Acharya, Anushka — Project # 1

Completed Project, Engineering, Behavioral

Designing A Machine Learning System To Predict How Humans React In Various Situations Based on Dominant Personality Traits

Psychologists have been able to break down people's personalities into five main personality traits, which affect how others think, respond, and make decisions in contrasting ways. While many engineers have created machine learning systems to predict human behavior based on their interactions with other humans or technology, there are no machine learning systems that predict how people of each dominant personality trait make decisions and react in different environments. In order to do this, I collected data from a survey, in which participants chose one out of five options for how they would react in five different situations. They also took a personality test and recorded their results. I then used Google TensorFlow, a machine-learning engine, to predict how people of each dominant personality trait would react and compared the results form TensorFlow to the results from the survey. Data thus far shows progress towards completion. Teachers would be able to take advantage of this because it could help them decide how to teach in a way that is engaging for their students. This system would also be beneficial for employers by giving them information on how to effectively manage and communicate with their employees in an effective way that makes everyone comfortable and well-adjusted.

Amity Regional High School
Teacher: Catherine Piscitelli

Adams, Alice — Project # 2

Completed Project, Science, Environmental

Testing the Optimum Delivery Method and Formula of Plant Probiotics and Probiotic Soil

The current widespread use of fertilizers have been shown to cause negative impacts on surrounding wildlife. It has been demonstrated that probiotics are good at promoting plant growth, and can be used as a substitute to these harmful fertilizers. This study focuses on discovering the best system for delivering probiotics to plants. Most store bought plant probiotics are mixed into soil, however it is hypothesized that other delivery methods may also be suitable or even superior. It was specifically hypothesized that the probiotic spray would be the most beneficial. In addition, a novel probiotic soil was created with carefully selected ingredients and hypothesized to be superior to store-bought versions. There were two phases of probiotic testing. In the first phase, two types of plants with several methods of probiotic application were tested, including a dry coating, probiotic spray, and mixing probiotics directly into the soil. Two control groups were also included. Plant growth for each probiotic method was measured and recorded. In the first phase, it was discovered that the novel probiotic soil was most beneficial to the plants tested. The second phase focused on comparing the novel probiotic soil mix to a store-bought probiotic soil. In this phase the novel probiotic soil was shown to be more beneficial that the store-bought soil. This study provides information on the best ways to deliver plants probiotics and explores solutions and replacements for traditional fertilizers, which can be harmful to the surrounding environment.

Sacred Heart Greenwich
Teacher: Mary Musolino

Adams, Jaime　　　　　Project # 3

Allergic Reactions and the Immunoglobulin Response

The purpose of this experiment would be to research and find a possible way to block/stop the release of histamines which causes reactions to allergens. Since the immunoglobulin IgE triggers the release of histamine if there was a way to prevent the activation of this immunoglobulin it could prevent a reaction. Most of the progress for the experiment would be data mining and research. Since this experiment has not been carried out there have been no results yet. N/A

Newtown High School
Teacher: Timothy Dejulio

Agrawal, Anika　　　　Project # 4

Developing a Program that Utilizes Sleep and Behavioral Data Output from Smart Watches to Identify The User's Circadian Rhythm in Order to Promote a Healthy Lifestyle

Today, modern technology and the average person's lifestyle have heavily influenced the human body's natural processes. With exposure to artificial light in buildings in the day and blue light from devices during dark hours, circadian tendencies are being changed. This project aims to help people become more aware of their sleep schedules, metabolism and other factors associated with a heavily altered oscillator. Visual Studio Code, the text editor, was downloaded. Through this platform, the coding language Python was used in order to create a computer program. A FitBit was worn for a week in order to collect data that would then be analyzed by the program. The program was tested periodically after every addition. The mentor, Dr. Margaret Pisani, looked over the projected graphs to determine their accuracy. Any bugs or mistakes in the code were edited accordingly. The program creates sleep graphs (PSG), electrocardiograms, hormonal and metabolic behavioral charts, and personalized feedback given circadian data acquired from smart watches using a blue-tooth component. Although apps already exist, they mainly focus on specific functions of the circadian rhythm like metabolism or sleep debt and disturbances, with the users inputting a majority of the data themselves. Doing so is incredibly tedious, and data and graphs provided are often difficult to interpret. This research can contribute to helping people be more conscience of their circadian rhythm to help avoid possible consequences and, overall, improve their quality of life, giving the user a more well-rounded, easily accessible, and understandable option.

Amity Regional High School
Teacher: Catherine Piscitelli

Akula, Monisha   Project # 5

The Cost Efficiency of the Ion 540 and 550 Sequencing Chips

Sequencing DNA can help scientists confirm which genes code for certain functions. Next generation sequencing (NGS) has been used to complete the rapid sequencing of base pairs in DNA or RNA. NGS uses DNA chips that have semiconductor technology to determine the genetic code of DNA. NGS is used for a variety of research including cancer and inherited disease research. DNA chips are used to sequence DNA quickly and efficiently. There are different types of DNA chips offered by Ion Torrent that can be used in their Ion Chef and Ion S5 sequencing machines. Researchers are testing whether the Ion 550 Chip is more cost efficient than the 540 Chip. The 550 Chip costs more than the 540 Chip, but is able to sequence a larger amount of DNA. The accuracy of the 540 and 550 chips is being tested. The results of the 540 and 550 are compared to the control, which is a known DNA sequence. The 550 Chips are predicted to have the same accuracy as the 540 Chips, which supports the idea that the 550 Chip is more cost efficient than the 540. More data is still being collected. The research will be used to help scientists determine which chip is better to use for their research.

Darien High School
Teacher: Guy Pratt

Alexander, Alena   Project # 6

Achieving Robustness By Incorporating Rigid Links In a Multi-Robot System

All-terrain robots have been advanced over the years, but achieving robustness has proven a difficulty. I am designing a novel approach to incorporating Fire-ant biomechanics into a multi-robot system to build rigid structures to better adapt to rough terrain. I have been fascinated by the Fire-ant's abilities to work socially with distributed power. Combining these two factors to address robustness was always one of my engineering dreams. My research will be approached by designing and analyzing a prototype. The design will be created by utilizing an Engineering CAD software and cost effective materials. The prototype will be based off of data I collect from trusted sources about Fire-ant linking locomotion. I expect to find that the Fire Ant colony decentralization model will prove to be an efficient alternative for an all-terrain robot system, as compared to past navigational terrain-based robot systems, because of the new system's robustness.

