanoparticles will release with the CRISPR. Then the CRISPR will attempt at editing the harmful cells by permanently disrupting the tumors survival gene. The CRISPRs single-guide RNA will modify a DNA sequence. This is just proposed research, but I can infer that the LNP will successfully deliver the CRISPR-Cas9 RNA to the harmful cancer cells and stop it from growing and/or surviving. The LNPs will be safe and nonimmunogenic and are engineered for antibody-targeted delivery. The implications of a safe way to deliver CRISPR-Cas9 will be very impactful. The ability to disrupt gene expression in tumors opens new avenues for cancer treatment and research. It would not stop CRISPR from doing its job and could open up new ways for the technology to help. Melanomas specifically are the most common and serious type of cancer.

Ridgefield High School

Teacher: Patrick Hughes

Project # 174

Florio, Lia

Promoting Seawall Biodiversity with Live Oysters versus Oyster Shells

Research Proposal, Engineering, Environmental

The economic aspect of seawalls on coastal borders is prioritized over the destruction of biodiversity and habitable conditions for native marine species. The purpose of seawalls must be modified from only protecting land from erosion, to additionally promoting coastal biodiversity. Through applying oysters to seawalls, this research will specify the best method to both support marine life, while conserving shorelines. Studies have established that heterogeneity is increased on seawalls when cement tiles with 2.5 cm crevices are seeded with local oyster species, and are then applied to preexisting seawalls. So, live and deceased oysters will be epoxied to separate cement surfaces of 25 x 25 cm by their shells. Species diversity will be monitored over a 12 month period after the separate tiles have been affixed to a seawall. While live oysters filter toxins to yield nutrient-rich water for their habitat, oyster shells provide shelter for native epifaunal species. When species richness is tested between tiles seeded with live oysters versus only bivalve shells, the results will determine the more beneficial state of oysters to use to encourage heterogeneity on declining seawalls. Retrofitting eco-engineered tiles to established seawalls is a technique that combines coastal protection with organism preservation, and can efficiently mend degradation caused by human urbanization. Although this experiment will be conducted in the northeast, locations with varying environmental conditions can use their local bivalve species as subjects to improve deteriorating ecosystems.

Ridgefield High School

Teacher: Ryan Gleason

Project # 175

Gaaserud, Ellie

Intravenous Immunoglobulin Gamma and Infliximab as Treatments for Kawasaki Disease

Research Proposal, Science, Health and Medical

Kawasaki disease, an inflammatory illness, is the number one cause of acquired heart disease in children. Finding treatments to reduce inflammatory effects and manage the immune response is crucial to protect children from dangerous coronary artery aneurysms and heart damage. This study seeks to analyze the effects of a combined treatment of intravenous immunoglobulin gamma and Infliximab on inflammatory markers and clinical symptoms of KD as compared to a treatment of just IVIG in children under three years old. 250 children diagnosed with Kawasaki disease will be split into two groups, one receiving IVIG, the other receiving a combination of IVIG and Infliximab. The children will be monitored closely with daily observations on the clinical symptoms including conjunctival infection, changes in the lips and oral cavity, cervical lymphadenopathy, and polymorphous exanthema; and the inflammatory markers including white blood cell count, c-reactive protein levels, and tumor necrosis factor alpha levels. The combined treatment of Infliximab and IVIG is expected to bring the inflammatory indicators close to or within normal levels faster than the IVIG treatment alone. The combined treatment should also cause a greater improvement in the clinical features. This study aims to examine whether a treatment of IVIG and Infliximab is a viable option for a primary treatment for Kawasaki disease. The findings of this study could lead to a more widespread use of Infliximab in addition to IVIG, ultimately helping children by decreasing inflammation and instances of coronary artery aneurysms, lessening the risk of myocardial infarction and heart damage.

Darien High School

Teacher: Christine Levanthal

Project # 176

Gannon, Charlotte

Analysis of Cancer Diagnosis Prevalence in Witnesses of the 9/11 Attacks^[P.P.]_[SEP]

Research Proposal, Science, Health and Medical

Due to the attacks of 9/11, the general population of Manhattan was exposed to a dust cloud that contained carcinogens. While there is research on the effects on first responders, minimal research has been conducted on witnesses. This project focuses on the health of witnesses of the attacks. This study compares the incidence of selected cancers in Manhattan residents during and after the attacks. My research focuses on witnesses of 9/11 who were exposed to harmful chemicals in the dust cloud and their post-exposure living in Manhattan below Houston Street for five, ten, and fifteen years. Data on air quality below Houston Street will be used. Participants must have either lived and worked in New York City or in the suburbs during the time period studied. Controls include no history of smoking or cancer in the family. Commuters will be excluded from this study. In this article, we expect to find a significantly large number of witnesses with cancer diagnoses. The cancer incidence will compare with the suburban group's cancer incidence. I expect that exposure time (5, 10, 15 years) will be associated with cancer incidence. This study points to further avenues of research to focus more on the witnesses that were not directly involved as first responders. In addition, it provides more information on air quality after 9/11 and how it affects the general health of the public. It can inform decisions about the impact of air quality in the future and possible evacuation times.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 177

Gazal, Giovanna

Do bilinguals rely more on different parts of the brain for their first vs. second languages?

Research Proposal, Science, Behavioral

There is an existing study that implies that different languages are represented in different sides of the brain, but there is not enough information to support this. It is hypothesized that bilinguals rely more on different parts of the brain for their first vs. second languages. More specifically, it is expected that the left side of the brain is responsible for the second language learned and the right side is responsible for the first language the participants learned. This experiment will consist of about 20 bilingual participants all speaking the same first and second languages aged between 14 years old and 18 years old. Two activities will be performed in both the participants first and second language. Each activity performed reflects the functioning of either the right or left temporal lobe, and each activity is performed in two different languages. Then the results will be compared in order to determine which part of the brain is associated with the first and second languages. It is expected that activities targeting the right side of the brain will be performed better or the same when performed in the participants first language as opposed to their second language and that activities done in the left side of the brain will be performed better in the second language as opposed to the first language. The results of this experiment will help researchers to better understand how languages are stored in the brain in relation to bilinguals. This might also help researchers to determine the most effective way for bilinguals to learn.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 178

Gilbert, Piper

The Effect of Simulated MSG-1 Martian Soil on the Growth Rates of Plants

Research Proposal, Science, Environmental

Space exploration allows humanity to determine its universal place and progress towards an advanced civilization. This project aids Martian exploration by determining plants' growth rates in simulated Martian soil (SMS) mixed with Earth soil (ES) in different ratios. It is hypothesized a 3:1 ratio of ES:SMS will produce optimal plant growth and plant type will determine the macronutrient fertilizer that best supports plant growth—for all ratios tested. It is hypothesized that a 3:1 ratio of ES:SMS will yield optimal plant growth for all plants. 30 planters will be assembled for each plant type—10 for each nutrient fertilizer (potassium, nitrogen, and phosphorus), and 2 of each ten will be dedicated to each ratio. This will allow for duplicates of all soil, fertilizer, and seed combinations. Plants will be watered regularly, and plant growth will be monitored. The growth rates—number of germinated seeds, length of germination time, and plant height—will be measured. It is expected that the experimental variable of simulated MSG-1 Martian soil will limit plant growth. At any point, in all soil ratios containing SMS, plant height will be lower, and time to germinate longer. Nevertheless, plants are expected to grow, and the experiment will thus reveal the possibility of growing plants on Mars. The implications of these results will be immense. Mars' surface conditions make life incredibly difficult and, as such, NASA has not yet sponsored a human mission. This experiment furthers the possibility of Martian and future space exploration.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 179

Goldstein, Milo

The Efficacy of Tannin Extract from the *Melissa officinalis* plant as an Antibacterial Sanitizer

Research Proposal, Science, Health and Medical

Covid-19 has drastically lessened the already limited availability of sanitization products in developing nations around the world, leaving many susceptible to disease. Tannins, such as those found in *Melissa officinalis* have been found to have antimicrobial properties. This experiment intends to utilize these properties and create an alternative sanitization product that can be easily accessed or made in these developing regions. Tannins will be extracted from the *Melissa officinalis* plant using maceration with water as the solvent. Confirmation of their presence will be tested for using the ferric chloride test. The agar disc diffusion method will be utilized, and *E. coli* inhibition will be measured after 48 hours of bacterial growth. The extracted tannins should exhibit antibacterial effects as their properties entail, blocking the growth of potentially harmful bacteria in a manner that is comparable to marketed sanitizers. If the results prove conclusive, tannin extraction in the widely available, wild *Melissa officinalis* plant will prove to be a natural and cheap alternative to sanitizers where the products aren't readily available. This would cause decreased pathogen exposure, and therefore decreased disease spread, if utilized in these areas.

Joel Barlow High School

Teacher: Paul Testa

Project # 180

Gordon, Madison

The Response of Gut Microbiota of Freshwater Shrimp to Density Stress

Research Proposal, Science, Health and Medical

Organism digestion and immunity has been a problem within aquaculture, specifically related to the function of the gut microbiome of shrimp. The microbiome function of digestion and health preservation partially relies on various stress factors shrimp experience, density being one of them. This stress can directly alter the microbiome and its relationship with the various processes it is expected to undergo. Using PCR, the effect of clustering stress on the function of shrimp gut microbiota will be explored by amplifying and modifying the V3-V4 region of 16S rRNA gene sequencing on gut microbiota isolated from shrimp placed in density compositions of 10, 25, and 35 shrimp per 3' x 2' tank. Fifteen gastrointestinal tracts will be extracted and the results and amplicons will be quantified and combined. The paired reads of the results will be filtered and analyzed to find the most abundant sequence. It is projected that the diversity of gut bacteria will be more prominent in the control group than in the groups with high stress densities. Shrimp within high stress densities will have a higher relative abundance of OTUs but no major differences between the experimental groups. More genera than phyla will be identified from the JNK inhibitor. Density is essential to aquaculture, and if the specific stress abundance can be determined, farmers can then be informed about specific clustering amounts to avoid and the necessities of taking care of their cultured shrimp; creating healthier eating habits and providing clean and approved food to customers.

Greens Farm Academy

Teacher: Matthieu Freeman

Project # 181

Gupta, Aditi

The Effect of Somatic Gene Therapy on Cancerous Cells

Research Proposal, Science, Health and Medical

It is estimated that by 2040, there will be 6,833,432 more cancer-related deaths, a problem that currently has limited solutions. However, one possible solution is somatic gene therapy, an experimental treatment that involves introducing genetic material into a person's cells. The introduction of new genes into a cancerous cell or the surrounding tissue can cause cell death or slow the growth of the cancer. The purpose of this research is to investigate the effectiveness of somatic gene therapy as a cancer treatment. In order to perform this meta-analysis, data will be collected from various clinical trials studying somatic gene therapy as a treatment for metastatic melanoma and prostate cancer, among others. The data will be analyzed for a correlation between the use of gene therapy and the death of the cancerous cells. Through this research, I expect to find a success rate in the treatment of cancer with somatic gene therapy. I also expect to find the recurring use of adenoviruses and retroviruses as vectors, as they have been proved to be the most efficient. With the implications of this research, the effectiveness of somatic gene therapy as a treatment for cancer can be proved. The effective use of somatic gene therapy can help cure a large number of diseases and increase the survival rate of most cancers back up from an average of 50%. The search for a cure for cancer has come a long way, but with the use of somatic gene therapy, medicine could progress even further.

Ridgefield High School

Teacher: Ryan Gleason

Project # 182

Heaton, Ryan

Research Proposal, Science, Physical Science

Music - the universal language - has been a mainstay in our human culture for thousands of years. Constant innovation has been made in the field of how to create music, but up until recently, humans have always played a large role in the process. Recent progress in machine learning technology has allowed for the development of music without the creative input of humans, but there has not been much previous work done exploring this fusion of art and technology. Using a BLSTM (Bidirectional Long Short Term Memory) neural network, programmed using Python and TensorFlow Keras, I plan to train the algorithm on a sample of classical music data from various online sources. The resulting output will be in the form of MIDI files, which can be imported into Ableton Live and played using a standard piano instrument. These outputs will be analyzed based on their structure and musicality, as well as played for a number of participants to be judged on how "good" they sound. This analysis will be accounted for and used to tune the network in order to make the "best" music possible. While I don't believe I will be able to generate an output that will be indistinguishable from real, human-made music, the music that is made will show progress towards hopefully reaching that point sometime in the near future.

Other (please list below)

Teacher: Victoria Schulman

Project # 183

Hidy, Evelyn

Photodynamic Therapy with the Use of Photofrin and Laser Activation with Differing Drug-to-light Intervals in The Treatment of Malignant Glioma

Research Proposal, Science, Health and Medical

The use of Photodynamic Therapy (PDT) has previously been successful in the treatment of cancers, including lung and esophageal cancer. Photodynamic therapy uses a photosensitizer and a light source to produce a cytotoxic agent in order to kill tumor cells. Researchers have performed studies using PDT for the treatment of brain tumors, specifically, malignant glioma. An obstacle to the treatment of malignant gliomas is that they are difficult to resect and frequently return after treatment, but PDT may be able to combat this. In this study, malignant glioma cells will be treated with a photosensitizer, Photofrin, and laser radiation while different drug-to-light intervals are tested. After collection, the malignant and normal glial cells will be divided into well plates. Following the application of Photofrin, Red laser light will then be applied to specific cells over different hour intervals and the remaining untreated cells will serve as a control. The results will be examined through transmission electron spectroscopy. The number of malignant cells versus normal glial cells killed will be compared. It is hypothesized that the optimal drug-to-light ratio will occur after around 60 hours of time due to the results of a previous study showing the effect of Photofrin on esophageal cancer. Determining the optimal drug-to-light interval for malignant gliomas is significant to further the possible effectiveness of PDT as a treatment. The ideal drug-to-light interval can be used to offer the most effective treatment possible and provide a key piece of data needed to further the potential use of PDT against malignant gliomas.