My research could be a factor in the advancement of using multi-robot systems for search and rescue, sea floor exploration, and space exploration. This strategy can ensure robustness to failures and will be designed to face all-terrain conditions in a feasible way.

Ridgefield High School
Teacher: Ryan Gleason

Amadeo, Harry   Project # 7

Readily available catalysis in ammonium perchlorate-based solid rocket propellant

Speeding up burn-rates in ammonium perchlorate composite propellant (APCP) can be helpful in order to lift heavier loads to extreme altitudes. Ferrocene is a very effective catalyst when used in APCP, but readily sublimes at standard temperature and pressure, which can ruin the propellant over time. My project involves characterizing how it ages and to see what it affects over time. Propellant is cast into individual segments (grains) and fired one grain at a time using a stand'no projectiles are involved. Three different trials are run with different ferrocene percentages: 0.25%, 0.375%, and 0.5%. They were fired at different time intervals: one, two, and three weeks after mixing. Pressure data were gathered on the burns and thrust was derived. Burn-time and burn-rate were also gathered for analysis. The aged grains tend to have a more progressive burn-profile than the newer grains (the pressure and thrust increase over the course of the burn rather than stay constant). This is likely due to the fact that ferrocene migrates to the outer surface of the grains, so the burn-rate increases as the ferrocene concentration increases. The burn-time consequently increased and the pressure decreased from this phenomenon. Knowing how ferrocene-containing grains will age is valuable for defense. Surface-to-air missiles that are designed to intercept incoming enemies and bombs need to accelerate incredibly quickly, and to do that they need a fast-burning propellant. Being unable to use ferrocene for this task would be a major setback, as ferrocene is unmatched by any other common compound as an APCP catalyst.

King School
Teacher: Victoria Schulman

Amara, Jake   Project # 8

Downsizing Basic Fusion Devices

My research will take the design of a device able to fuse hydrogen particles into helium to create energy, and make it smaller and more compact compared to usual fusion devices like the JET, PLX, and ITER reactors. My motivation is based on creating clean, self-sufficient and notably transportable generators that can replace carbon-emitting sources of energy. If fusion reactors are made more compact, then it can be easily built, transported, and used. I will be initially be designing reactors which are significantly smaller but are able to efficiently create fusion plasma utilizing design software. I will be using methods of fusion such as laser-heating, electromagnetic, and magneto-inertial fusion as the basis for my design of the reactor. I expect to create designs of smaller and less cumbersome reactors which can be built and adapted from current designs making them more transportable and not take as long to build like the ITER. I suspect that current reactors with their own methods like the PLX reactor and it's magneto-inertial method can be used to create smaller but equally as efficient reactors. Fusion technology is a vital stepping stone in the pursuit of clean efficient energy as it can greatly reduce the carbon footprint made by the energy production industry thus mitigating the effects of climate change. With this technology, wider application of fusion technology, a less harmful alternative to traditional sources of energy, is possible because the reduced size would allow for smaller reactors to be used commonly without specialized facilities.

Ridgefield High School
Teacher: Ryan Gleason

Amoruso, Malika   Project # 9

Remediating Pharmaceutical Pollution: The Effect of Boron Doping on the Ability of Graphene Oxide Membranes to Adsorb Aqueous Acetaminophen

Water pollution is a global problem, from developing to established nations. Pharmaceutical residue in drinking water, such as acetaminophen, have been found to interfere with regular fetal, reproductive, and endocrine development of aquatic organisms such as fish (Minnesota Department of Health 2014). Graphene and graphene oxide have been tested to desalinate sea water. It is hypothesized that water contaminated with acetaminophen will be purified after filtration using powdered boron-doped graphene.

Colorimetry was employed on 2 ppm solutions of acetaminophen, and a spectrophotometer was used to measure absorbance to create a calibration curve. The solutions were created using a modified Reckitt Benckiser procedure. The solutions were filtered through a filtration apparatus, containing either boron-doped graphene, graphene oxide, graphene, or activated charcoal within a dual layer of glass fiber filters. The resulting concentrations of the solutions were measured using the spectrophotometer. Results suggest that powdered activated charcoal is the most efficient means of removing acetaminophen from water. Testing in several trials demonstrated that activated charcoal exhibited an average 72.6% removal rate. Boron-doped graphene was not as efficient, displaying an average rate of 32.5% removal in several trials. A double mass trial of activated charcoal was tested, and this exhibited a removal rate of 80%. Future work includes testing activated charcoal from different sources and in various forms on acetaminophen solutions, and exploring a combination of boron-doped graphene and activated charcoal, with the goal of creating a consistently efficient filter. This work could lead to additional measures being taken at wastewater treatment plants to target acetaminophen removal using this filter.

Sacred Heart Greenwich
Teacher: Mary Musolino

Attisani, Deanna
Wagner, Samantha   Project # 10

Three Generations of Women and Their Views on the Feminist Movement Based on Behavioral Surveys

Feminism is a movement for the advocacy of women's rights with the goal of reaching political, economic, personal, and social equality of the sexes. In the 21st century, social media has given the younger generation a voice to share ideas on this issue. Three generations of women, young, middle aged, and elderly, are expected to have varying views on this topic. Due to the rise of the internet and increasing amounts of information available, the youngest generation of women (younger than 30) was expected to display the greatest affinity toward feminist ideals.This survey was administered to 45 female Connecticut residents, and combined with 533 surveys from female New York residents. It included 27 questions. 20 were answered by Agree (A), Disagree (D), No Opinion (N), 1 short answer response on the subjects view of feminism, and 6 questions about the subject's demographics, including age and marital status. The results were analyzed by SPSS to determine the generational differences. The results of this study displayed a negative correlation between age and feminist attributes, a negative correlation between religious devotion and feminist attributes, and a positive correlation between education and feminist attributes. These results show that women who are younger, less religious, and have a higher education level, tend to be more feminist. These results can lead to more research that includes determining how in touch people are with society and ways that we can get people more involved with the current social issues we encounter each day.

Darien High School
Teacher: David Lewis

Atwood, Henry

Completed Project, Engineering, Physical Science

Creating a Thermometric Generator Using a Propane Stove for use in a Camping Setting

A Thermometric generator was constructed as a propane stove attachment. The TEG generates power in a camping setting and can be used to make power for a light source or other small appliances. The device utilizes the Seebeck effect, which states that when a temperature differential is applied over two different conductors, a direct current is produced. A Thermometric generator was constructed as a propane stove attachment. The TEG generates power in a camping setting and can be used to make power for small appliances. Campsites are often devoid of power, and this TEG allows for some power production. The device utilizes the Seebeck effect, which states that when a temperature differential is applied over a conductor a direct current is produced. The TEG supplies an adequate power supply for a phone charger and works well with other small appliances. The TEG allows for the stove to cook as well as provide some power. The TEG worked well as its desired purpose to power a light or a phone charger as well as work adequately as a stove. The stove TEG allows for easy access to power while disconnected from the grid, and allows for small necessities to be powered and recharged where electricity is devoid. The TEG will reduce battery usage minimally, allow the stove to serve a dual purpose, and indirectly increasing the efficiency of the stove. The TEG improves the utility of a stove and shows promise on similar related devices.

Amity Regional High School
Teacher: Nicholas Shamp

Axel, Brooke

Research Proposal, Science, Behavioral

The effects of oxytocin and vasopressin on cluster B personality disorders

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. Individuals with AsPD and NPD often cause harm to others, whereas BPD and HPD can often lead to suicide or self harm. Overall these disorders ruin the lives of not only those afflicted, but everyone surrounding them as well. Through a systematic review of previous data on both the levels of the neuropeptides oxytocin and vasopressin naturally present in people with these disorders, as well as the effects of added oxytocin or vasopressin, I will create a proposed treatment plan for each of these disorders. The types of data used will include fMRI scans, observed behaviors and behavioral changes, and quantitative measures of neuropeptide levels. Through my research I expect to consistently find abnormal levels of these neuropeptides in people with cluster B personality disorders. I also expect to find a correlation between changed oxytocin levels and increased empathy in people with AsPD or HPD, as well as changed vasopressin levels and increased empathy in people with BPD or NPD. Two-thirds of serial killers have been clinically diagnosed with a cluster B disorder, treating individuals with these disorders will help them to become more mentally stable, allowing them to be productive members of society. While sometimes genetic, these disorders are commonly caused by early childhood trauma, often from having a parent with the disorder.

Ridgefield High School
Teacher: Patrick Hughes

Aysseh, Dalton
Harvey, Ronald   Project # 13

Household solutions used to preserve browning red delicious apples

Schools have trouble buying devices for students and leftover money for necessities. These devices break as well. These devices don't have plenty of functionality and can't work with all programs in the classroom. Some devices include Chromebooks and iPads. The operating systems aren't good because of very limited user interfaces that don't allow students to fully interact with devices. The device designed is an affordable and durable device for students in schools.

Phase one was the design and prototyping phase. That included hardware connections in the custom 3D printed casing. The software installation, including user-friendly Android programs was created. Phase two was measuring the effectiveness of this device including the durability of the device. My device was tested as iPads are. These tests included the process of tumble drops, face-up drops, and side drops. There was a questionnaire tailored to the device and its usability that some (10) volunteers filled out. Another test included the maximum capacity that the device can store files digitally and physically. (16GB)

Some future implications include programs that include features tailored to each device providing a more customizable experience. Another future implication can include programs specifically designed for a school allowing the devices to be controlled by administrators. In the end, schools now get an alternative to today's expensive and limited functionality of devices. Schools will be able to buy devices in bulk without losing a lot of money in the budget.

Amity Regional High School
Teacher: Nicholas Shamp

Babajanyan, Aaron   Project # 15

Determining the Effectiveness of Porous Concrete to Mitigate Basement Flooding

Basement flooding is a recurring issue in many households; damaging property, walls, and is often quite expensive. The purpose of this project was to determine the effectiveness of replacing basement floor concrete with porous concrete to mitigate issues caused by basement flooding. Four samples of concrete were with coarse aggregate at varying porosity were created. Underneath each testing sample was packed earth, woven wire mesh, and a container. Water absorption was tested by pouring 4 liters of water through them. Then, the average pressure applied on a typical basement floor was found to emulate a real-life basement and then was applied on the surface of each concrete sample to record strength. Data trends thus show that concrete with 20% porosity will withstand the pressure and efficiently absorb water simultaneously. This concrete is more porous than the 10% porous concrete sample and is stronger than the 30% porous concrete sample. These tests will determine the most efficient percentage of porosity in porous concrete applied to basement floods in regards to water drainage efficiency and structural integrity. This project aims to efficiently reduce the severity of basement floods. This will help save money and relieve a great deal of stress from the general society as well as provide a possible solution to new homes.

Amity Regional High School
Teacher: Nicholas Shamp

Badagliacca, Caroline   Project #16

Music and Memory: The Ideal Dosage of Music for Improved Cognition and Quality of Life in Patients with Alzheimer's Disease and Dementia

Alzheimer's disease is a degenerative neurological disorder that attacks and kills brain cells, causing loss of memory, thinking skills, language, and behavioral changes. Little can be done to prevent, cure, or slow the disease. However, musical therapy targets areas of the brain left unaffected by dementia and increases cognitive function while decreasing recorded agitated behaviors. This study uses the Music and Memory personalized listening program to implement personalized musical enrichment in various nursing homes while simultaneously tracking participants' agitated behaviors using the Cohen-Mansfield Agitation Index (CMAI). It is hypothesized that there is an ideal dosage of personalized musical enrichment that produces optimal effects with increasing cognitive function and reducing agitated behaviors in Alzheimer's patients. This study was completed by implementing the Music and Memory program, which provides individuals suffering from Alzheimer's disease or dementia with music playlists tailored to their personal history of music preferences. The Cohen-Mansfield Agitation Index (CMAI) is a widely-used tool that evaluates agitated behaviors of participants using a caregivers' rating questionnaire consisting of 29 agitated behaviors each rated on a 7-point scale of frequency. When CMAI and listening data for individual Study IDs were analyzed, it was found that participants receiving a higher dosage of music showed a greater decrease in CMAI score, indicating fewer agitated behaviors. Furthermore, there is a dosage that maximizes improvements. These findings demonstrate that using a specific dosage of music will provide benefits to Alzheimer's patients and can be applied to reduce their need for anti-anxiety and antipsychotic drugs.