Darien High School

Teacher: David Lewis

Project # 184

Hisler, Caroline

Uncovering Patterns in Young Adult E-cigarette Usage Before and After the Trump Administration's 2019 "Flavor Ban"

Research Proposal, Science, Health and Medical

Nicotine is an addictive stimulant that has negative effects on the respiratory, cardiovascular, and digestive systems. In 2019, the Trump administration banned "fruity" flavored e-cigarette pods (except menthol) in order to discourage teens from smoking e-cigarettes. It is hypothesized that the flavor ban did not have a significant effect on e-cigarette usage among young adults who were already using e-cigarettes. We will analyze data from The Food and Drug Administration (FDA) to uncover patterns in e-cigarette usage in young adults, focusing on the number who quit before and after the ban. Using observations from FDA data, we will design and administer a survey that will reveal patterns in behavior changes in e-cigarette usage among young adults in the Greenwich, CT area. The Greenwich survey will show that there was little to no change in the number of youth who currently use e-cigarettes before and after the flavor ban. It is expected that the decrease in usage is due to fewer people taking up e-cigarettes rather than an increase in the number of quitters. This is based on FDA survey results that show that while there are 1.8 million fewer young adults using e-cigarettes, there is still a large number of young adults who use them. These results will help spread awareness about the harmful and addictive effects of inhaling products with nicotine. This information will help inform future policy decisions regarding the regulation of e-cigarette use among young adults.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 185

Horn, Avery

Dual EGFR and ICAM1 CAR T cells as a Target for Triple Negative Breast Cancer

Research Proposal, Science, Health and Medical

Triple negative breast cancer (TNBC) is a highly invasive form of breast cancer that lacks estrogen, progesterone, and human epidermal growth factor 2 receptors. The absence of these receptors makes targeted cancer therapy more challenging and thus there are fewer treatment options for patients with TNBC. It has been shown in previous experiments that TNBC cells do express ICAM-1 and EGFR, which are both transmembrane proteins that are overexpressed in malignancies. In the proposed experiment, EGFR CAR T cells, ICAM1 CAR T cells, and dual antigen EGFR/ICAM1 CAR T cells will be utilized to assess the response in two TNBC cell lines and healthy breast tissue in vitro. CAR T cells are a form of immunotherapy that create a targeted antitumor response. First, the CAR section will be constructed using scFvs for both receptors, and introduced into human-derived T cells using a lentiviral vector. The double antigen CAR T cells will be constructed using the dual CAR T cell method. Samples will then be evaluated for cell lysis by cytotoxicity and lysis assays. In addition, immunofluorescent techniques will be performed to compare cell line samples. This research would provide evidence that employing a dual CAR T would be a highly specific and sensitive treatment option for TNBC tumors. If CAR T cells are engineered to contain dual receptors ICAM1 and EGFR, then these cells will have the highest tumor specificity, and thus yield a higher lysis percentage in the TNBC cells lines compared to the single constructs.

Darien High School

Teacher: David Lewis

Project # 186

Johnson, Jalen

A Measurement on the Mental Health Effects of the Coronavirus on Teenagers and Adults in Fairfield County

Research Proposal, Science, Health and Medical

Research is mounting on the impact of COVID-19 on mental health in American teenagers. In children aged 13 to 18, 25.1% are reported to have high anxiety levels according to the Anxiety and Depression Association of America (ADAA). The conditions of a global pandemic like the coronavirus require individuals and households to provide safe environments while reducing human contact and access to medical and domestic necessities. Teenage stress can be performance related. Therefore, an area like Fairfield County, containing the Westport School District, the highest ranking Connecticut school district in academic performance, will have notable levels of teenage anxiety. This project will test if the conditions of a pandemic increase teenage stress levels significantly above the national average. In this experiment, data reflecting the anxiety levels of children aged 13 to 18 in Fairfield County will be gathered, showing anxiety rates one, two, six, and twelve months into the pandemic, compared to one month before the pandemic's spread to the US. The expected upward trends in the data will demonstrate the effects of COVID-19 on anxiety in Fairfield County teenagers. The data is expected to reflect an increase in teens stress levels to a presence over 50% greater than the 25.1% national average that represents normal levels of anxiety. This will indicate that teenagers suffer an irregularly high increase in anxiety during medical crises. In the future, high schools can utilize this data to accommodate their students and provide resources for anxiety management as they prepare for college.

Joel Barlow High School

Teacher: Paul Testa

Project # 187

Jones, Ryan

Observing the effects of enhancing actin polymerization in *Toxoplasma gondii* on the filamentous actin network

Research Proposal, Science, Health and Medical

Toxoplasma gondii uses a filamentous actin (F-actin) network to facilitate material exchange between parasites in a parasitophorous vacuole. This network is formed of small intrinsically unstable filaments of actin that are essential to many cellular functions of the apicomplexan parasite. The most notable are: cell egress and replication. F-actin is also believed to be responsible for the synchronization of these events. By enhancing F-actin polymerization through the introduction of Jasplakinolide in infected host cells, the dynamics of the F-actin network and its function will likely be disrupted. Jasplakinolide binds to and stabilizes actin by supplementing nucleation which lowers the concentration of actin required to form filaments. In vitro, Jasplakinolide strengthens and stabilizes F-actin. However, in vivo, Jasplakinolide induces polymerization of monomeric globular actin into amorphous masses. The development of these amorphous masses will likely lead to a disordered F-actin network with insufficient monomeric actin. The disordered F-actin network will likely disrupt cell egress and replication. Actin-chromobody, a fusion of an actin-binding protein found in alpacas and a fluorescent protein, will be used to visualize the F-actin network and the effect of Jasplakinolide. In addition, the effect of Jasplakinolide on the host cells biological processes will be observed, too. If Jasplakinolide does not interfere with the host cell processes, but does interfere with the F-actin network in *T. gondii*, then Jasplakinolide can possibly be tested further in order to consider its feasibility as a treatment for *T. gondii*.

Darien High School

Teacher: Guy Pratt

Project # 188

Katz, Hannah

Hydrocarbon Refrigerant vs Air to Maximise Energy Output and Efficiency Inside a Micro- Compressed Air Energy Storage System

Research Proposal, Science, Physical

In the race to achieve net-zero emissions before 2050, greater efficiency with green energy storage is necessary . The subject will be instructed to look directly ahead during testing in order to prevent them from tensing their ankle, which would alter the ankle of inversion. Tensing would alter the final data as they would have their guard up decreasing the accuracy of data. They will also be told to relax their ankles. At random times the inverting platform was dropped causing the subject's ankle to invert. Each subject will have five recorded trials of inversion that will be analyzed for each shoe condition. There will be four conditions, the same basketball shoe with various vinyl acetate concentrations, 10%, 20%, 30%, and 40%. If Propane hydrocarbon is used as a refrigerant inside the reciprocating compressor, then there will be a higher heat extraction, and therefore a higher amount of compressed heat energy. If propane can be a more trusted and effective refrigerant than the original air compressant could replace it's function inside the reciprocating compressor. Results of this study might increase the efficiency of the compression system as well as increase the variety of applications of propane as a hydrocarbon.

Staples High School

Teacher: Amy Parent

Project # 189

Kieran-Mendez, Joanna

What effects does COVID-19 have on the treatment of Ureteric Calculi in hospitals between extracorporeal shockwave lithotripsy (SWL) or ureteroscopy (URS)?

Research Proposal, Science, Health and Medical

What effects does COVID-19 have on the treatment of Ureteric Calculi in hospitals between extracorporeal shockwave lithotripsy (SWL) or ureteroscopy (URS)? My motivation is my curiosity, my mind is constantly running with questions, be it good or not, I always want to learn more. I want to learn more about the inner workings of the human body and things that are common in everyday people. COVID-19 has caused dramatic changes in how people live their lives, however, it causes more damage in hospitals than anywhere else. My research will help show a course of action in the treatment of Ureteric Calculi which can help prevent the future spread of the virus. Extracorporeal shockwave lithotripsy (SWL) and ureteroscopy (URS) are the two techniques used to investigate the treatment of ureteric calculi. The effects of covid-19 and hospitals will be studied by using which treatment of ureteric calculi is best fit to limit the spread of COVID-19, SWL, or URS? During my research I expect ureteroscopy (URS) to be more problematic than extracorporeal shockwave lithotripsy (SWL). URS is more invasive than the SWL, this provides more risk factors in the hospitals. SWL has a much safer route, with its less invasive procedure, it has significantly fewer chances of exhausting PPE and less risk of putting the hospital staff in danger of contracting the virus. I expect to learn how to conserve medical resources and personnel in this research. I will analyze my data based on factors such as; use of anesthesia, the number of attendance per patient, and the average cumulative LOS per patient. Implications may include longer stays for URS patients due to its invasive procedure, more use of anesthesia for the URS patients, and higher numbers of attending personnel per URS patient rather than SWL. My anticipated results point to hospitals cutting their nonurgent surgeries by a large percentage, and new procedures to limit contact between staff and patient to limit the control of COVID-19 Virus.

Darien High School

Teacher: Christine Leventhal

Project # 190

Krauss, Rachel

How the Addition of Stem Cell Grow Cardiac Muscle Cells Effect Weaken Cardiac Muscle Cells

Research Proposal, Science, Health and Medical

Does attaching cardiac muscle grown from stem cells to weakened cardiac muscle affect the muscle ability to contract and send blood throughout the body? This study purpose would be to search for a new way to be able to treat heart failure There will be three groups tested to see the number of contractions. Testing the weakened cardiac muscle first then regular cardiac as a control both with 25 cells. The stem cells before testing will be added to a DMEM and 10% FBS solution to allow them to differentiate into cardiac cells. Then connecting them to the weakened cells. Doing the same test pumping blood through the cell tube and counting the number of contractions. The conditions during the test will be similar to those in the body. Research that has been done in similar fields have gone well and the stem cells have done what has been expected of them. Based on these studies the newly grown cardiac cells in this study will increase the strength of the weakened cardiac cells and decrease the bpm of the muscle. Using your own stem cells allows for a cut back on the medications the patient would have needed to take. No anti rejection or immune supplements because the body already knows that the stem cells are the patient's own. It is also another permanent solution for heart failure. The results from this study will be useful in learning another way stem cells can be used to help treat the heart.

Newtown High School

Teacher: Timothy Dejulio

Project # 191

Larkin, Mia

Inactivation of Cyanobacteria through Hybrid Ag-TiO₂ under Sunlight

Research Proposal, Science, Health and Medical

Cyanobacteria has the ability to produce potential health hazard toxins in drinking water through algal blooms. The presence of cyanobacteria in drinking water reservoirs worldwide raises concerns for the range of toxins that cyanobacterial blooms can generate. Photocatalytic processes have demonstrated effectiveness in disinfecting water through destruction of microorganisms and bacteria. In this experiment, hybrid Ag-TiO₂ nanoparticles will be used to inactivate cyanobacteria under sunlight. Ag-TiO₂ nanoparticles will be obtained through impregnation of AgNO₃ and TiO₂ to deactivate microcystis cyanobacteria. Constant amounts of cyanobacteria will be suspended in water to determine the effectiveness of varying amounts of Ag-TiO₂ nanoparticles in deactivating the cyanobacteria. Analysis of the data would be able to provide results of lowered concentration of cyanobacteria while a visual color change from blue-green to brown would indicate a damaging oxidative process took place due to the Ag-TiO₂ nanoparticles. The growth of cyanobacteria and its toxins in drinking water has potential health hazards. Thus, through the exploitation of Ag-TiO₂ nanoparticles activated through sunlight, cyanobacteria can be deactivated to prevent health hazardous toxins in drinking water.

Joel Barlow High School

Teacher: Paul Testa

Project # 192

Lash, Camilla

The Study of CM-AT on Adolescent Patients

Research Proposal, Science, Health and Medical

Autism Spectrum Disorder (ASD) has an array of symptoms and cases. Although ASD fails to have a single standardized screening, an up and coming drug called CM-AT helps fix enzymes within an ASD patient's brain. Camilla's motivation is to study CM-AT and record the trial results. This study is important as a cure for ASD would be more affordable and beneficial for patients and their families. If CM-AT works on at least five different cases of ASD, then it should be approved and set for usage. Camilla hopes to answer these two statements; Does CM-AT work for all types of Autism? How long does it take for CM-AT to work? The University of San Francisco is currently conducting a trial of efficacy for CM-AT in a phase III open lab setting. Curemark is still getting CM-AT to be FDA approved and widely used. Camilla expects to see an overall effectiveness for only three types of ASD but not every type of ASD especially cases that actually are mixed and a patient has at least two forms of ASD. Camilla will analyze the data by type of ASD and by age. The anticipated results will lead to further avenues of research such as a faster and accurate ASD screening and more studies of possible ASD treating drugs.

Darien High School

Teacher: Christine Leventhal

Project # 193

Lauria, Gabrielle

Developing a research tool to help determine the risk of Chronic traumatic encephalopathy in football players.

Research Proposal, Engineering, Health and Medical

Chronic traumatic encephalopathy (CTE) is found in many football players after they die. Players go undiagnosed until after an autopsy is performed. This is important to study because many people know little about CTE and this can be the cause of why some players die earlier on in life. My project seeks to develop a screening and a data collection tool for football players, so that they can determine if they are at risk of developing CTE earlier on. I will develop an app that football players can use daily after their games. This app's algorithm would use existing data on association between concussion and disease to estimate risk of CTE in players. Players will record into the app how many concussions they have previously had and fill out the questionnaire. I will have questions regarding the symptoms that CTE players had before they passed away. Based on the input from the user, the app will help predict if users may have increased risk of CTE. With this app I will be assessing for bugs so that the app will become more user friendly to the players. One result can be that there is additional field data available for researchers. This study will help future researchers further their understanding about CTEs. This study will have to be longer because of the very little research on this topic. The app can improve our capabilities for early diagnosis.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 194

Leao, Isabella

Assessing the Effect of Bisphenol A on MCF-12A Breast Cell Line

Research Proposal, Science, Health and Medical

Bisphenol A (BPA), is a hazardous chemical that mainly affects women with Inflammatory Breast Cancer (IBC). While many studies have been focusing on the effect of BPA on cancerous cells, this project seeks to test whether or not BPA has an effect on a “normal” breast cancer cell, MCF-12A. It is hypothesized that BPA does not have an effect on MCF-12A. To test this hypothesis, the IBC and MCF-12A cells will be exposed to BPA and measured by the physical changes that occur, such as proliferation, loss of contact inhibition, and the activation in EGFR and ERK proteins. When performing the experiment, the same amount of BPA will be exposed to each of the cells, and it will be a lower range than that used by previous researchers. It is predicted that IBC cell will continue to be affected by the BPA as shown by previous researchers, and will proliferate at a higher rate than MCF-12A. Furthermore, it is predicted that the MCF-12A cell will not be affected by the BPA, or will not be affected as much as the previous cell demonstrated by less proliferation, and less protein activation. If my hypothesis is supported, then it is clear that BPA only has an effect on cancerous breast cells. This can point to further research as it is possible to test BPA on various types of cancerous and noncancerous cells. This will benefit consumers, especially those with cancer risks, as they will be informed of the dangers of their products.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 195

Learsy-Cahill, Otto

Use of Alloys in preventing corrosion in Long Term Nuclear Storage Containers

Research Proposal, Science, Physical

Currently, long term nuclear storage containers are corroding faster than expected, which could possibly lead to nuclear contamination. In order to determine whether the implementation of a barrier would stop the accelerated corrosion, five alloys with primarily copper as a base will be placed under accelerated corrosive conditions over a 30 day period. It is hypothesised that the barrier between the ceramic glass and the stainless steel container might slow corrosion to prevent nuclear waste contamination. If the copper barrier is effective at preventing corrosion then it would eliminate a major issue preventing the implementation of long term storage.