Sacred Heart Greenwich
Teacher: Mary Musolino

Bahel, Piyush   Project # 17

Developing an Algorithm to Improve the Accuracy of Oncologist's Diagnosis of Malignant Cancer

In today's world, when someone is tested for cancer, they are required to go through a series of scans to image the cells inside to see if one has a malignant tumor. An oncologist observes these images and diagnose for a malignant tumor. Such diagnoses are highly susceptible to human error and is only 74% successful in accurately diagnosing a malignant tumor. Therefore, a more accurate process of diagnosing tumors is much needed. In this project, a predictive algorithm was created which used deep-learning techniques to develop artificial intelligence which analyzed an image with better accuracy to identify a malignant tumor. To do this, the algorithm was implemented using the Python computer language, and then data from online data libraries was gathered as input data for training the AI algorithm. To choose the images (train data), a dataset from the vast assortment of online data libraries will be chosen and then used. To test the AI, new images that were not chosen to train the AI were run through the AI and the AI had to determine if the image was a malignant tumor. Data thus far shows positive success toward end goals. Because the AI was successfully able to identify images as a malignant tumor with an accuracy rate of higher than 76%, this project was successful. Overall, this project will positively impact oncologists when they are examining the cancer tumor in order to determine if it is benign or malignant by increasing their accuracy rate.

Amity Regional High School
Teacher: Catherine Piscitelli

Bahel, Anchal — Project # 18

Developing an Affordable Prototype to Detect and Alert a Seizure for Epilepsy Patients

At present, approximately 4 million Americans have epilepsy. Epilepsy is a neurological disorder that leads to a variation in nerve activity, which results in seizures. When an epilepsy patient has a seizure, there are various shaking movements involved. If a caretaker is not alerted, there could be many life-threatening complications. Thus, there is a crucial need for an accessible, affordable, and accurate detection system for seizures. In this project, a prototype was created to detect and alert a seizure for epilepsy patients. Phase one entailed the construction of the detection system and a basic alerting system. The detection system was constructed using an Arduino Uno, a breadboard, and various other circuit materials. In the second phase of the project, the alerting system will be further improved by contacting a caretaker during a seizure. To test this prototype, the shake sensor went off, and the prototype's alerting system activated successfully. The objective of the prototype was successful as it detected and alerted a seizure for various time increments. This project has the potential to reduce the economic burden of millions, as this will only be one device to purchase instead of multiple accessories. Importantly, this will also significantly improve the quality of life for millions of people who deal with epilepsy every day.

Amity Regional High School
Teacher: Nicholas Shamp

Banks, Claire — Project # 19

Engineering a Common Inhibitor of Receptor Sites in Various Bacterial Pathogens

Staphylococcus aureus kills more people than Parkinson's disease, HIV/AIDS, emphysema, and homicides combined. Staph bacteria have become resistant to various engineered inhibitors and are at fault for thousands of deaths per year. Quorum sensing (QS) is a density-dependent process which, when at high levels of cell density, allows for groups of 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 are looking for receptors on nearby cells. An inhibitor has been engineered to replace the AIs, blocking the receptor sites, and preventing advanced stages. These microorganisms either have an arg system, produce hemolysins, or both. Research has been conducted using various inhibitor peptides that have been successful in the prevention of the production of the agr gene. This experiment will analyze peptides, those that accomplish the same inhibition and engineer a common AI inhibitor by drawing out similarities of the pathogens' agr systems and peptide inhibitors. It is expected that the inhibitor is partially or wholly able to stop the production of virulence factors and biofilm development in pathogens having consistent similarities. Results could be used to transform vaccines and methods when attacking infectious diseases.

Darien High School
Teacher: David Lewis

Barlow, Samantha   Project # 20

Peanut Sublingual Immunotherapy

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 6 months, for up to 10 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

Barnett, Abby
O'Connor, Anne   Project # 21

Testing a Storm Drain Run-Off Filter to Reduce the Prevalence of Phosphates and Nitrates in the Long Island Sound

Pollutants from excess car leaks and plant fertilizers flow through storm drains and are directly disposed into the Long Island Sound. This leads to eutrophication and an increased growth of algae, which results in lower dissolved oxygen levels, and harms marine life. The discoveries of the effects of nutrient pollution prompted further research on the creation of alternative filters using various ingredients to remove nutrients from bodies of water. It is hypothesized that a filter will reduce the amount of nitrates and phosphates in stormwater runoff drains. The study first measured the levels of phosphate and nitrates in simulated runoff. The control is the simulated runoff without filtration and the independent variable is the type of filter being tested to absorb the nutrients. The different types of filters include a phosphate sponge, an activated carbon sponge, and activated media. The dependent variable is the amount of nutrients after filtration. Results are pending, but thus far, the phosphate sponge is the most effective at reducing the nutrients, as the levels of phosphate decreased by 75%. After introducing the sponge on a much larger scale, it is expected that it will be able to absorb a significant amount of nutrients and prevent polluted stormwater from entering bodies of water. Furthermore, when a filter is introduced directly on storm drains, it is hypothesized that marine ecosystems will benefit by decreased growths of algae blooms and an increase in the amount of dissolved oxygen. Providing the novel filter to local and potentially national water systems would create a more efficient method to prevent nutrient pollution and runoff into local bodies of water.

Sacred Heart Greenwich
Teacher: Mary Musolino

Barretta, Katie   Project # 22

A Long Term Follow-up on Development of Anhedonia in Individuals with OCD

Obsessive Compulsive Disorder (OCD) is characterized by thoughts and fears that evolve into obsessions and advance into compulsive behaviors. Anhedonia is defined as lack of pleasure, which decreases the quality of life. Anhedonia is considered a symptom of major depressive disorder, which is linked to impaired functioning and poor results from treatment. Recent studies propose that anhedonia is a transdiagnostic construct that can occur apart from variant depressive symptoms. Anhedonia may contribute significantly to the symptomatology of OCD. The purpose of this study is to aid in the clarification of the relationship between anhedonia and core OCD symptoms over time. It was hypothesized that the correlation between anhedonia and OCD is amplified as time progresses. The independent variable in the study was the time progressed with OCD symptoms. The dependent variable was levels of anhedonia. The control of the study was OCD patients without depressive symptoms. In order to complete this study, previous patients at the clinic at least 3 years ago, with clinically significant OCD symptoms (18-65 years of age) were re-recruited through the Yale OCD Research Clinic. To collect data, we reviewed the participants' records from 3-10 years ago. Then, the participants took a survey to determine the correlation between their OCD and anhedonia symptoms. Once the data was drawn from the clinical records and the self reported measures, data was analyzed using ANOVA tests. The implications of this study are to improve treatments for OCD patients, so individuals with OCD will have a better quality of life.