Staples High School

Teacher: Amy Parent

Project # 196

Lehrman, Myles

The Relationship Between the amount of Acidic Rain and Varying Health Effects of Northeastern Botany

Research Proposal, Science, Environmental

The purpose of this study is to distinguish the levels of human emissions today and the impact it has on *Nymphaeaceae odorata* and *Matteuccia Struthiopteris* plants. I will be studying the impact different pH levels have on plant growth and ultimate height to determine the quantity of what acidic rain plants can withhold before not being able to survive. This will be an experiment conducted at home. I will have multiple tanks where I compare the two different plants, *Nymphaeaceae odorata* and *Matteuccia struthiopteris*, with different pH levels and test to see how it stunts their growth. I will measure their final heights and see what impact the different pH levels had on each plant and whether or not the two plants responded differently than the other. If varying pH levels are representative as acid rain and are added to *Nymphaeaceae odorata* and *Matteuccia Struthiopteris* then the health of the plants will be directly correlated to the height of the plant, meaning the more pH, the smaller the growth and vice-versa. This matters because of our entire environment and ecosystems. During the tough times we are experiencing now, we may forget about the simple things such as thinking twice about what we are emitting into the atmosphere. Doing this project can not only help spread awareness to stop spreading toxic chemicals into the atmosphere, but it will educate others about acid rain and what it not only does to plants, animals, and lakes, but how it affects us humans

Weston High School

Teacher: Stacey Greenberg

Project # 197

Levinson, Reed

Assistance in walking for people with Parkinson's Disease through the use of a soft robotic exosuit

Research Proposal, Engineering, Physical Science

People who are afflicted with Parkinson's Disease commonly suffer significant damage to their gait and lose the ability to retain and efficiently use energy. This study seeks to determine whether a soft robotic leg-based exosuit is capable of reducing metabolic rates and easing walking for these subjects. There will be two main trial phases: one walking without the exosuit and one with. Throughout the testing periods, respiratory rates will be gathered from the subjects through a device based around the mouth in order to determine their metabolic rates. Additionally, at equal intervals throughout the testing, subjects will be asked on a scale of 1-10 how stable they feel and how severe their discomfort is in order to determine whether their walking has been eased or not. It is expected that the subject will not only report a significant decrease in metabolic rate when using the exosuit in walking but that their level of stability and comfort while walking will also increase. These results will indicate that the use of a leg-based exosuit in walking for patients with Parkinson's Disease will be an aid for their gradual decrease in motor function as their condition worsens. Additionally, they could indicate a potential similar trend when analyzed in subjects who suffer from other gait-impairing diseases/conditions.

Darien High School

Teacher: Guy Pratt

Project # 198

Lin, Andrew

Systemic infection results in self isolation in polydomous ant colonies

Research Proposal, Science, Behavioral

Polydomous ants are ants that form multiple nests with multiple queens in one colony. Such ants form networks between each other in order to share resources and to maintain the colony. These networks can be changed due to many factors, such as availability of food. This experiment aims to determine the effect of causing a systemic infection in one nest on the social networks that connect the nest. In this proposal, colonies of *Formica Exsectoides* ants will be used. Colonies will be taken from nature and raised as stock colonies. After setting up multiple nests with artificial networks, one nest will have all of its brood workers infected with an *Escovopsis* fungus. The amount of ants traveling between networks from the infected colony will be counted before infection and after one week of infection, with direction of each ant being recorded as well. In this study, it is expected that the amount of ants traveling between the infected colony and the non infected colonies will drastically decrease. It is also expected that there will be more ants moving towards the infected colony than away from the infected colony. Ants have evolved alongside pathogens for a very long time, and as such, ants have developed many social behaviors in order to keep pathogens from killing the entire colony. This study shows that infected ants will self isolate in order to prevent systemic infection, which is a behavior that has evolved from thousands of years of disease.

Darien High School

Teacher: Christine Levantahl

Project # 199

Litz, Graham

The Effects of Polyphenols on Carbon Mineralization in Soil Organic Matter of Peatlands

Research Proposal, Science, Environmental

Peatlands, though comprising just 3% of the world's surface area, hold approximately a third of its soil carbon content. Polyphenols, organic molecules consisting of one or more hydroxyl groups bonded to a carbon ring-structure, have been shown to inhibit carbon turnover and organic matter degradation. As peatland ecosystems disappear and climate change accelerates, scientists are turning their attention towards rehabilitating these ecosystems in a process known as "peatland rewetting." Although rewetting is an important first step towards protecting valuable carbon stores, the exact correlation between phenolic compounds and mineralized carbon substances has not been thoroughly investigated. In this statistical analysis, the effects of total phenolic content, as well as amounts of condensed and hydrolyzable tannins, will be analyzed with respect to levels of mineralized carbon in peatlands' soil organic matter (SOM). This study will look specifically at the correlation between total phenolic content, levels of condensed tannins, and levels of hydrolyzable tannins and levels of carbonate, a mineralized form of carbon. Soil organic matter with higher levels of polyphenols should have higher levels of mineralized carbon. This shows the capability of phenolic compounds to inhibit microbial degradation of soil organic matter. Going forward, the influence of polyphenols on mineralized carbon could be critical in geoengineering peatland ecosystems to maximize carbon storage. An understanding of the unique impact of polyphenols on carbon mineralization could prove critical to stabilizing rewetted peatlands.

Joel Barlow High School

Teacher: Paul Testa

Project # 200

Lockenour, Franky

The Impact of pesticide Formic Acid on Varroa mites in different weather conditions

Research Proposal, Science, Environmental

Varroa mites are causing a serious decline in bee populations. There will be four different groups consisting of three beehives with different temperatures and humidities that will be tested with formic acid. The data will be collected by counting the fallen/dead varroa mites at the end of a testing period. It is anticipated that higher temperatures and lower humidities will be the most effective conditions for using formic acid. These conditions will result in a higher number of fallen/dead Varroa mites. The objective of this study is to learn how humidity affects formic acid and whether or not beekeepers will need to increase the dosage when testing.

Staples High School

Teacher: Amy Parent

Project # 201

Lowe, Daniel

Developing an improved blood brain barrier model for secondary TBI drug testing

Research Proposal, Engineering, Health and Medical

Traumatic brain injuries affect roughly 1.5 million Americans every year. These injuries can vary drastically in severity. Primary trauma causes physical damage while the lesser known secondary trauma can lead to brain cell death and dementia later in life. The blood-brain barrier is a highly specific permeable membrane that lines the microvascular veins and arteries of the brain. This membrane prevents harmful toxins from entering the brain and potentially harming non regenerative tissue in the brain. By utilizing models that mimic this barrier, scientists can create drugs that can pass through the barrier, protect brain tissue, and affect neurons. This bioengineering project, overseen by Dr. Chris Bolden at the University of Texas, Medicine and Science Center at Houston, aims to create a newer, improved model of the blood brain barrier to be used for medical testing. This in vitro, microfluidic organ-on-a-chip model will consist of a multi cell culture design. These cells will be derived from stem cells to increase reusability for future scientists. This proposed research will hopefully become realized in the spring or summer of 2021. It is expected that this model will be more effective in obtaining accurate blood brain barrier results. This research is important to helping study secondary traumatic brain injuries and developing medicine to combat the harmful reaction and loss of brain tissue that occurs after these injuries.

Darien High School

Teacher: David Lewis

Project # 202

Lucian, Hannah

Edits To The Current United States Election Vote Tally And Submission Algorithm Through Programming

Research Proposal, Science, Behavioral

For my project, I will conduct research on the current and past voting systems, voter demographics, and analyzation process in order to create an ulterior way to submit or count votes. The purpose of this research project is to find other means of tallying or submitting votes in current day elections. After analyzing the necessary data from various websites and databases, I will work to investigate different programming software to find the most appropriate for my research project and use that in likely addition to different mathematical/statistical equations to view probable outcomes with the process that I have created. I also plan to contact local and state government officials for advice and guidance. I expect to find an effective alternative means of tallying votes and election results. I hope to find a process of counting votes in an election that is appropriate and adequate to fit the means and demands of the current day. I would also hope for my research to be used or referenced in the future. I believe this will be useful as votes in current elections are still counted manually in most regions of the United States of America. I hope that computer programming in addition to demographic analysis will be effective for future use in eventual elections or data analysis from elections.

Newtown High School

Teacher: Timothy Dejulio

Project # 203

Maerean, Ellen

The Effect of Color Change on Belief in Misinformation Corrections

Research Proposal, Science, Behavioral

Facilitated by the internet, the spread of misinformation in news headlines has created a distrust in scientists and credible news sources. Despite using corrections to stop belief in misinformation, the Continued Influence Effect states that previously encoded false information persists in the mind. To stop the spread of misinformation, a textual correction must be effective. This experiment determines the effect of color change on the efficacy of misinformation corrections. In phase 1, participants are shown statements in which they rate their belief. In phase 2, repeated statements appear in black font and correction statements appear in either black or red font. In phase 3, participants recall phase 1 statements and are asked whether the phase 2 statements corrected them. If they respond “yes”, participants recall correction and misinformation statements and rate their belief in the phase 2 statements. The expected findings are that there will be an improved recall and a greater belief in the colored correction statements. The color change, as a visual cue, demands a higher level of attention and improves memory recall. With an increased attention being drawn to the colored corrections of misinformation, belief in the corrections will increase. As social media platforms and news websites correct political misinformation and misinformation regarding covid-19, effective corrections are necessary to reduce the spread of false information. An investigation on whether changing the color of a textual correction improves belief in misinformation corrections will aid fact checking organizations in effectively correcting misinformation statements.

Ridgefield High School

Teacher: Ryan Gleason

Project # 204

Maisonet III, Felix

Invasive Electromagnetic Neuromodulation

Research Proposal, Science, Health and Medical

Neuromodulation is the alteration of nerve activity through the direct or indirect application of a stimulus. These stimuli can be anywhere from electromagnetic (EM) radiation to chemical substances. This process could be used to enhance an individual's neuroplasticity after undergoing brain trauma, or being diagnosed with a neurodegenerative disease. This idea is that EM radiation can be applied to enhance chemical synapses in the brain. PD-APP mice exhibit an APP mutant gene that causes signs of Alzheimer's disease. Ideally, there would be a select group of mice that undergo Invasive Electromagnetic Neuromodulation (ENM) by having their brains directly exposed to EM radiation. Another group of PD-APP mice will not undergo this process. All mice will be examined by completing cognitive tasks. The examination will dictate the effectiveness of EMN. Expected results are that the deteriorated brain cells from PD-APP mice will be able to carry out basic chemical synapses that weren't completed before. This will signify that the EMN heals, and helps repair the mice's ability to carry out neuroplasticity. In other words, it will demonstrate that the PD-APP mice successfully underwent this process and can perform motor and cognitive functions because neuroplasticity has been enhanced. Research will test if direct EM radiation is a usable treatment for Alzheimer's and other neurodegenerative diseases. The belief is that the completed cognitive tasks from the PD-APP mice will be somewhat directly correlated to the human brain and thus lead to more developed treatments of Alzheimer's through EMN.

Ridgefield High School

Teacher: Patrick Hughes

Project # 205

Maloney, Megan

Determining the Prevalence and Risk of Female Athlete Triad Syndrome in Female High School Athletes

Research Proposal, Science, Health and Medical

The Female Athlete Triad Syndrome (ATS) is a medical condition that affects female athletes worldwide. Little is known regarding the risk and prevalence of the ATS in non-professional high school athletes. This project will determine the prevalence risk and the syndrome faced by non-professional female high school athletes of different sports. It is hypothesized that a similar prevalence of risk (77%) to that found by previous researchers will be found. To determine the prevalence of ATS, a survey will be administered that will target symptoms of the triad, such as amenorrhea, low energy levels, insufficient energy consumption, emotion, and injury. The sample population will consist of females ranging from ages 15-18 from a private all-girls school, across several sports. The survey will model that of the questionnaire used by previous researchers. It is expected that there will be a similar percentage of participants susceptible to the triad as found in one previous study. Higher endurance sports (for example, cross country running and rowing) will have a larger percentage of risk compared to less endurance-based sports (for example, volleyball and diving). This study will demonstrate that the risk of developing Female ATS is not limited to collegiate and professional athletes. This will show that high school female athletes across various sports are at risk for the female ATS, and will help raise attention and awareness among parents, coaches, and athletes to help prevent future harm.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 206

McGrath, Regan

The Effects of Light Wavelengths on Striped Bass

Research Proposal, Science, Behavioral

Fish passages are vital for allowing fish to migrate; however, current passages aren't very effective. My research will solve the problem of ineffective fish passages preventing migration across dams by utilizing light wavelengths and determining the most successful method for attracting striped bass. I am testing what wavelengths of light are the most effective at repelling and attracting a larger amount of striped bass. My approach will be to use a fish tank in a dark room and individually test different wavelengths of artificial light. I will position the light near a tube leading out of the tank and into another to represent the fish passageway. Some light will attract the fish while others repel it, so the most effective for attracting and repelling more fish should be used in a passageway. The light more suitable for attraction will be used near the entrance and the light better for repulsion will be used in other areas to guide the fish. I expect to find that the white and blue light, which have similar wavelengths, will be the best for attracting the striped bass; however, the color of light for repelling fish has shown more varying results in past experiments. My research is important because it will make fish passages more effective, therefore increasing the migration rates. An increase in migration for fish will result in the capability for fish to reproduce, escape increasing water temperatures, and find shelter.

Ridgefield High School

Teacher: Ryan Gleason

Project # 207

Meier, Stella

In vitro testing of focused ultrasound's effects on calreticulin and phosphatidylserine expression and testing a combination of focused ultrasound and anti-CD47 immunotherapy in glioblastoma

Research Proposal, Science, Health and Medical

Only 25% of glioblastoma patients survive more than a year. Previous studies have shown that the CD47 antigen on glioblastoma cells aids in cancer cells evasion of macrophage phagocytosis. Anti-CD47 immunotherapy, which inhibits the CD47 antigen, is an efficacious glioblastoma treatment but is most effective when paired with other pro-phagocytic signals like calreticulin and phosphatidylserine which become expressed on damaged cancer cells. Focused ultrasound, a non-invasive cancer treatment that uses focused sound waves on tumor cells, could increase these signals by damaging the cell's proteins with higher temperatures. If ablative focused ultrasound is used on glioblastoma in vitro, then the tumor cells will increase calreticulin and phosphatidylserine expression and a combined treatment of focused ultrasound and anti-CD47 will be a more effective treatment and increase phagocytosis. LN-229 GBM cells will be treated with focused ultrasound while a control group will receive no treatment, and then PBMC-derived macrophages will be added. In another test, GBM cells will be treated with focused ultrasound and either 10 $\mu\text{m}/\text{ml}$ of anti-CD47 or an immunoglobulin control and then added with macrophages. For all tests, the phagocytosis assays and calreticulin and phosphatidylserine expression will be determined by a flow cytometer. Based on previous studies the hypothesis is expected to be supported because focused ultrasound is shown to increase expression of similar pro-phagocytic signals, and phagocytosis increases significantly when anti-CD47 is paired with irradiation, a treatment that increases pro-phagocytic signals. This research may advance the efficacy of the anti-CD47 treatment and save lives.

Darien High School

Teacher: David Lewis

Project # 208

Mendiratta, Isha

A System for Underwater Passive Identification of Acoustic Signatures of the Delphinapterus leucas

Research Proposal, Engineering, Physical Science

There are pre-existing programs utilizing the Fourier Transform to recognize specific vocalizations of bats and aves, but none are operational underwater. For species like the *Stenella Clymene*, a like system which utilizes deep learning to identify and track dolphins based on signature whistle types can provide currently unknown population estimations. Due to limited access to the *S. Clymene*, programming will be done using vocalizations of the *Delphinapterus leucas*. Aforementioned pre-recorded signatures will be used as controls for identifying vocalizations among an array of sounds. A modified AI recognition program, created using pre-existing programs which identify the organism from which a vocalization was emitted, will apply the Fourier Transform to separate audio into individual wavelengths, isolating components deemed significant. These select waves will then be searched for presence of a combination of wavelengths that suggest derivation from a Beluga. The success of this program will be marked by its ability to identify the origination of a specific vocalization by isolation from environmental noise. The primary objective at this stage is to develop the program with such capability. Based on adaptations, the AI program created using inputs of the *D. leucas* vocalizations can be adapted to account for relative variance in *S. Clymene* vocalizations. The program can ultimately be applied to provide a new way of passively monitoring population analysis of marine life, in a larger scheme, specifically including that of the *S. Clymene*. Such analysis of populational figures will allow for evaluation of measures needed to be taken to protect marine life from possible endangerment.

Newtown High School

Teacher: Timothy DeJulio

Project # 209

Mengwall, Sebastian

Identifying signals to predict the onset of martian dust storms

Research Proposal, Science, Physical Science

Although reliable tools exist to forecast temperature and wind on Mars during stable atmospheric conditions, current prediction models struggle with determining the onset of martian dust storms. These storms have a great impact on the arid climate and communication with rovers and instruments on the ground. Understanding the development of dust storms is a necessary step to help minimize damage to instruments and alert future manned missions to Mars. This research will explore the development of several major martian dust storms and determine if preliminary signals exist in the weather datasets before the storms emerge. Data supplied by NASA from the Mars Climate Sounder (MCS) on the Mars Reconnaissance Orbiter will be analyzed, and global dust storms in Martian Years 25, 28 and 34 will be the focus of this analysis. Gridded, interpolated and kriged datasets from Montabone et al. (2020) will aid in establishing trends over shorter time spans. Python programming and analytical tools will be used to clean and plot the data, and a SQL database will be used to store and query the large datasets from MCS. With the goal of finding common trends, analyzing across the three major dust storms will be beneficial. A better understanding of Mars dust storms with the limited data available is crucial for future missions on Mars. Once precursory trends of dust storms are found, next steps include further analysis of the underlying causes and potential methods to incorporate the dust storm signal detection in martian forecasts.

Darien High School

Teacher: David Lewis

Project # 210

Mitchell, Ava

How Often Pediatric Autoimmune Neuropsychiatric Disorder Associated with Streptococcal Infections is Overlooked

Research Proposal, Science, Health and Medical

PANDAS, Pediatric Autoimmune Neuropsychiatric Disorder Associated with Streptococcal infections, is classified as a rare autoimmune disorder. Since group A streptococcal infections have molecular mimicry, antibodies can mistakenly attack the brain. This results in sudden behavior changes such as OCD, anxiety, depression, and emotional or developmental regression. This study will focus on investigating how often PANDAS is misdiagnosed as other psychiatric disorders. To understand how often PANDAS is misdiagnosed, children with OCD, anxiety, depression, emotional or developmental regression would be surveyed to see if they meet the criteria of PANDAS. Pediatric psychiatric doctors in Fairfield County would be asked to survey their patients with a detailed questionnaire. Comparing results against PANDAS criteria would determine the likelihood of a misdiagnosis. The patient would then seek a professional diagnosis. The predicted findings are that PANDAS is more common than believed, and 25% percent of the children displaying symptoms similar to those of PANDAS have a high likelihood of having PANDAS. It can also be presumed that once this data is collected and analyzed, PANDAS will be better understood. It is very likely that this study would lead to further research. Identifying how often PANDAS is misdiagnosed will lead to more knowledge of PANDAS overall. From this, the issue of diagnosing PANDAS can be greatly improved leading to better care for PANDAS patients, and ultimately prevention. Increasing the awareness of PANDAS will allow us to resolve autoimmune disorders as a whole.

Newtown High School

Teacher: Timothy DeJulio

Project # 211

This project has been withdrawn.

Project # 212

Morrow, Kristin

Assessing the effect of access to healthcare on the survival rates of patients over 65 that contract COVID-19

Research Proposal, Science, Health and Medical

COVID-19 is a serious disease that has affected many people, disproportionately affecting those over the age of 65. This study will determine the effect of access to healthcare on the survival rates of patients over 65 that contract COVID-19. It is hypothesized that this study will show an association between the survival rate of patients with COVID-19 in each county studied, and the access to healthcare in each county studied. This study will use COVID-19 data from a sample of counties to determine the COVID-19 survival rate for those over 65 in each county. This study will look at the differences in survival rate among patients over 65 in each county and look for an association between the access to healthcare in each county, or the number of beds available, and survival rate. It is expected that different survival rates will be found for each county. Additionally, it is expected that there will be an association between the access to healthcare in that county, and the COVID-19 survival rate in the county. It is expected that these findings will lead to a deeper understanding of the importance of access to healthcare, especially for those over 65. It is also expected that this study will show that access to healthcare has a measurable effect on the chances that someone over 65 has of surviving COVID-19.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 213

Murdock, Ian

A system comprised of Neural Networks that will accurately predict and determine optimal reaction conditions and enthalpies

Research Proposal, Science, Physical Science

The formation of complex bonds and large-scale reaction systems are difficult to quantify, even more so to predict said processes. Using Neural Networks and an iterative approach to Machine Learning, we can more efficiently predict and understand these systems, and attempt to improve rudimentary networks into workable techniques. Using Python libraries such as PyQuante and ChemPy, we will construct a Neural Network that can predict a reaction system and the associated enthalpies. However, due to the large amount of calculations necessary for this type of simulation, a more efficient method of simulating this than a large, multi hidden layer network is needed. We will use an iterative approach and preferably a single layer network to mitigate this issue. The anticipated findings of this project will be less of a confirmation on a certain hypothesis, and more of an exploratory project looking into more optimal and time-efficient methods of simulating deep and broad systems, utilizing the raw power and brute force of a computer to the highest extent. The implications of this work lie largely in the processes of the systems we will make, and the methodology used in manufacturing such. Additionally, the concepts enumerated in the project already are beginning to have large effects on research, industry, and the development of better chemical processes.

Ridgefield High School

Teacher: Patrick Hughes

Project # 214

Murphy, Robin

Comparison of COVID-19 immune responses and mRNA vaccine-induced immune responses in high risk patients

Research Proposal, Science, Health and Medical

Severe COVID-19 cases are associated with immune hyper-activation or autoimmunity in high risk individuals, so those most susceptible to infection should be monitored when testing vaccine candidates. This project seeks to compare the natural immune response to COVID-19 and vaccine-induced immune response. It is hypothesized that the risk of developing autoimmunity in response to the vaccine will be lower compared to COVID-19 in vulnerable individuals. To prove this hypothesis, I will focus on individuals identified as high risk for developing severe COVID-19 in the U.S. and U.K. Data collected by other researchers will be used to compare natural COVID-19 immune responses to Pfizer and BioNTech's mRNA vaccination immune responses. Markers of immune and autoimmune responses that will be looked at will include T cell count, antibodies and autoantibodies. To date, the vaccine has had no adverse effects regarding hyper-immunity or autoimmunity despite it triggering an increased production of T cells and antibodies in the immune system. Therefore, it is expected that vulnerable patients who take the vaccine will be less likely to develop autoimmunity compared to patients who had severe COVID-19. If the hypothesis is supported, these findings will contribute to a better understanding of immunity and autoimmunity, as well as the long term safety of the mRNA vaccine. The lack of definitive information on this topic prompts further research on specific causes and reasons for autoimmunity and hyperactivity.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 215

Murphy, Ellis

Testing a Chloroform-Based Passivating Solution on Silicon and Perovskite Solar Cell Performance

Research Proposal, Engineering, Environmental

Research has shown that surface passivation of a solar cell yields improved device performance. This study investigates whether a chloroform-based passivating solution results in greater relative device performance of silicon or perovskite solar cells. Contaminants in the atmosphere can lead to quick degradation of key solar cell components. Minimizing the threat of degradation is imperative. It is hypothesized that the stronger silicon cell will have an improved power conversion efficiency over the perovskite cell as a result of its greater chemical stability. The article "An Interface Stabilized Perovskite Solar Cell With High Stabilized Efficiency and Low Voltage Loss" by Jason Yoo et al. provides the experimental basis of this study. Researchers discovered that a CF-based passivating technique yields optimal results when applied to perovskite solar cells. After coating silicon and perovskite cells in the passivating solution and subjecting both to artificial sunlight, power conversion is measured. It is expected that the silicon cell will exhibit a higher power conversion efficiency relative to the perovskite cell. In the original study, researchers found a stabilized device efficiency of ~22.6%. Because of silicon's strength relative to perovskite, the results will match and likely exceed those of the perovskite solar cell. The anticipated results point towards further research opportunities in areas concerned with maximizing solar cell energy output. Combining strengths of silicon and perovskite solar cells has been a point of research recently, which opens other research pathways. As the solar cell industry continues to evolve, maximizing efficiency will remain at the forefront.

Darien High School

Teacher: Christine Leventhal

Project # 216

Murphy, Cole

Akselos's RB-FEA Digital Twin Modeling to determine the longevity of In-service Aframax Oil Tankers.

Research Proposal, Engineering, Physical Science

Large Scale Engineering Assets are difficult to monitor. These Assets are critical aspects of the global economy and must be monitored to determine the longevity and health of the Asset. However, current methods use Finite Element Analysis (or FEA), this method is crucial in examining Structural Integrity but lacks the ability to analyze larger Assets. FEA is also too slow to analyze an Asset that is constantly changing. For example, an Aframax oil tanker is extremely hard to analyze, but with new technology from Akselos (RB-FEA), a reduced basis FEA that can process data 1000x faster, A large tanker with a load capacity of 80,000 to 120,000 tons can be modeled with an accurate digital twin that constantly relays sensor data from the Asset. Using Akselos it will be important to analyze years after commissioning tankers against the number of structural issues to provide an educated guess on the longevity of the tankers. Overtime, Aframax tankers, like all large structures, degrade due to the immense loading, and it is expected to find that as time passes the Tanker will face more structural problems; likewise, this comparison can be used to estimate the projected lifetime of the tanker. This data provides vital information to the owners of such Assets. With this data, companies can maximize the production of their Assets (like Tankers) without risking a catastrophic loss, leading to environmental and monetary damage. Additionally, RB-FEA can work alongside machine learning to alter load placement and mitigate structural damage.

Darien High School

Teacher: Christine Leventhal

Project # 217

Nafde, Ayush

Finding The Best Way To Predict Cardiovascular Disease In Black Americans, And How This Could Be An Important Step In Stomping Out Racism In Our Healthcare System

Research Proposal, Science, Health and Medical

Vascular stiffness predicts cardiovascular disease (CVD). The majority of CVD studies utilize the Framingham Heart Study (FHS) of mostly healthy white participants. However, there are wide differences in the risk factors, incidences, and outcomes of CVD by race. I will determine if the pulse wave velocity (PWV) ratio better predicts vascular stiffness and subsequently CVD than conventional carotid-femoral pulse wave velocity (CFPWV) in Black Americans. Within the Jackson Heart Study, I will conduct arterial tonometry, a non-invasive measurement of arterial blood pressure, carotid-radial pulse wave velocity (CRPWV), CFPWV, and central pulse pressure (CPP). I will collect data on the socioeconomic determinants of health and CVD outcomes and death and follow up over five years to determine the risk of major CVD events. All CVD-related hospitalizations and physician visits will be adjudicated. I will divide participants into 4 groups according to their CPP status and presence of high vascular stiffness. I will evaluate the association between these groups and incidence of CVD events using Kaplan-Meier plots and multivariable-adjusted Cox proportional hazards regression models. I will test statistical interaction using interaction terms, stratify analysis by age, and assess improvement in discrimination using the C-statistic. I predict that PWV ratio can better predict vascular stiffness and subsequently CVD disease in Black Americans. My findings may help ease CVD burden in Black Americans. I expect to catalyze a pivot from the current approach of reporting racial disparities to actively discovering solutions for underprivileged communities.

Darien High School

Teacher: Guy Pratt

Project # 218

Narang, Anusha

The Effects of Allelopathy on Soil Microbial Communities

Research Proposal, Science, Environmental

Allelopathy is an organism's production of biochemicals that influence the growth, influence, survival, development, and reproduction of other organisms. Plant allelopathy has been studied as a possible mechanism for agricultural management in the form of a replacement for synthetic herbicides. To further this research, I will examine the effects of allelopathy on soil microbial communities. I will use the Solidago Altissima & Poa Pratensis and grow three different plots: a control plot of just dirt, a plot of S.altissima, and a plot of S.altissima put in intraspecific competition with P.pratensis. I will analyze the solid microbial communities after 7 weeks of plant growth. I will analyze the allelochemicals produced by the plants as well Allelopathy is hypothesized to have significant effects of soil microbial communities. Determining the effects of allelopathy on soil microbial communities is an important step toward agricultural management and using plant allelopathy as a herbicide.

Darien High School

Teacher: Guy Pratt

Project # 219

Nemec, Katherine

Using Artificial Skin Tissue to Analyze the Effect of Molecules Disrupted In Renal Carcinoma 3 and 6 Hydroxy Aminopurine on Melanoma Progression

Research Proposal, Science, Health and Medical

Melanoma is the deadliest progressive skin cancer that requires invasive treatment plans that result in negative long term effects. This study seeks to conduct a comparative experiment between two alternative treatments for melanoma patients using natural body chemicals, Disrupted In Renal Carcinoma 3 (DIRC3) and 6 Hydroxy Aminopurine (6-HAP). It is hypothesized that DIRC3 and 6-HAP will suppress melanoma tumors and increase survival rates. Using the 3D artificially engineered skin model, established by scientists Bourland, Fradette, and Auger, invasive tumors were cultured through the Self-Assembly Method. Each microbiome environment will receive either 6-HAP, DIRC3, both the chemicals, or neither of them. The chemicals will be applied or injected in different increments, which correlate to previous studies and will measure the proliferative index of the tumors daily. It is anticipated that DIRC3 and 6-HAP will decrease the proliferative index of the melanoma tumors, and when scientists apply them to the skin, the two will act synergistically to increase a patient's survival rates. 6-HAP will be proven more effective because of its stronger direct correlation to decreasing the size of the melanoma tumor versus DIRC3, which only activates the natural tumor suppressor, IGFBP5. Due to the ambiguous nature of DIRC3 and 6-HAP, scientists may come across unforeseen behaviors, which could worsen the tumor's metastasis in the study. These results, however, could open up alternative treatment options for other forms of cancer that before used radiotherapy or chemotherapy. The Self Assembly Method provides a new outlook on cancer progression in clinical medicine testing.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 220

Noaman, Nadine

Analysis of Publicly Available Data to Generate Novel Ideas and Discoveries in Pathways Involving Hypoxia and Metabolism Starring RBX1 and HIF1alpha.