Amity Regional High School
Teacher: Catherine Piscitelli

Beaudette, Mason   Project # 23

Designing an Affordable Fall Detection Bracelet

Controlled flight into terrain (CFIT) is an accident in which an airworthy aircraft, under pilot control, is unintentionally flown into the ground, a mountain, a body of water or an obstacle. CFIT accidents were identified as a cause of 25% of USAF Class A mishaps. The main goal of this project is to design a ground collision avoidance system (GCAS) in which CFIT accidents can be identified before they happen. To identify that a CFIT accident is impending the code did 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 were fed into a prediction algorithm.

This device was found to work with minimal complications, we were able to design a proficient algorithm. The device could take in data through the BNO055, interpret it, and run the data through the algorithm. It also could be fit into a reasonable enclosure in order to fit into cramp cockpits where space is limited. This system can be applied to not only planes but adjustments can be made to fit helicopters, ultralight aircraft, and even para motoring. The projected outcome is 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.

Amity Regional High School
Teacher: Catherine Piscitelli

Bell, Savannah
Janiski, Laura — Project # 24

Completed Project, Science, Behavioral

Studying the Evolution of People Pleasing in Canis lupus irremotus in Comparison to Canis lupus familiaris

We wanted to complete a wolf dog comparison experiment because we noticed there are few experiments comparing them. We focused on how eager dogs and wolves are to please humans. To measure this we paid attention to how many times the wolves/dogs correctly guessed the right toy, and how long they stood at the fence paying attention to us. We used two toys, one with a positive connotation and one with a negative connotation. The squeaky cow had a positive connotation so when the wolf/dog touched it with their nose they received a treat. When they touched the tennis ball, with a negative connotation, they received nothing. We did two minute trials with a two minute break.

The wolves were consistently engaged in the experiment. They guessed correctly 1,678 times over 77 trials, which averages out to be 10.9 times per trials. The dogs only guessed correctly 45 times over 52 trials, and 42.3% of the time the dogs didn't interact with the experiment at all. The wolf results proved they are very food motivated, while the dog results revealed they are motivated by a relationship. The dogs had a much shorter attention span than wolves. This confirms the belief that training dogs in short spurts fosters their learning, which is important for training dogs for task forces. This raises the question, since humans have evolved to have things such as food much more readily available, is their attention span also shortening, similar to dogs?

Ridgefield High School
Teacher: Ryan Gleason

Bennett, Grayson
de Alessandrini, Elle — Project # 25

Completed Project, Science, Environmental

Determining the Benefits of Reinforcing Bioplastics with Silk Fibers

It is believed that reinforcing bioplastics with silk will make it stronger and also add antibacterial properties. By creating an affordable and environmentally friendly plastic, we can help to reduce waste in an accessible way. This is significant because global warming has become a prevalent issue in today's world and a main contributing factor is pollution from plastics. Green banana flour, tapioca starch, as well as other starches were used as the starch base and cornstarch was used as a control. Traditional plastic was also tested. To further strengthen our bioplastic, we added strands of silk in various quantities as well as other components. Lastly, we tested tear strength, antibacterial properties, and biodegradability. Results are pending, but it is expected that once we reinforce the bioplastic with silk, that the resulting bioplastic will be biodegradable and ultimately as strong as traditional plastic. It will also be anti-bacterial, so it could potentially be used for medical purposes, maximizing its benefits. With both of these contributions, this versatile bioplastic can essentially be used as an environmentally friendly alternative to regular plastic. Our reinforced bioplastic can potentially help to reduce both food and material waste from supermarkets or dry-cleaners by implementing the silk fibers or plant starches not being used. Additionally, the biodegradability of our product can reduce the amount of waste and greenhouse gasses that accumulate from the petroleum-made plastic that sits in landfills. Lastly, its affordability and antibacterial properties make our bioplastic an ideal candidate for medical usage.

Sacred Heart Greenwich
Teacher: Mary Musolino

Berkery, Isabelle   Project # 26

Determining if the Amount of Training that a Service Dog Receives Correlates with Increased Activation in the Amygdala and Caudate

Different dog breeds can have different brain profiles, determined partly on what their specialized purpose is. Service dogs are typically trained for a six- to nine-month period, but some can be trained for up to two years. This study will determine if the amount of training a service dog receives leads to improvements in the amygdala and caudate, parts of the brain that correlate to lowered excitability and increased motivation. To test this hypothesis brain scans of different dog breeds will be obtained and compared to the brain scans of the same breed but with different time periods of service training (every 6-months for up until 2 years). I will look for trends in the differences of the dog's brains before and after their training. The results should demonstrate a significant change in the dog's brain scans, especially in the areas that determine a dog's lowered excitability and increased motivation since these are the characteristics that should improve during training. Looking at the brain scans from before and after the dog's training period, it is expected that their amygdala and caudate will be more activated than when they started started, and will increase with increased training, likely up to 1.5 years. This work could lead to improvements in service dog training for specific dog breeds and how the dogs improve over the training period. This study can also find new breeds that are not traditionally trained as service dogs, and future work can involve training them to see if they exhibit similar improvements in brain development.

Sacred Heart Greenwich
Teacher: Mary Musolino

Bonner, Avery   Project # 27

Auditory Processing Skills in Children at Risk of Developmental Dyslexia

Dyslexia is a learning disability impacting roughly 1 in 10 Americans. While the disability has no effect on IQ, it causes weaker phonological awareness, decoding, and reading skills. Since reading is associated with speech and comprehension of sounds, auditory deficits may be present within dyslexia. This experiment investigated the relationship between dyslexia and auditory processing skills. It was predicted that children at risk of dyslexia would demonstrate poorer auditory processing skills. To test this, 32 kindergarteners in English general education were selected around the San Francisco area. First, they took the Kaufman Brief Intelligence Test. The Woodcock Johnson IV Edition was administered, evaluating skill sets critical to reading. Nine children who scored below average on a majority of reading tasks while maintaining average IQ were identified to be at risk of dyslexia. Auditory skills were assessed, measuring subjects' abilities to perceive differences frequency and rise time (RT). Subjects were presented with animations containing three stimuli, being asked to determine which stimuli sounded different from the other two. While the subjects at risk could comprehend a smaller difference in frequency between sounds, refuting the hypothesis, they could not comprehend sounds differing in RT as well as those not at risk, supporting the hypothesis. Due to a small sample size and wide variance, further experimentation is needed to formally accept or reject the hypothesis. Identifying a correlation between dyslexia and auditory processing skills could strengthen diagnosis and intervention methods, providing help to the 1 in 10 Americans impacted by dyslexia.