Research Proposal, Science, Health and Medical

Osteosarcoma is a type of bone cancer occurring in children and young adults. Osteosarcoma appears in any bone of the body, and its most common appearance is a primary tumor in long bones. Hypoxia is a critical hurdle the tumor must overcome to grow and metastasize. Hypoxia is a deficiency in the amount of oxygen reaching the tissues which is common in malignant tumors. Hypoxia alters cancer cell metabolism. I am using databases to discover novel mechanisms by which osteosarcoma induces angiogenesis. I will review resources for pathways that assist in countering hypoxia and compile a list of genes and pathways that bear more explanation. Databases include DAVID, STRING, ncbi.nlm.nih.gov/geo/, TF2DNA, HuRi, and TCGA. These publicly available databases are curated by the Laboratory of Immunopathogenesis and Bioinformatics and academic institutions. Analyzing GEO data set GSE42352 showed the regulation of HIF1A may be due to the regulation by RBX1. The regulation of RBX1 may be due to the regulation of RBX1 transcription by CTCF and YY1. This suggests a potential novel pathway of regulation of HIF1A by RBX1, CTCF, and YY1. HIF1A needs to be inhibited in hypoxic environments to prevent tumors from growing. Two ways that one can do that is through the regulation of RBX1 or regulation of CTCF and YY1. These regulations may be done through small molecule inhibitors or other therapeutic mechanisms. This may lead to improved therapy for osteosarcoma.

Glastonbury High School

Teacher: Diane Pintavalle

Project # 221

Norcross, Charlotte

The effects of honeybee venom on different types of cancer

Research Proposal, Science, Health and Medical

Cancer therapy can leave big consequences on the human body. My grandfather had cancer and had to go through multiple treatment types, each taking separate tolls on his body. Although honeybee venom hasn't been tested much in cancer research, it has shown promising results with high levels of selectivity while still being cytotoxic towards cancerous cells. In studies so far, it has shown to have small consequences on the human body, especially compared to existing treatments such as radiation therapy. Multiple data sets will be collected and analyzed from separate researchers on the effects of honeybee venom in cancer treatment. This will include multiple types of cancer and cancerous malignant and stagnant tumor growth within the body. Results from the different studies will be compared and contrasted with each other in order to determine the benefits, consequences, and effects of honeybee venom in cancer therapy. It's expected that the venom from honeybees will be effective in anticancer therapy, it can be paired with other existing treatments, and that it doesn't take such a large toll on the body as other treatments due to its high selectivity. This has been demonstrated in the usage of honeybee venom as treatment for HER2 enriched and triple-negative breast cancer. This research will have the benefit of furthering cancer research in the aspect of having a better understanding of safer, more effective methods for treatment and curing cancer.

Ridgefield High School

Teacher: Ryan Gleason

Project # 222

O'Connor, Annie

Testing Water Chemicals Between Municipalities to Uncover Environmental Racism in Ethnically Vulnerable Communities

Research Proposal, Science, Environmental

Although the Safe Drinking Water Act (1974) was supposed to guarantee safe drinking water for all Americans, existing U.S. water systems continue to fail their constituents, especially in racially vulnerable communities. Although there have been studies examining the impact of water violations on a national scale, few provide analysis of violations varying between municipalities within the same geographic area. I hypothesize that communities who are vulnerable will have high rates of pollutants that pose an immediate health risk in their water. I will test water for pollutants that pose a health risk to local vulnerable communities. To identify these communities, I will engage in participatory research, by contacting leaders in communities to obtain permission to test their water. I will use a home water test kit to uncover chemicals. Water test results from municipalities will be compared. I will use statistical tests such as an odds ratio to look for an association between vulnerability and drinking water violations. It is expected that communities that are more ethnically vulnerable will have a higher number of water violations than those which are not. Communities of color who are considered "vulnerable," meaning they cannot cope with the impacts of disaster to their communities, are the most prone to experience water violations. If there is an association between vulnerability and water violations, policy makers will be alerted, and those communities will be prioritized in terms of regulation. For future research, it will be important to determine the sources of pollution to drinking water.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 223

This project has been withdrawn.

Project # 224

Ogden, Spencer

Measuring the effect of wildlife bridges on road kill frequencies

Research Proposal, Science, Environmental

My problem statement is how does the presence of a wildlife corridor affect the frequency of roadkill in the area. My motivation came from a trip a few years ago to Banff National Park, where I learned about the wildlife bridges they had there. This is how i became interested in researching wildlife crossings For this experiment, I will be doing a meta analysis of data regarding roadkill numbers that I hopefully would receive from the CT DEEP. I would then look at the frequencies of roadkill 2 years before and 2 years after the wildlife corridor was built. After analyzing the data, I would then come up with a conclusion and begin writing a journal article As this is proposed research, I do not have any results. However, I am expecting that the years after the wildlife tunnel was built, the frequency of wildlife being hit and killed by vehicles will be lower than the years before the wildlife tunnel was built. If my hypothesis is proven correct, this proves that wildlife corridors are worth the investment, and more should be built in order to conserve the remaining species we have on this planet.

Ridgefield High School

Teacher: Ryan Gleason

Project # 225

Ogrinz, Alexis

The Use of Pleurotus Ostreatus As Mycoremediation for Poly-Lactic Acid Plastic In Landfills.

Research Proposal, Science, Environmental

The accumulation of Poly-Lactic Acid (PLA) plastic in landfills creates a dangerous environment for local wildlife. The slow biodegradation of PLA plastic means that the rate of decomposition is significantly lower than the accumulation of more plastic. Pleurotus ostreatus, oyster mushrooms, are capable of the mycoremediation of PLA plastic in cultivated conditions. This experiment will test if oyster mushrooms can continue that trend in landfill conditions. In this experiment, oyster mushroom spores will be grown on glass agar dishes. Each trial will contain a 3D printed PLA plastic ring to test for the degradation of the plastic by the oyster mushrooms. The trials will be run in different ratios of agar to landfill components beginning from 100%:0% and decreasing by tens until 0%:100% for a total of eleven trials. The oyster mushrooms will be evaluated over two months on the growth of their mycelium and the amount of PLA plastic degraded by mass. Oyster mushrooms growing in conditions with a higher landfill material ratio should still show mycelium growth and plastic decomposition comparable to the spores grown in solutions with a higher agar ratio. This demonstrates the oyster mushroom's ability to decompose PLA plastic to the same degree outside of cultivated conditions. In the future, oyster mushrooms could act as a clean source of mycoremediation for PLA plastic in landfills, effectively lowering the accumulation of plastic waste and making the area safer for both wildlife and humans.

Joel Barlow High School

Teacher: Paul Testa

Project # 226

Olsen, Alexander

The Effect of Glucosamine on Exoskeletal Development in Crickets

Research Proposal, Science, Health and Medical

In many endoskeletal organisms, glucosamine is often used as a therapeutic supplement because of its ability to promote cartilage and joint health. I intend to discover if glucosamine is also beneficial to exoskeletal organisms by testing the impact of supplementing n-acetyl-d-glucosamine—a natural compound found in chitin, a key polymer in crickets' exoskeletons—on the development of crickets' exoskeletons. Supplemented crickets will receive a dose of 0.1 mg of glucosamine to supplement their standard diet. I will analyze crickets while they “molt,” or repeatedly shed their exoskeleton prior to developing wings. This process occurs 8-10 times throughout the lifespan of the cricket. I will gather the percent change in mass of crickets' molted exoskeletons along with detailed observations about how quickly they complete their developmental processes to investigate the effectiveness of glucosamine in catalyzing exoskeletal development. Based on evidence supporting glucosamine as a supplement for endoskeletal organisms, it can be hypothesized that glucosamine will increase the rate by which crickets develop, and also increase the percent change in mass of molted exoskeletons because of its role in synthesizing chitin—a polymer crucial to the development of a cricket's exoskeleton. If this experiment renders positive results, it suggests a new method—supplementing glucosamine—to stimulate growth in exoskeletal organisms. I hope that this project will inspire me to pursue innovative research about supplementation in endoskeletal organisms, enabling me to develop better methods to enhance physical performance and return the injured to their usual activities.

Weston High School

Teacher: Stacey Greenberg

Project # 227

Orr, Josephine

Testing the Effect of Common Pesticides on Hermit Crabs

Research Proposal, Science, Environmental

Pesticides are a prevalent non-point source pollutant and a very dangerous one. Studying them is very important because they can affect ecosystems, the environment, and human health. Not enough research has been done to see the impact of these chemicals on marine animals or coastal ecosystems, so we aim to study the effects pesticides have on hermit crabs, specifically *pagurus longicarpus*, a common species in the local Long Island Sound. We will split the hermit crabs into three groups: a control that we will not expose to any pesticide, and two that we will expose to varying amounts of the chemical. We propose to periodically measure the mass and volume of the hermit crabs, determining their growth over a length of time. We will keep the hermit crabs in a controlled environment to prevent external variables from affecting the experiment. We expect the pesticides to inhibit the growth of the hermit crabs. The more pesticides, the slower they will grow. Any diseases or deaths will also be more prevalent in the hermit crabs that are exposed to higher amounts of chemicals. If our hypothesis is supported, we will publish our results, proving that these pesticides are dangerous to non-target animals. We will also look into ways to prevent people from using these chemicals and for them to stop polluting Long Island Sound. The implications if our hypothesis is supported is that many species can be both directly and indirectly affected by pesticides and that the chemicals are bad for coastal ecosystems.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 228

Team: Pascal, Gigi; Nemec, Caroline;

Association between Aggressive Behavior in Purebred and Mixed Breed Canines and Gene Variants

Research Proposal, Science, Behavioral

In 2017, one in sixty-nine people were bitten by dogs. This sparked our exploration of the genetic roots of aggression and how it correlates to certain breeds of dogs. Previous studies have identified gene variants for dog aggression using genome wide associations. It is hypothesized that differences within DNA amongst certain breeds of dogs are associated with dog aggression. In this two part study, we will conduct a survey for data from dog owners to collect information on dog's selected aggressive behaviors. Then with permission from dog owners we will sequence the genomes of all of the dogs to investigate whether there is an association between the aggressive genetic variants identified by previous researchers and their aggressive behavior. We predict that results from the survey will show that the mixed breeds will be more likely to show the behavioral traits of aggressive behavior. We predict that the mixed breeds will be associated with genetic variants that correlate with aggressive behavior. We hope to look into associations between dogs and their behaviors while also being able to uncover possible genetic causes. This research enables us to find a possible explanation behind dog aggression by applying a scientific perspective behind a dog's reactions. This study not only looks at the genetic basis but a comparison between purebred dogs and mixed breed dogs. This research will promote further research for dog breeders since now there is a connection between the dogs genetics and the behaviors recorded amongst multiple participants of the survey.

Convent of the Sacred Heart

Teacher: Joan Fei

Project # 229

Passaretti, Andrew

Effects of Bacteriophage Therapy In Vivo

Research Proposal, Science, Health and Medical

Multiple studies have been performed showing the effectiveness of a phage cocktail against various mixtures and strains of bacteria but most results have been performed in vitro. It is important to understand the effect phages in vivo in comparison to antibiotics. The bacteriophage cocktail will be more effective at controlling the bacterial mixture than the antibiotics. The experiment would be performed 3 different times. For each experiment there will be 3 mice per variation (BC, Antibiotic, bacteriophage) , all infected with C Difficile, E coli and Salmonella. .The mice will be given 12 hours for the first evaluation, 24 for the second, 36 for the third and 48 for the fourth. The phage treatment will result in healthier mice. I expect to learn the side effects of antibiotic and phages. The data will be quantitative, CFU per mL, and qualitative, the general state and behavior of the mice. The research will likely show the benefits of phage therapy, little to no side effects and faster treatment. Bacteriophages could also be combined with immunotherapy. Further avenues of research would be human trials or just any different variation of phage and bacterial strain.

Darien High School

Teacher: Christine Leventhal

Project # 230

Pasumarti, Kareena

Repeated Intravenous Administration of Proline in Parkinson Disease: Effect on Oxidative Stress

Research Proposal, Science, Health and Medical

Parkinson's disease (PD) affects 4.6 million individuals, yet remains incurable. Proline is the precursor to glutamate; the two amino acids should vary directly. PD patients have depleted glutamate levels, but one study observed elevated proline levels in PD patients. This study assesses oxidative stress indicators, malondialdehyde and 4-hydroxynonenal, to ascertain the relationship between glutamate and oxidative stress, which is associated with PD. Would proline administration decrease malondialdehyde and 4-hydroxynonenal? Blood samples will be collected from the PD patients and healthy controls before, during, and after the 30-day trial. The levels of malondialdehyde (MDA), 4-hydroxynonenal (4-HNE), and proline will be discerned from the plasma. UPDRS and Hoehn & Yahr rating scales will be utilized to assess the severity of the Parkinsonian symptoms experienced by the individuals with PD before and after the trial and their respective responses to the proline. No adverse effects are foreseen, but appropriate changes to the prolidase dosage regime might occur if undesirable symptoms are experienced. The numerical change between the baseline, during, and post-trial measurements of controls and PD patients will be compared. Oxidative measures and thus PD rating scores are expected to decrease after this trial, as the relationship between proline and glutamine points to increased proline levels as yielding a favorable result. If these results are substantiated, proline could abate Parkinsonian symptoms. The possibility of diagnosing PD earlier is also created. Proline is the precursor to glutamate, so depleted proline levels could be detected before a glutamate deficiency even develops. This is essential because existing PD treatments are more effective when administered early into the disease. Future research includes the effect of other amino acids on PD—possibly another angle to attack PD.

Darien High School

Teacher: Christine Leventhal

Project # 231

Persily, Benjamin

The use of impedimetric biosensors to increase the limit of detection of E. Coli O157 compared to other biosensors

Research Proposal, Science, Environmental

Pathogens in drinking water cause between three and five million deaths per year. The detection of these pathogens in water sources is crucial in preventing many deaths and illnesses, and one technology on the rise shows great potential for detecting these pathogens are biosensors. Biosensors are detectors that utilize a bioreceptor and a transducer to convert the amount of a specific analyte into a measurable reading. Many different types of biosensors exist, and the types are classified by the transducer and methods used. In this research, it was determined that an impedimetric biosensor would be the most sensitive biosensor based on its limit of detection (LOD) of colony forming units per milliliter (CFU/mL). In this study, known quantities of E. Coli O157 were placed in cultures and each biosensor was tested against these different quantities of colony forming units until a limit was determined. Four types of biosensors were tested, the most common being surface plasmon resonance (SPR), and also quartz crystal microbalance (QCM), impedimetric, and lateral flow assay (LFA). Ultimately, the impedimetric biosensor had a significantly lower limit of detection compared to the three other biosensors. While other methods of detecting bacteria in samples exist such as PCRs and ELISAs, these are expensive, time consuming, and require specialized personnel to operate, and biosensors are point of care and can be used by people with limited training. Impedimetric biosensors show great promise to provide a simple and on site way of detecting harmful bacteria in drinking water.

King School

Teacher: Victoria Schulman

Project # 232

Peters, Liv

Aberrant Saliene in Schizophrenic Patients Before and After the Treatment Of Oxytocin and Clozapine

Research Proposal, Science, Health and Medical

Aberrant salience is a dysregulation in dopamine that can cause people with schizophrenia, a potent form of psychosis that affects 1.1% of the US population, to pay too much attention to stimuli that are not actually important. Aberrant Salience will show a higher correlation in patients primarily being treated by clozapine to patients being treated by oxytocin and clozapine due to oxytocin positive effects on dopamine regulation. 20 Patients who are treatment-resistant schizophrenics will begin treatment of clozapine. Once there is a leveling out in the PANNS scale, will be tested using the Salience Attribution Test (SAT) before the introduction of oxytocin. They will be tested once again after the introduction of oxytocin. A control group of 10 patients who had never taken the test before would also be given the test during their treatments. Predictions of a lower aberrant salience correlation will be shown after the introduction of oxytocin. Researchers may conclude the oxytocin will be helpful in regulating positive dopamine responses in appropriate situations due to its ability to shape social behavior. This would be seen by proper responses to situations requiring dopamine release, and better social integration. Patients who have lower aberrant salience are better at social engagement and response to normal stimuli. Patients are able to engage in interactions and have more of a positive reaction after receiving the stimulus that typically ignites a dopamine reaction. Patients will also express closer bonding patterns with other individuals.

Darien High School

Teacher: Guy Pratt

Project # 233

Petron, Isabel

Unexpected UVR mutation burden in melanomas – a continuation of research in a United States Cohort focusing on UV impact on cutaneous melanomas

Research Proposal, Science, Health and Medical

The way in which melanoma subtypes are characterized is too generalized, mostly considering melanomas as caused or not caused by the sun. This project looks at the impact of UV rays on cutaneous melanomas to test whether or not all of them are caused by the sun. It is important to expand this research – originally completed by the University of Sydney – to evolve the general understanding of non-UVR melanomas and the patients affected by them. For this study, a publicly available dataset, retrieved from ICGC database, was utilized. The DNA mutations of 38 patients will be examined to see if their UVR-mutation burden classifies them as unrelated to the sun. The demographics of the non-UVR subjects will then be compared to find risk factors. A linear regression will compare the UVR signatures to the risk factors, to substantiate the relationship. By statistically analyzing, the expectation is that 1-5% of the cutaneous melanomas will harbor a UVR-mutation burden below the required. This will classify them as not matching their subtype. The clinical data of these subjects will then be examined, and are expected to show similarities. This will show which characteristics indicate a non-UVR dominant melanoma. Expansion of the information on the heterogeneous nature of melanomas has important public health implications. Namely, through outlining potential risk factors. This can help suggest preventative measures for patients and the general public. It can also guide future research on the non-UVR mutagenic processes of melanomas, thereby furthering our understanding of this cancer.

Joel Barlow High School

Teacher: Paul Testa

Project # 234

Pistone, Olivia

Isolating Embryonic Neurons From DDX3X Mutant Mice And Normal Mice and Comparing Dendritic and Synaptic Development

Research Proposal, Science, Health and Medical

DDX3X is a rare neurological disorder that affects 2% of females around the world. It is a new disorder, and was only founded in 2015, so the developmental aspects still remain unclear. It only affects females because it is an x-linked syndrome, meaning that females have an xx chromosome and males have an xy chromosome, so if there is a mutation on one of the x's the females will survive because they have an extra one. On the other hand, the males will not survive because they only have one x so it becomes lethal. If neurons harvested from healthy mice and mutated mice with DDX3X syndrome are evaluated and compared, the neurons from the mutated mice will be smaller and less developed. To test this, mutated and healthy mice will be bred, then the embryos will be harvested after 15 days. Then the neurons will be put in a culture to develop and grow. Then the neurons will be analyzed and observed to see any developmental differences between healthy and mutated neurons. It is expected that the mutated neuron's synapses and dendrites will be smaller and less developed than the healthy neurons. This is because the DDX3X gene controls development so if there is a mutation then there will be developmental setbacks causing the neurons to be smaller. This will help to begin understanding the molecular functions of this syndrome, which will help the people suffering around the world who also know nothing about this syndrome.

Darien High School

Teacher: David Lewis

Project # 235

Podila, Kavya

The Effect of Time Since Diagnosis of Type 1 Diabetes on the Survival of a Beta Cell Subpopulation

Research Proposal, Science, Health and Medical

The purpose of this experiment is to determine whether an immune-attack resistant subpopulation of beta cells in type 1 diabetes is more likely to persist during the “honeymoon phase” or in the long-term. The motivation is to identify the time in type 1 patients where beta cell remission and a potential mass increase could occur. The experiment would be performed on mice, given the difficulty in conducting an in vivo human study. The islets of a group of controlled non-obese diabetic mice will be studied for beta cell mass 3 weeks after birth, before diabetes can occur. Data will then be collected at 7 weeks for regrowth and presence of the subpopulation. Finally, data will be collected at the end of their lifespan. The findings should show when the protected subpopulation is prominent, and what beta cell improvements appear as a result. The pre-diagnosis tests will reveal the initial beta cell mass and the “honeymoon phase” data will demonstrate to what extent the natural regrowth occurs, and if the subpopulation is present that early. The later test will show the possible change in strength of the subpopulation after natural remission. This experiment would explain if beta cell survival becomes more likely through the combination of the resistant group and honeymoon stage. It would also show at what time the population’s resistance is strongest. This is helpful in determining the best time to insert beta cell islet transplants to increase the amount of time before resumption of insulin.

Ridgefield High School

Teacher: Patrick Hughes

Project # 236

Porter, Sabrina

Inhibiting MDM2 with Nutlin 3a in triple negative breast cancer to allow for expression of P53

Research Proposal, Science, Health and Medical

P53 is a tumor suppressor gene which inhibits the proliferation of cancerous cells. P53, however, becomes mutated when it binds with MDM2. Cells with mutated P53 have higher chances of forming tumors. The problem being researched is if Nutlin 3a can inhibit binding between oncogene MDM2 and P53, how that will affect the proliferation of cells in triple negative breast cancer (TNBC). Cell lines of triple negative breast cancer from mice with mutated P53 will be dosed with Nutlin 3a in three dosing quantities. One dish will contain no Nutlin and will act as the control. Dishes will sit in an incubator for 48 hours. After dosing, cell lines will undergo electrophoresis to determine the differences in levels of P53 expression. Expected results are that cells treated with higher dosings of Nutlin 3a will have higher levels of P53 expression because the binding between P53 and MDM2 is inhibited. It also can be concluded that the dishes treated with higher amounts of Nutlin 3a will have elevated levels of cell death as a result of P53 performing its task and killing off the cancerous cells. Research will test if Nutlin 3a is a usable treatment for TNBC and allow for P53 expression. The hope is both to prevent the mutations of P53 and see if treated P53 has properties to stop cancer from spreading under the support of the drug. It can prove that there is a possible treatment to prevent the start of TNBC tumors in the first place.

Ridgefield High School

Teacher: Patrick Hughes

Project # 237

Price, Allison

The Prediction of Future Forest Fires Due to Vegetation Moisture

Research Proposal, Science, Environmental

Forest fires have become a growing issue in most parts of the world. I came across the journal article utilizing different criteria to determine the areas most at risk. Hearing about the tragedies on the news, I know there has to be a solution. While researching forest fires and their movement, I plan to be able to find the regions most at risk in order to warn others with the capability of stopping it. I will use the USGS VegDRI 7-day eMODIS data to analyse the probability of a fire in a given area. The VegDRI model determines drought probability, further transferring to forest fire prediction. Using the USGS VegDRI methodology diagram will be very helpful for many to foresee the possibility of dangerous climate conditions. The diagram will be very helpful for larger regions and small regions but also gives much broader information. This research will save many lives by predicting the movement of fires. This will revolutionize the prediction of weather and other environmental issues. With this data there will be less casualties and global disasters due to these reckless forest fires.

Ridgefield High School

Teacher: Ryan Gleason

Project # 238

Quayle, Emma

The Impact of Race: Forensic Patients' Self Reports of Confessions and Denials When Guilty and Innocent During Police Interviews

Research Proposal, Science, Behavioral

With the current awareness of the mistreatment of BIPOC at the hands of police, it's important to recognize the coercion and manipulation suspects face during police interviews. This study will investigate the impact of race on the rate of false confessions in order to bring attention to the racial tensions present within the justice system. Forensic patients of different races (White, Black, Asian, and Indigenous) will take surveys asking about their behavior during the suspect interview. A mix of guilty and innocent patients when interviewed will self-report whether they falsely confessed. Patients will be asked to consider any aggression present towards them during the interview. Since this experiment relies on self-reported data, it risks different individual perceptions of what a false confession is. I predict that the rate of false confessions will increase when BIPOC are interviewed due to racial stereotypes and assumptions police make during suspect interviews. I expect that BIPOC forensic patients will be more likely to make a false confession due to the increased likelihood of mistreatment. To determine the rate of false confessions for one race, the different survey answers of that race will be compared. To analyze the results, the rate of false confessions of each race will be juxtaposed. Future studies can continue this research to test how other factors such as gender or sexuality impact the rate of false confessions. This experiment can provide evidence of the discrimination toward BIPOC present in the justice system and the need for change.

Darien High School

Teacher: Guy Pratt

Project # 239

Reynolds, Matthew

Rapid Transport for Refractory Out-of-Hospital Cardiac Arrest Patients to Initiate Extracorporeal Cardiopulmonary Resuscitation

Research Proposal, Science, Health and Medical

Patients suffering from cardiac arrest in an out-of-hospital setting have an extremely low chance of survival. If rapid ambulatory transport is initiated, for refractory cardiac arrest patients, to a hospital capable of performing Extracorporeal Cardiopulmonary Resuscitation (ECPR), higher survival rates and better neurological outcomes will be revealed. As an Emergency Medical Technician, through Darien-EMS-Post-53, I am motivated to find alternate ways to treat cardiac arrest patients in the field. The EROCA study at the University-of-Michigan is similar to my proposal. The studies are similar, though differentiated by post-transport results. The theoretical modeling of my experiment is its conduction at a specific, ECPR-capable hospital and data collection over one year. The feeding EMS agencies must be in collaboration with the experimental protocols, and the Seldinger Technique will be used for cannulation. I expect to discover that when the transport of out-of-hospital refractory cardiac arrest patients to a pre-determined hospital is faster, the patient will have higher chances of survival with better neurological outcomes. Data is analyzed by comparing the time a patient was in refractory cardiac arrest until ECPR initiation to survival-rate and neurological outcomes. If my anticipated results prove accurate, researching the functionality of bringing ECPR into the field would be my next focus. Paramedics, EMT's, and other rescuers, can have a tremendous impact on the improvement of CPR and an even bigger impact with ECPR-protocols in place. If Healthcare professionals can minimize transport time of ECPR candidates, they can improve the cardiopulmonary resuscitation survival rate and save lives worldwide.

Darien High School

Teacher: Christine Leventhal

Project # 240

Riebling, Riley

Human Impact on the Migration Behaviors of Sharks

Research Proposal, Science, Behavioral

An organism's behavior is often influenced by another's; this characteristic is especially prominent in animals being impacted by human action. More specifically, how the abnormal behavior of the human population because of the COVID-19 pandemic has affected the habits of sharks on the east coast of the US. This research will look into the migration patterns of a species of shark in 2019 and compare it to the migration of that species in 2020. The tracker Oearch, (a global marine animal tracker) will be used. The species of shark with the most tracking data available will be analyzed in 2019 and then in 2020. Already written reports off Oearch of specific shark tracking will also be used in the comparison; hopefully by the end of this year, more reports of 2020 tracking will be published that can also be used in the data analysis. The study is expected to result in the conclusion that the sharks have begun migrating and gathering closer to shores and beaches while continuing with their regular seasonal migrations. This is because they are able to be closer to the coasts, as opposed to deeper, open ocean, because human interaction would be less common with the pandemic keeping people off the beaches and off boats. This research is important because it looks closer into the idea that human behavior impacts animal behavior. If animal behavior changes because of major changes caused by humans, people can learn how their actions will affect other organisms and hopefully change their behavior for the better.

Ridgefield High School

Teacher: Ryan Gleason

Project # 241

Rizzio, Sarah

The Effect of Academic Burnout on Mental Health

Research Proposal, Science, Behavioral

Student life should be a balance between self care and academics. Immense pressure for students to succeed can negatively impact their emotions- causing academic burnout. Academic burnout is when students are unable to meet constant demands, characterized by symptoms of exhaustion, depression and the inability to complete assignments. The lack of motivation to complete schoolwork combined with the increasing demand in schoolwork creates vicious extremes in one's grades-and mental health. The methodology of my research will be to talk to students to gain insight to their lives as a student and possible experiences with burnout. Taking proper safety precautions, I will ask students about their thoughts on school, if they've experienced any of the token symptoms of academic burnout, and if they've had a different attitude towards school now that schools are teaching on a covid-compliant model. I expect that I will confer with students with differing attitudes about school. I also predict that I will conference with students that have experienced academic burnout, whether they knew about it or not. I foresee that I'll also record varying student reactions regarding school during COVID-19. Overall, my expectations are that I'll record a broad spectrum of opinions, in hopes that it will support my hypothesis. The implications of my research is that it will benefit student mental health, which is often disregarded. By understanding academic experiences from a variety of students, schools will be better equipped to assist students who are overworked or burnt out from school.

Ridgefield High School

Teacher: Patrick Hughes

Project # 242

Rodriguez, Evia

Biodegradation Analysis of Recent Renewable Plastics

Research Proposal, Science, Environmental

People use plastics every day, therefore; environmentally friendly biodegradable substitutes for common plastics are needed. Because of this, investigating and comparing the biodegradation properties of sustainably derived plastics to those of non-renewable synthetic plastics will determine the feasibility of specific sustainable plastics replacing non-renewable plastics. An aerobic biodegradation test of a renewable plastic will be used to determine its performance in a real-world scenario. River water samples will be collected and incubated, and the plastic will be submerged in a jar with the solution. The TOC (total organic carbon) within the jar will be measured using an HPLC machine as a metric for the biodegradation rate. The biodegradation rate of a sustainable terpene-derived plastic will likely be comparable to that of a non-renewable plastic due to the similarities in structure. In order to make the terpene-derived plastic and non-renewable plastic have almost indistinguishable properties, the structures must be closely related. Therefore, since the biodegradation process depends on the structure of the polymer, the biodegradation rate is likely to be comparable. Although sustainable plastics may be derived from plant biomass, this does not necessarily mean they are biodegradable. It is important to test the biodegradation of renewable polymers to determine the possible environmental damage during the end of life stage of the polymer in a real-world scenario. Without the knowledge of the biodegradation of novel polymers, implementing recently developed plastics into mass-production becomes difficult.