Darien High School
Teacher: David Lewis

Bouton, Abigail — Project # 28

Optogenetic Stimulation of the Substantia Nigra to Improve Motor Dysfunction in Mice with Parkinson's Disease

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. This results in tremors and slowed movement. It is hypothesized that using optogenetic stimulation of the substantia nigra will increase dopamine production, thereby improving motor functions. A previous study showed that optogenetically stimulating the secondary motor cortex (M2) in mice with PD improved motor function due to neuronal projections between M2 and basal ganglia structures. The neurotoxin 6-OHDA will be given to mice to induce Parkinsonian symptoms. The gene that codes for channelrhodopsin 2 (ChR2), a light-sensitive protein found in green algae, will then be injected into the substantia nigra and laser light will be used to optogenetically stimulate this region. Dopamine concentrations prior to and after the experiment will be measured and behavioral testing such as speed and cylinder tests will be performed to assess if motor functions in the mice improved. After stimulation of the substantia nigra, it is expected that motor functions will improve due to an increase in dopamine production in the brain. A current device treatment for PD is electrical stimulation of the subthalamic nucleus through deep brain stimulation. However, due to its use of light and genetic methods, optogenetics is more precise and less damaging to tissue. If the hypothesis is supported, these findings can help lead to better and safer treatments for PD.

Darien High School
Teacher: David Lewis

Boyar, Jacob — Project # 29

Genes Dysregulated in Obesity May Increase the Likelihood of Breast Cancer Development

In the United States, obesity has become an epidemic. The countrywide increase in obesity has resulted in an increase of obesity-related diseases, including cancer. The American Cancer Prevention Study II found that mortality due to all cancers was 52% higher in obese men and 62% higher in obese women, compared to individuals with a normal body-mass index (BMI). Breast cancer is the most commonly diagnosed cancer, and postmenopausal obesity is associated with an increased likelihood of breast cancer development. Gene expression data from 300 women was analyzed using RNA-seq. Weighted Gene Correlation Network Analysis (WGCNA) was used to determine the modules of coregulated genes. These modules were compared to variables for BMI, menopause, and crown-like structure presence to determine the relationships between the modules and traits. The pathways of the most significantly dysregulated modules were analyzed to determine with which bodily functions they impacted. The WGCNA analysis resulted in a single module that was highly upregulated with BMI. The module's pathways were analyzed, and its genes were found to be associated with various immune, collagen, and extracellular matrix pathways. This module included the gene TGFB1, which has been repeatedly shown to stiffen the cellular matrix of the cell and is linked to cancer development. The module of genes upregulated with BMI is likely linked to breast cancer development in obese women. A method of inhibiting these genes would decrease the likelihood of breast cancer development in not only obese women, but others with similar breast cell makeups.

King School
Teacher: Victoria Schulman

Boyce, Eva Project # 30

The Effect of Photo Recognition Software on the Ability to Recognize Harmful Algae Blooms

Harmful algae blooms (HABs) release harmful toxins such as microcystins which are corrosive to the skin, may cause respiratory difficulty, and organ failure. The rate of growth and production of these blooms and toxins have caused illness and death among several plant and animal species. Although the development of these blooms are nearly impossible to remove, avoiding them would help to prevent ourselves and our beloved pets from being effected. In order to do this, there needs to be a common device that can distinguish the harmful from the nontoxic: a phone. If IPH can be used to cure acute liver failure (ALF) in non-human primates, immortalized human hepatocytes could possibly cure ALF in humans. This research could lead to clinical trials of reversibly immortalized human hepatocytes which could be transplanted into humans with ALF. The code, once given an original image of the blooms, will give a reading either correct to the specie of algae entered, or incorrect. Once each strand is tested at three stages of their development, the amount of correct readings will be weighed against the incorrect readings to determine the applications reliability. With a way to identify the different strands of algae, further coding can be done to include a wider range of algae, increasing the population of people it could assist. Community sharing aspects would allow researchers to see where harmful algae blooms are most common, helping them look into the possible causes, and try and eliminate them.

Joel Barlow High School
Teacher: Katharine Nuzzo

Brady, Ainsley Project # 31

The Correlation Between Specific Risk Factors and the Development of Alzheimer's Disease

Alzheimer's Disease is a neurodegenerative disease growing in prevalence. There are hundreds of factors that potentially impact the disease yet many of them remain unexplored. The purpose of the data analysis is to observe the impact of several disease factor combinations. These factors include Type Two Diabetes, hormone replacement therapy, and presence of the ApoE4 allele. In order to conduct this analysis, data must first be collected from a database with Alzheimer's Disease patient records. This data will be on all female individuals with a range of factor combinations. The data will be analysed, graphed, and combed for outlying variables. The goal is to identify a dominant factor and investigate the significance of differing factor combinations. Based on previous reading on the topic, ApoE4 is hypothesized to be the dominating factor with the most significance. All factors combined together are predicted to result in the highest rate of cognitive decline and disease development, however other underlying factors may impact this. It is also hypothesized that Type Two Diabetes will have little consequence on its own, but its impact will be magnified by the presence of ApoE4. The proposed results of this analysis will have very broad implications. The observed impacts of hormone replacement therapy will help settle the dispute over its cognitive impacts and help doctors better determine which patents are best for its use. Furthermore, it will increase the understanding of the significance of the ApoE4 allele, and how it differs in effect when combined with other factors.

Ridgefield High School
Teacher: Ryan Gleason

Bulsara, Karishma   Project # 32

Completed Project, Science, Behavioral

How Different Modes of Information Delivery and Assessment Affect Amount of Content Recalled

Technology has become very important in our lives, therefore, many teachers have incorporated technology into academic learning. The purpose of this project is to determine how different modes of receiving and assessing information affect the amount of information one can recall which I hypothesized was that if the material was read on a device and is assessed on a device, then they would remember the least information. For this experiment, participants from ninth grade were split into four groups. The independent variables were the modes of receiving and assessing information. The dependent variable was the amount of information recalled. Each of the four groups were assigned a different mode of receiving information and the mode of assessment. They were asked to answer a series of recall questions after a certain time period based on the information they read. This was assessed by analyzing the results of the questionnaire through an ANOVA test to calculate the statistical difference between the results of each group and their scores. The greater the statistical difference is the more of an impact one mode had over the other. Preliminary data supports original hypothesis. The data gathered can help teachers and students. Teachers can plan lessons more accurately and students can better understand their ways when learning the information.

Amity Regional High School
Teacher: Catherine Piscitelli

Burbank, James   Project # 33

Completed Project, Engineering, Physical Science

Applications and Properties of a Ferrofluid Piston

With the worlds current use of fossil fuels, renewable energy sources are cast to the shadows. A Stirling Engine has been around for over 200 years and can utilize almost any renewable energy source, but has not been used in large-scale energy production due to several design issues. However, Ferrofluid used in a piston can potentially solve many of these issues, and make Stirling engines a viable option. to produce a piston made out of Ferrofluid project each piston head will be made using four neodymium magnets in pairs of two with the poles facing away from each other and a washer spacing them apart. Ferrofluid will be coated on the magnets to create a strong liquid seal. the pistons will be the same dimensions as the original pistons and both will be tested in the same way. Due to Ferrofluids magnetic and lubrication properties it has the ability to retain a fluid seal with the piston head being at multiple angles and the rigidity of the seals while still retaining liquid like properties. A Ferrofluid piston can reduce overall cost of parts over time by eliminating the need for certain joints and potentially increase efficacy of a Stirling engine by also reducing friction and making better seals. Increasing a Stirling engines efficiency could be extremely beneficial as our society progresses towards a more clean energy future. with more and more improvements being made to the engine, it can be made to a more viable option for more applications.

Newtown High School
Teacher: Tim DeJulio

Butler, Joz — Project # 34

Using GANS to generate images directly connected to image input

Generative networks perform well at generating images that mimic an input database; however, when faced with the problem of image translation, the accuracy of the network is much lower. GANs work through a discriminator and a generator, with the generator constantly attempting to fool the discriminator by generating images. If a secondary discriminator is added to the model then it will more accurately and effectively convert images by creating a measure of good conversions, teaching the network at a deeper level. Here, a base model is used to translate between human and muppet faces with three tests for each of the categories, run over one thousand images. Due to the second discriminator, which will specifically look for accurate conversions, not just images that resemble the desired output, the conversions will be closely related to the input image and not just a disconnected output. The base network model will then be modified with the addition of a second discriminator and will be run for three different experiments over the input databases. Accuracy and image translations will be gathered for analysis. With the addition of second discriminator, which looks for accurate conversions, output will be closely related to the input image rather than disconnected from the original. The creation of a more accurate generator will open new doors in the AI community. This increase could cause GANs to be more widely used, possibly in reconstructive applications such as missing or obstructed evidence at crime scenes.

King School
Teacher: Victoria Schulman

Caiola, Alison — Project # 35

The Minimizing of Environmental Impact When Converting to Alternative Energy Sources

As the effects of climate change and global warming becomes increasingly more apparent, people are beginning to truly get behind the use of alternative energy and leaning off of fossil fuels. The reality of this process is that it greatly affects a community. The goal of this experiment is to answer the question, how can a small town (specifically Ridgefield, CT) switch to alternative energy with minimal impact on its citizens. Using calculations and zoning techniques from journal articles I have read, I will predict/suggest the most ideal spot in Ridgefield to place a wind turbine. This location will be chosen based on proximity to other buildings, average annual wind patterns, impact of wildlife, and energy output. Ridgefield's ranging altitudes make it difficult to find open areas where a turbine could be placed, however the ridges create wind tunnels that wouldn't exist if the terrain was flat. Areas like Tiger Hollow (the athletic field at RHS) have high annual wind flow, however are close to densely populated areas. Seeing that Ridgefield's open space is limited compromises would have to be made to install a turbine. After executing my experiment I expect to find that Ridgefield can make small but impactful changes to the community that help support the global green movement, but in no major way shift Ridgefielders way of life.

Ridgefield High School
Teacher: Ryan Gleason

Calcano, Cameron
Rogers, Isabella
Project # 36

Completed Project, Science, Environmental

The Effects of Construction on the Quality of Water in the Mianus River

The Mianus River is used by over seven rowing teams who practice daily three seasons every year. In the fall of 2019, a large construction project started on the river with the RowAmerica Greenwich Boathouse being built. It is hypothesized that the construction and debris from this project will affect the quality of the water and have detrimental effects to marine life and to the people who use the river. Three testing sites were chosen to measure water quality parameters. The first site is adjacent to the construction at RowAmerica Greenwich, the second site is under the train bridge, and the third site is a control site at Goose Island, a pristine location that should be unaffected by the construction. The train bridge site will also exhibit lower water quality due to ongoing observations of pollution. Water was collected before and during construction and the following parameters were measured: temperature, dissolved oxygen, conductivity, nitrates, pH, coliform bacteria, and total dissolved solids. Results are pending but preliminary data thus far demonstrates differences in water quality parameters among the three sites. It is expected that the water quality will be lower at the construction site when compared to the control. Once the study is complete, we can educate the town and hopefully limit the pollution to the water. There are additional actions that may be taken after learning the results, such as limiting boat pollution in the Mianus River to help return the water to a healthy state, and regulating and enforcing construction rules when they are in the vicinity of a body of water.

Sacred Heart Greenwich
Teacher: Mary Musolino

Caruso, Olivia
Project # 37

Research Proposal, Science, Environmental

Testing the Use of the Invasive Plant Phragmites as a Biofuel Material

As carbon dioxide increases in the environment, there is a need for alternative eco-friendly ways to decrease the use of fossil fuels. Phragmites are invasive plants that reduce the biodiversity of ecosystems. This project seeks to test Phragmites as a biofuel to reduce the number of fossil fuels used. It is hypothesized that Phragmites will be a natural alternative for automobile fuel because it has a high level of cellulose. To test this hypothesis, Phragmites will be collected and converted into ethanol through fermentation. The fuel will then be refined to purify it and tested for effectiveness and efficiency. I will also test out the effect that the biofuel has on the environment. Other standard biofuels will be tested for comparison. It is expected that the invasive plant will be able to be used effectively for ethanol for automobiles while reducing the amount of the plant in the ecosystem for better survival of the native species. It will be at least as effective as the most commonly used source of biofuel. This study will demonstrate that the invasive plant Phragmites could be effectively used as a biofuel to reduce the carbon in the environment, as well as to reduce the destructive plant for an increased chance for survival of other species in ecosystems.