Ridgefield High School

Teacher: Ryan Gleason

Project # 243

Roth, Julia

Examining the Susceptibility of Introverts versus Extroverts Obtaining An Altered Immune System While Socially Isolating

Research Proposal, Science, Health and Medical

A weakened immune system due to stress, a sedentary lifestyle, and low levels of vitamin D can decrease the body's capability of protecting itself from harmful events. Social isolation, a global method used to lower the spread of the Coronavirus Disease, increases the prominence of these threats. It is hypothesized that people with extroverted personalities will face the greatest changes in their immune system while socially isolating. This study will evaluate changes in the subjects' immune systems by comparing complete blood count results of introverts and extroverts before and after isolating for six months. The Myers-Briggs test will establish if subjects are introverts or extroverts. In isolation, subjects will face stressors. There will be a control group that does not isolate. T-Tests and P values will determine the difference and statistical significance between the complete blood counts results of the groups before and after the experiment. It is projected that the average white blood cell count of participants in the introverted personality group will decrease less than the average white blood cell count of participants in the extroverted personality group. Minimal changes will be observed in the control group. If it is found that social isolation has a large impact on the immune system of extroverts, then extroverts may strive to find ways of completing "normal life activities" while socially isolating. This research could also lead to clinical trials where new ways of protecting and strengthening the immune system under social isolation are found.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 244

Rubio, Maya

The effect of parabolic dunes on beaches

Research Proposal, Science, Environmental

The problem that I have chosen to research is the effects of parabolic dunes on beaches. The main reason why I got into this topic is because i've been going to beaches all my life. I've been fortunate enough to see the effect of dunes on towns and beaches over the years. I find it very interesting how dunes are made and how they help the beaches and community during storms. Overall I want to find out the specifics on how beaches with and without parabolic dunes are affected. My current approach to the question of how parabolic dunes affect beaches is to study a specific beach over a period of time and see how the dunes affect the area in either a beneficial way or see the disadvantageous it brought. I am researching the history of parabolic dunes. Also once I have a better understanding I will be looking into specific beaches and seeing how the dunes help or break down the area around there. Right now some of my findings are that the dunes have been most beneficial to beach towns. For example, there is a beach in Outerbanks with parabolic dunes and research has shown how the dunes have kept houses standing and prevented the town from flooding. Furthermore, I would like to research how different beaches would benefit from having parabolic dunes or how beaches with parabolic dunes would react if they were smaller, larger, or just not there at all. Overall this research is important because it can provide information about dunes and how we can change the current situation to one that is more beneficial for some places. I also think this information will help the community prepare more for a storm by having a better understanding of their environment.

Ridgefield High School

Teacher: Ryan Gleason

Project # 245

Saad, Samira

The Effect of the Cold-to-Hot Empathy Gap on the Treatment of Humans Experiencing Chronic Pain

Research Proposal, Science, Behavioral

The more than 1 in 5 American adults that experience chronic pain face stigma and prejudice in the workplace, school, and community as they are penalized for medical conditions due to the cold-to-hot empathy gap (Dahlhamer et al, 2016). The cold-to-hot empathy gap is a type of cognitive bias that occurs due to a discrepancy in perception based on the state of the subject (Lowenstein, 2005). In the context of pain, someone in a cold state would not be experiencing pain while someone in a hot state would be. In this study, people of varying cold and hot states will be tested on the empathy they feel for someone in the hot state of chronic pain, based on their responses to questions regarding a written scenario. The scenarios will describe a common example of the daily life of someone who experiences chronic pain and the corresponding survey questions will ask the subject how they would respond to the actions of the exemplified person and their opinions on the person. Survey responses across different experimental groups will be used to gauge trends and differences in empathy. It is hypothesized that the lesser experience people have experiencing chronic pain, the less empathy they will show towards the scenario, with the experimental group never experiencing chronic pain showing the least level of empathetic response and the experimental group currently in the hot state (experiencing chronic pain) showing the highest levels of empathetic response. If this hypothesis is correct, this study will provide greater understanding for why humans treat each other in the ways that they do, giving more basis to research on cognitive bias and empathy gaps in general.

Staples High School

Teacher: Amy Parent

Project # 246

Salman, Shafay

Are Rotator Cuff Injuries in Baseball Players treated better after going through conservative rehabilitation after surgery, or aggressive rehabilitation after surgery?

Research Proposal, Science, Health and Medical

So many baseball pitchers injure their rotator cuff, and in almost all cases, are never the same. This is an important topic to study because people who suffer from rotator cuff injuries have trouble doing everyday activities, and we should figure out how to help them. Which type of rehabilitation following surgery allows for the better and long term treatment in a rotator cuff, conservative rehabilitation or early aggressive rehabilitation? Currently, baseball players get a surgery following their injury, and follow a strict treatment and physical therapy plan. In my experiment, I will have ten pitchers who have each injured a rotator cuff. 5 male pitchers will go through conservative rehabilitation, and five through early aggressive rehabilitation, and whichever Injured shoulder exerts the most force and looks most similar to the non-injured one will be considered the superior rehabilitation. In my research, I expect conservative rehabilitation to be better because it builds in intensity as the muscle gets stronger simultaneously, and I expect early aggressive rehabilitation to cause much strain on the rotator cuff early, and not allow it to recover early. I will measure my data using pitching speed (mph), how many pitches can be thrown before feeling pain, and which group exhibits more force (N) following rehabilitation. Some implications could be due to age differences, prior injuries, difference in sleep, and amount of rotator cuff use outside of rehabilitation. My anticipated results could cause me to look into how to treat rotator cuffs with just rehabilitation.

Darien High School

Teacher: Christine Leventhal

Project # 247

Sasse, Alexa

Comparing the Sustainability and Environmental Impact of Different Processes and Types of Regenerated Cellulose Fibers

Research Proposal, Science, Physical Science

Regenerated cellulose fibers such as lyocell, viscose, and many more have become a popular choice in the clothing industry. The man-made fibers are made from natural materials and undergo various processes to result in a product similar to cotton, but biodegradable. Certain methods used to create fibers impose different environmental impacts. In some cases, harmful chemicals are released as by-products and many fossil fuels are used. To find the most sustainable and environmentally friendly regenerated fibers an analysis must be completed that highlights the strengths and weaknesses of all the different fibers. Most importantly information that needs to be addressed is the durability of the fabric, the efficiency of the process used, and its overall impact on the environment. Based on previous research, lyocell is hypothesized to be the most eco-friendly fiber because it is made from wood pulp and uses a dry jet-wet spinning method when being reconstructed. It is also predicted that many of the plant-based fibers such as viscose and rayon will be very eco-friendly fibers compared to more commercial materials such as polyester. With the knowledge of which regenerated cellulose fibers are the most eco-friendly, consumers will be able to purchase clothes that can reduce their ecological footprint. It also brings to light the harmful effects that the textile industry has on the environment and ways society can lessen the damage inflicted. Overall, it's important to know the product your buying and what kind of quality it is offering.

Ridgefield High School

Teacher: Ryan Gleason

Project # 248

Sateeshkumar, Sibi

Structure-based drug design for future coronavirus outbreaks

Research Proposal, Science, Health and Medical

Despite multiple outbreaks of human coronaviruses (HCoVs), the drug discovery process is often reactive. It is impossible to design a drug from scratch during a live outbreak. There are still no effective antiviral drugs available for Covid-19. Sequence and structure comparison of same proteins from different viruses will provide a novel drug docking site. This site will display new constraints which represent all compared viruses. In-silico docking studies against these new binding sites will lead to novel lead compounds for future designing. Structures from PDB, sequences from NCBI, small molecules from SWEETLEAD and FDA approved drugs libraries will be used for the current studies. Molecular docking will be performed by Autodock Vina. FASTA and ClustalW will be used for Sequence comparison and UCSF Chimera for structural modeling. Seven pathogenic HCoVs have been found so far. Each protein from different HCoVs displayed significant similarities. For example, the envelope protein of SARS-CoV-2 displays 96% sequence identity with SARS-CoV while the spike protein exhibits only 77%. The current study will compare Viral enzymes (PLpro, 3CLpro, RdRp), spike, Envelope, Membrane, nucleocapsid, and accessory proteins from HCoVs. We will construct a new binding site for each drug target, that will represent various coronaviruses. We will conduct in-silico docking studies against these newly constructed binding sites and subsequent whole cell assay. This approach may result in potential lead compounds that can be used as starting points against new coronavirus outbreaks. The study may lead to new antiviral drugs for multiple coronaviruses including Covid-19.

Darien High School

Teacher: Guy Pratt

Project # 249

Saunders, Tyler

Finding substances that inhibit the efflux pump LmrS on S. aureus.

Research Proposal, Science, Health and Medical

I will find potential substances that will be tested to see their effectiveness in preventing the LmrS protein to work on S.aureus. The LmrS protein is an efflux pump which pumps out antibiotics to prevent them from working . Because this protein on S.aureus helps the bacteria not to die when exposed to linezolid, trimethoprim and chloramphenicol, it is important that we prevent the protein from helping the bacteria. Research will be done in a research institution with a mentor. It should take about a year to find some substances that can be candidates for finding a compound that could inhibit the LmrS protein. The experiment will cost money to buy the bacterial agents and other testing equipment for the experiment. I am expecting to find substances through reviewing scientific articles that will be tested for inhibiting the LmrS protein on S.aureus. After we have found the compounds, we would test their effectiveness in a research facility. We would then change the compound to increase the effectiveness in inhibiting the efflux pump. Following we would test the substances for any toxicity and change them to be less toxic if present. The implications for finding an inhibitor for the LmrS efflux pump is that the inhibitor would reduce linezolid, chloramphenicol and trimethoprim resistance in S.aureus. This is important because these are important antibiotics used in S.aureus infections. To add, resistance against linezolid has already been reported only a year after its approval by the FDA.

Newtown High School

Teacher: Tim Dejulio

Project # 250

Shabet, Sarah

Harnessing the Immune System to Fight Gastric Cancer

Research Proposal, Science, Health and Medical

Gastric cancer affects over 1 million people globally every year. It is the 5th leading cause of cancer deaths worldwide. National estimates report that the cumulative 5 year survival for gastric cancer in the U.S. is less than 5%. In many other cancers, immunotherapies have demonstrated high efficacy. Which immunotherapy targets will be most effective in different types of gastric cancer? Due to the COVID-19 pandemic, lab research is currently infeasible. Thus, this research will be completed through a thorough reading and analysis of the existing literature in hopes of developing a list of viable candidates for immunotherapy targets that can be tested once able. In order for immunotherapies to function, target proteins expressed on the surface of the cancer cells—yet not somatic cells—must be identified so a corresponding immune warrior, such as a CAR T-cell or TCR, may be synthesized. Different types of cancer cells may express the same proteins and different immunotherapies may attack the same protein. This research will identify promising matches for effective treatment. The therapy options proposed in this study may demonstrate great efficacy and aid in the treatment of gastric cancer, which, in the United States alone, has over 26,000 new diagnoses each year and over 10,000 of said patients will not survive. The discovery of the CD-19 CAR T-cell therapy revolutionized treatment for specific lymphomas and this study aims to do the same for gastric cancer.

Darien High School

Teacher: Christine Leventhal

Project # 251

Siddiqi, Ali

Performance Methodology for Lithium-Ion Batteries

Research Proposal, Science, Physical Science

Lithium-ion batteries are unique, and their applications are specific to their characteristics. With future applications such as new electric cars and a lack of available energy alternatives, a specific series of verification tests, combining static and dynamic tests, is required to determine a lithium-ion battery's area of use. They act differently at different states-of-charge, temperature, and current outputs. In order to determine the viability of a battery, models of these unique properties must be analyzed. To do so, tests will be conducted to determine what conditions optimize battery performance, and how properties such as capacity, temperature, and voltage are affected. However, in order to determine a battery's viability, these will be combined with dynamic tests to determine the effects on temperature, current, and voltage when performance interferes with different temperatures, voltage, and resistance. This experiment is designed to verify a proposed seven-step methodology and its accuracy in determining the behavior of a lithium-ion battery, based on a previous research project. By additionally verifying the equivalent electrical circuit (EEC) test, which examines battery voltage in response to resistance, the experiment will also be able to determine the dynamic range of the battery's viability. This methodology will be able to analyze different lithium-ion batteries, and accurately determine their output at different conditions. This will allow for future prediction of an array of batteries in different conditions, and where they will be applied best.

Joel Barlow High School

Teacher: Paul Testa

Project # 252

Simari, Charlotte

The Use of Organic and Non Organic Chemicals Relating to pH and Nitrogen Levels in Surrounding Lakes or Ponds

Research Proposal, Science, Environmental

In recent years there has been an increase in nearly unlivable water sources that can be attributed to the runoff from chemicals put on properties. There have been some organic chemicals produced, and while they are better for the animals, it is not sure if they are better at reducing possible unhealthy runoff into lake water. In order to measure the difference between the organic and inorganic lawn chemicals there will be three 6ft X 6ft lawns planted with grass seed. One of the lawns will be treated with inorganic chemicals in order to mimic an average lawn and another will be treated with organic chemicals. The third lawn will be treated with nothing except for water. Underneath these lawns there will be containers of water that will resemble lake water and in between the lawn and the groundwater there will be a plastic barrier with small holes. The water will be tested bi-monthly for mostly nitrogen levels, and pH. It is most likely that the inorganic chemicals will have higher nitrogen levels and a lower pH because there are salts in the inorganic chemicals that can break down the soil. This research could help dictate the future of lawn care especially in areas near water or around hypoxic water to show that someone can have a nice lawn without harming the environment.

Darien High School

Teacher: Guy Pratt

Project # 253

Staubly, Sam

Accessible program and system to accurately align a star tracking mount using a DSLR camera.

Research Proposal, Engineering, Physical Science

Astrophotography attracts plenty of people, but the entry price is high. Star tracking mounts for beginners start at \$300, which is very pricey for many. Plus, star tracking mounts must be aligned very precisely with the North Celestial Pole, an invisible point in the sky, and devices which do this cost a lot. How can we create a program to polar align a star tracking mount using a DSLR Camera? The equipment will be set up, including a Nikon camera, a tripod and other mounts, and a star tracker. A program will be written for a computer which will communicate with the camera. A graphical interface will guide the user through the process, displaying the camera feed and showing the user where to align the mount using many complex algorithms. Each alignment test will be timed for speed from rough alignment to perfect alignment, and tested for accuracy based on the length of the star trails. A plate solving algorithm may also be used to verify the accuracy. The objective conclusion is to polar align the setup in under five minutes with an accuracy of 30 arcseconds, which means pointing the rotational axis of the mount at an invisible point in the sky that is smaller than the apparent size of Jupiter in the sky. This will enable greater capabilities in astrophotography on a tight budget.

Newtown High School

Teacher: Timothy DeJulio

Project # 254

Thompson, Christian

Neurological Exercise as It Pertains to Individualized Learning

Research Proposal, Science, Behavioral

Usually in a classroom setting a common curriculum is set for all students in the class. Students are expected to absorb and understand the curriculum that is taught to them in the one way it is taught. For many it is often the case that the one common way a subject is being explained does not resonate with them. Learning should be individualized to optimize the success of each student. The proposed experiment would be to have all the groups first complete maze on pen and paper. The students would be filmed and timed doing this test; filmed to capture how often they get distracted and timed to measure growth. This would be at the beginning of the experiment and end of the experiment to measure growth. For some groups I would have them do a daily maze along with a daily meditation; others would only do the meditation and others just do the maze. Along with a control group to measure just the first testing of the maze and the final test as a control group. Presently the goal would be an improvement in the children's time completing the maze and a decrease in how many times they lift their pen off the paper to check their work and get distracted. Gauging how practice as well as meditation affects focus, visual skills, and planning skills. This is the first step in understanding the effect of mediation and practice as it factors into focus and individualized learning.

Ridgefield High School

Teacher: Patrick Hughes

Project # 255

Tullis, Ada

Bioplastics

Research Proposal, Science, Environmental

I have been researching the degradability of different types of bioplastics, depending on the materials they are comprised of. In addition, how do these plastics affect different ecosystems if they get into the ecosystem, and how do they taint it? I will be testing 3-4 different types of plastics (PLA, Cellulose Derivative, PHA/PHB), including a control petroleum-based plastic. I will test the degradation rate at a fairly set temperature, in different ecosystems, salt water, fresh water, and brackish as well as the possibility of soil. I will then monitor how they decompose and how the decomposition can taint the ecosystem more specifically in the water systems. I hope to find evidence that the degradation of these plastics, can either taint the water supply but more specifically how they do so, particle contamination, ph levels, and anything else I can think of. The significance of my works is that these bioplastics are a relatively new thing and how do we know if they get into waterways and then decompose. That the different bioplastics aren't leaching toxins into the waterways and, doing irreparable damage.

Ridgefield High School

Teacher: Ryan Gleason

Project # 256

Turner, Lindsey

Large scale pBMC inoculation on coral reefs to increase resistance to bleaching

Research Proposal, Science, Environmental

Coral reefs are essential organisms in marine ecosystems that are bleaching due to temperature stress from the rising ocean temperatures. The objective of this study is to determine how the inoculation of pBMCs into corals will affect coral health in a natural marine environment. Previous experiments have supported the idea that the inoculation of pBMCs into coral will lessen the effects of coral bleaching, thus helping to alleviate pathogen and temperature stresses. Microbiome manipulation has yet to be tested on larger scale reefs. The pBMCs will be inoculated onto coral polyps using a syringe of pBMC-NaCl solution. It is expected that the inoculation of pBMCs on a larger scale reef will improve the coral's resistance to pathogen and temperature stress and will improve photosynthetic efficiency. The photosynthetic efficiency of Symbiodinium will be determined using the PAM fluorometry as a proxy for coral health. The PAM submersible diving system will be used to measure the photosynthetic efficiency of Symbiodinium, and determine the maximum quantum efficiency of photosystem II using the Fv/Fm ratio. Changes in coral color will be compared using the color score chart. Inoculation of pBMCs can be used on a larger scale to improve coral health and its resistance to bleaching. Further research might be to apply the same methods to reefs facing severe temperature stress, such as the Great Barrier Reef, to test if bleaching can be inhibited through the use of pBMCs.

Darien High School

Teacher: Guy Pratt

Project # 257

Varnas, Lucas

Evaluating A Application That Can Save Time While Shopping Online

Research Proposal, Science, Physical

On average 57% percent of working Americans waste 1.7 hours a day shopping online (Dickler, 2018), this is time that Americans could be using to work. To get people to spend less time shopping online, an application will be developed and tested to determine if it can reduce the time people spend shopping online. The study will compare shopping online normally to using an online shopping aggregator (application) to determine if the application will save more time. The application will let the user search for an item searching different sites to find the cheapest version of that product on each site. To test the application, study participants will be given items to find, and will be timed on how long it takes to find those items. When someone uses the online shopping aggregator application they will be able to save time while shopping online since they won't get distracted by other things and will be able to save more money. If the app is able to save people time shopping online, it will let people work more on what they are supposed to do, and give them more time to do other things. This will not completely solve the problem because there will still be people that shop online normally, and not everyone know what they want to buy.

Staples High School

Teacher: Amy Parent

Project # 258

Voellmicke, Jacob

Risk factors for injury in right-handed v.s. left-handed pitchers

Research Proposal, Science, Health and Medical

While some researchers have looked at the risk factors for baseball pitchers in general, none have examined if the hand that they throw with may play a role in risk factors, something that I will look at. I was recently diagnosed with an injury in my elbow, so I wanted to learn more about this and help others to avoid injury in the future. I have been communicating with the Hospital for Special Surgery on a study that they are conducting on risk factors for baseball pitchers, and I will be able to help collect data. This will include metrics of each pitch, pitching practices of each pitcher, etc. I will then utilize this data to answer my own question as to how the data may be different or similar for right-handed and left-handed pitchers. I expect that the risk factors for the different handed pitchers will be very similar, and the data that is collected will indicate that the metrics are similar as well. I believe that the pitchers will not be affected by which arm they throw with, but instead affected by other external factors. This research is very important because pitching injuries are becoming increasingly prevalent as time goes on, so it is very important that the causes of these injuries are identified. One of the steps leading to this goal is seeing if there are any smaller factors, something that my research will address. If this is accomplished, then many future injuries can be eliminated.

Ridgefield High School

Teacher: Ryan Gleason

Project # 259

Vora, Palash

Chromosomal Instability of RB1 in Osteosarcoma

Research Proposal, Science, Health and Medical

Even though the gene RB1 was one of the first tumor suppressor genes ever found, and therefore it has been extensively researched and studied, there are still many questions that remain on how it could promote treatments and therapeutic strategies to cure osteosarcoma. Chromosomal instability is a hallmark of osteosarcoma and the deregulation of this mechanism in tumorigenesis forms the beginning of my work. For my data retrieval, I will use an array of publicly available databases like NCBI GEO, DAVID, STRING, and UCSC genome browser. I will collect candidate genes from NCBI GEO and analyze them in DAVID in order to find novel regulatory connections to osteosarcoma tumor initiation and progression. I will put this information into STRING and UCSC genome browser to find regulatory sites that will be important in understanding regulation. We do not have any findings or results as of this time since we have not finished conducting the experiments and therefore have no data on gene regulation of osteosarcoma. The goal of this project is to fully understand the relationship between genes that are disrupted during osteosarcoma tumorigenesis. After generating the list of genes, Dr. Hansen's laboratory can use that to screen for personalized medicine actions for treating osteosarcoma. The information that I will be finding is vital to the scientific community because it will allow more pathways to open for potential treatments and therapies to use.

Glastonbury High School

Teacher: Diane Pintavalle

Project # 260

White, Anna

Applied Placebo and Nocebo on Pain Reception

Research Proposal, Science, Behavioral

I will be researching the purpose of pain management from a neurological and psychological standpoint through the processes of placebo and nocebo effects. The purpose of this research is to figure out how this all happens (psychologically), figure out what physically occurs within the brain (neurologically), how these two are connected, and why this matters. In terms of the future, I plan to find a research team that is dealing with a topic similar to mine and is willing to share their data and possibly open up a mentorship. Or I could potentially do some surveying of my own alongside some data mining and compare the findings that I come across. The results I am hoping for include a clear understanding of how a psychological scenario causes a treatment to either not affect your body at all or to perform negatively solely based on expectations or experiences. I would also like to discover what goes on inside the brain while this is all occurring. Further research on placebos and nocebos will help better understand how our bodies (our immune systems) will react with a foreign substance introduced to its environment. An example of this would include vaccines and the expectations that people set for a said vaccine to perform 100% as planned or the anxiety of not knowing what will happen when taking a brand new treatment, expecting it to go poorly, and then that actually happening.

Newtown High School

Teacher: Tim Dejulio

Project # 261

Winterlich, Joseph

Escherichia coli Utilizes the Fe³⁺ ion for Protection Against LL-37

Research Proposal, Science, Health and Medical

Mycobacterium tuberculosis is becoming increasingly resistant to widely-used multidrug treatments; thus, the need for new antibacterial treatments is imperative for treating bacterial infections promptly and effectively to prevent widespread outbreaks. From previous research, I have identified the human antimicrobial peptide, LL-37, as a promising solution to this problem. However, little is known about whether the presence of Fe³⁺ in the environment impacts the efficacy of LL-37 to eliminate bacterial cells. To determine the impacts of Fe³⁺ on the potency of LL-37, we will investigate whether Fe³⁺ limits the capacity of LL-37 to eliminate colony-forming units of E. coli bacteria, a model bacterium for M. tuberculosis. Because we have previously identified that LL-37 targets the membrane of bacterial cells, we will use Propidium Iodide as a fluorescent probe to evaluate whether Fe³⁺ restricts the ability of LL-37 to permeate bacterial membranes. Our preliminary results suggest that the presence of Fe³⁺ restricts the efficacy of LL-37 to eradicate bacterial colony-forming units. Furthermore, we have shown that Fe³⁺ impedes the permeabilization of bacterial membranes from LL-37, which indicates that cells harness the Fe³⁺ ion for protection from the peptide. Since we have demonstrated that E. coli utilizes Fe³⁺ for protection, we can develop novel treatment methods that enhance the efficacy of LL-37. We plan to investigate the addition of an iron chelator to remove iron from the environment, which will increase the toxicity of LL-37 against bacteria. In turn, novel treatments will reduce the number of fatalities caused by tuberculosis infection.

King School

Teacher: Victoria Schulman

Project # 262

Wizda, Sam

Effect of color on online learning

Research Proposal, Science, Behavioral

Many studies conducted by cognitive psychologists in the past have concluded that color psychology can assist in learning. Most if not all of these studies were conducted in the context of schooling and education. With the emergence of online schooling, does the effectiveness of color psychology in learning differ on a screen than in person? Newer (LCD) monitors cast a blueish tint (Blue light) altering how colors are perceived. This may affect the retention rate of new information. For the purpose of this experiment, only middle and high school students will be tested by taking three different memory assessments (in random order) on an LCD monitor. Each assessment will have a different color background (red, green, and blue). Red was chosen as its results can likely be applied to other warmer colors, blue because of its relationship with LCD screens, and green because it is a neutral color and completes the RGB trio. A controlled assessment with a white background will also be used. The results of this experiment, when compared to past studies, will likely show the effectiveness of colors in learning decline in an online format. In the future, these results can be used to make online learning more accessible and either encourage or discourage the use of colors in online schooling dependent on the results.

Joel Barlow High School

Teacher: Paul Testa

Project # 263

Wolters, Katherine

Effects of CRISPR-Cas9 Correction of Heterozygous GBA1 Mutation

Research Proposal, Science, Health and Medical

Parkinson's Disease (PD) is the second most common neurodegenerative disorder, affecting one million Americans and six million people worldwide. PD manifests physically with symptoms of tremor, rigidity, and hypokinesia, and can lead to balance problems, gait disturbance, depression, dementia, and dyskinesias, among other problems. The neurological pathology of PD is a degeneration of mesencephalic dopamine (DA) neurons, which produce dopamine, a neurotransmitter that controls movement. Heterozygous mutations in the GBA1 gene are associated with PD, affecting 7-12% of patients with PD. Mutations in the GBA1 gene result in decreased levels of the lysosomal enzyme glucocerebrosidase (GCase). A reduction of GCase has also been observed in PD brains without the GBA1 mutation. There is an inverse relationship between GCase levels and alpha synuclein levels in patients with PD. In PD patients, there is a buildup of the protein alpha synuclein. In this experiment, the 100 mouse models with the GBA1 mutation will be observed. The DNA of these mice will be edited using CRISPR-Cas9 to correct the GBA1 mutation. These mice will then be monitored over the next two years, with special attention paid to their DA neuron levels to determine if they develop PD. It is expected that these mice will not develop Parkinson's Disease and their GCase levels will increase. If successful, this approach could be applied to PD patients with the GBA1 mutation.

Darien High School

Teacher: Christine Leventhal

Project # 264

Wurm, Lilly

Noninvasive vs. invasive vagus nerve stimulation on memory performance in mice models

Research Proposal, Science, Health and Medical

The vagus nerve is responsible for many signals from and to the brain and the rest of the body, through stimulating it, cognitive performance and overall well being can improve. Vagus Nerve Stimulation (VNS) has shown great reductions in symptom severity of individuals with neurodevelopmental disorders. This study's purpose is to compare non invasive and invasive VNS on memory performance in naive mice and an intellectually disabled mouse model. Noninvasive approaches will use an electrode prototype placed in the ear canal and invasive approaches will be done surgically with the implantation of a pulse generator on the left vagus nerve. All mice will be subject to an initial familiarization phase with the object and then a memory test after stimulation. Results should show mice who received invasive or noninvasive VNS improved memory performance more than mice who received none. Results of noninvasive VNS should mirror Auricular transcutaneous vagus nerve stimulation improves memory persistence in naive mice and in an intellectual disability mouse model by Vasquez-Oliver et al. Anticipated results will suggest memory performance in invasive VNS patients improves more but is less efficient once price and safety is factored in along with other external factors. The possible implications of this research include finding the most effective VNS therapy to improve the symptom severity of individuals with neurodevelopmental disorders.

Darien High School

Teacher: Guy Pratt

Project # 265

Xu, Sophie

Identification of epigenetic determinants of cell fate

Research Proposal, Science, Health and Medical

Cell fate is not only determined by its genome, but also the epigenome. The study of cell fate can create new treatment methods to inhibit the development of disease cells. Zebrafish are a model vertebrate organism with a similar genome to humans, making them an ideal organism to conduct research with. Zebrafish stripes are formed by pigment cells -- melanocytes and iridophores -- that have different phenotypes despite having the exact same genome. In this project, the goal is to identify the epigenetic events that drive pigment cell fate decisions. Pre-profiled DNA methylome, chromatin accessibility, and gene expression of zebrafish neurocrest cells, melanocytes, and iridophore, along with technology such as whole-genome bisulfite sequencing, ATAC-seq, and RNA-seq, will produce large amounts of next-generation sequencing (NGS) data. Bioinformatics approaches can analyze the data and identify differences in chromatin accessibility associated with differences in gene expression between melanocytes and iridophores. Commands in batch programming language will manipulate the sequencing data. Mapped reads can call peaks which represent open chromatin regions that could serve as regulatory elements such as enhancers. Results can be visually examined on the WashU epigenome browser. Results will be compared to protein enhancing regions such as Pnp4a, Gbx2, and Mitfa. Researchers can manipulate cell fate by identifying epigenetic events that drive pigment cell fate decisions. In the future, manipulation of these epigenetic events can treat many diseases, including cancer.

Darien High School

Teacher: Christine Levanthal

Project # 266

Yin, Tiffany

The Effectiveness of Melanin Glass in Blocking Harmful Blue Light Radiation

Research Proposal, Science, Health and Medical

Previous studies have shown us that spending time on technological devices exposes our eyes to harmful blue light waves. Avoiding technology completely is out of the question because we depend on it in this modern technological world, however, the use of melanin glass may be able to reduce the harmful effects. Melanin glass is made with melanin, the pigment found in living organisms that block ultraviolet rays from the sun, and it might be able to block harmful blue light rays as well. To test the effectiveness of melanin glass in blocking harmful blue light, I will shine white light through the sample of melanin infused glass and use a UV visible spectrometer to detect which wavelengths of light go through the glass. Harmful blue light is in the 415 to 455 nm range, so if the spectrometer doesn't detect light waves in that range, the glass is effective in blocking harmful blue light waves, and vice versa. Melanin's function in protecting our bodies from harmful ultraviolet radiation leads me to hypothesize that it may also be a viable protection from harmful blue light radiation. Findings from this research could show melanin's effectiveness in blocking blue light and could provide another glassware option that people can use to protect themselves from the growing amounts of blue light we are exposed to everyday. Protection from harmful blue light radiation is especially important in this rising virtual world, as we are constantly exposed to blue light radiation from our devices.

Ridgefield High School

Teacher: Ryan Gleason