Sacred Heart Greenwich
Teacher: Mary Musolino

Cavallaro III, Francis   Project # 38

The Effect of Polyvinyl Chloride Powder on the Development of the Lima Bean Plant and the Nutrients of the Surrounding Soil

The purpose of this investigation was to look for effects of microplastics, specifically polyvinyl chloride, on soil and plant life. Microplastics are becoming an increasing problem in our environment. I hypothesized that the lima bean plants grown in soil contaminated with more PVC powder would grow slower and less healthy than in soil with less or no microplastic. The independent variable was the amount of PVC powder in grams. The control experiment was a test with all soil and no microplastic. The constants included the type of bean plant, weight of soil, type of soil, amount of water, and place kept. I created a greenhouse and fill each of ten containers with soil. There were two containers for each of the following test groups: control, 5%, 10%, 15%, and 20% weight PVC powder. A sprouting bean was planted in each pot and each plant was exposed to the sun and an LED growth lamp to get the right amount of light and watered the same as needed. Variables measured included the height of the plants and the length of the leaves, the color and texture of the plants, and the pH, potassium, nitrogen, and phosphorus levels of the soil. Data throughout the experiment led me to believe that my hypothesis was true, and that microplastic harmed plant and soil life.

Amity Regional High School
Teacher: Catherine Piscitelli

Chalasani, Aditi   Project # 39

Development of a Low-Cost, Expandable Shoe Aimed to Adjust to Multiple Sizes and Provide Crucial Foot Support

The current expandable sandal retails for $59 and the only expandable, full-coverage shoe on the market retails for $159. These costs are out of the price range for the millions stuck in poverty/of the lower classes in numerous countries. This engineering project's purpose is to create the first expandable, full-coverage shoe, with a focus on proper arch support, that is also affordable for those of lower socioeconomic status. The student analyzed patents for different expendable parts of a shoe. After determining areas of expandability, the student designed a prototype shoe. The student went through a testing trial of using different materials for different parts of the shoe to determine a combination resulting in the lowest possible cost for production. Once areas of expandability and materials were determined, the student 3D printed shoe parts and put together a prototype. Progress thus far is being made towards the designing and creation of this shoe. This shoe is the first full-coverage, expandable shoe under $100 on the market. The shoe would be on sale for everyone, from those in the middle class to the extremely impoverished, but will be targeted towards those unable to afford a pair of shoes. This single pair would last almost three years despite childrens' growing feet. Overall, this shoe enables those in poverty, specifically those of impoverished communities, to go about their lives and travel about with more comfort and safety.

Amity Regional High School
Teacher: Catherine Piscitelli

Chang, Eugene   Project # 40

Assessing the Effect of Atmospheric Amines on the formation of Aerosols using The Extended AIM Thermodynamic Model (E-AIM)

The purpose of this study was to examine the impacts of atmospheric amines on aerosol formation in the atmosphere using the E-AIM model by identifying the minimum amine and ammonia mole ratios required for the amines to enter the aerosol particulate phase.

Atmospheric amines come from various natural and anthropogenic sources, ranging from the ocean to carbon dioxide sequestration methods. The E-AIM Thermodynamic Model is a computer model of a chemical system, consisting of gas phase, inorganic/organic solids, and up to two liquid phases: aqueous and hydrophobic. Preliminary findings showed that the presence of certain amine concentrations will change atmospheric aerosol properties by entering the aerosol phase. The independent variables were the relative humidity, anion/cation (H^+ and NH_4^+) concentrations and atmospheric amine content. The dependent variables will be the equilibrated atmospheric solid, gas and aqueous concentrations, including aerosols. The conditions remained constant at 25° Celsius and a volume of 1m^3. Incorporated into the models were common acids found in aerosols: sulfuric acid or oxalic acid (both acids were tested but not simultaneously); the concentrations of the acids were kept constant throughout the experiment. The control groups modeled a system consisting of only ammonia with an acid. The test groups added the following amines: methylamine, dimethylamine, trimethylamine to the model. The absorbed water content of the tested aerosol chemical combination containing ammonia, amine and an acid (sulfuric or oxalic) was plotted on a graph as a function of relative humidity for each simulation.

Amity Regional High School
Teacher: Catherine Piscitelli

Chaudhry, Ariba
Liu, Jody   Project # 41

Generating and Testing Deep Learning-based Attenuation Corrections for Myocardial Perfusion SPECT Scans

SPECT is a non-invasive imaging procedure that provides radiotracer distribution images of a patient's body by detecting gamma-ray photons and is a crucial tool for the clinical diagnosis of cardiovascular diseases. Attenuation of a SPECT image is the mechanism by which the strength of the signal emitted from soft tissue is diminished to better assess the intended target. Accurate attenuation correction is needed to perform analysis of SPECT images. To accomplish this, some SPECT systems include a computed tomography (CT) scanner. These scans present a more accurate and precise image. Unfortunately, these systems have many drawbacks, like cost and radiation. Our aim was to create a way for non-CT SPECT systems to be as accurate as SPECT/CT using only SPECT data and deep learning-based techniques to create estimated attenuation maps. The lab developed a preliminary program to create these estimates. We further developed that, created the code to integrate the program for clinical use, and tested for consistency between the estimated attenuation maps and the SPECT/CT scans. To accomplish this, we used Carimas to create and compare polar maps of SPECT scans without attenuation, SPECT scans with algorithm-based attenuation, and SPECT/CT scans. The polar maps with the algorithmic attenuation correction aligned with those of the SPECT/CT scans. This research will allow for SPECT imaging to be as accurate as SPECT/CT imaging without the drawbacks of CT, make this attenuation method easily accessible, and ultimately lead to more accurate diagnoses and better clinical outcomes.

Amity Regional High School
Teacher: Catherine Piscitelli

Chen, Christian — Project # 42

Comparing Y-BOCS and Image Rating Scores of OCD Neurofeedback Patients

Neurofeedback (NF) with functional magnetic resonance imaging (fMRI) is a type of biofeedback used to teach modulation of brain functioning with real-time displays of brain activity. It has been found in past studies that NF may be an effective way to noninvasively improve control over disorders. NF has been applied with OCD patients in an OCD NF study. To determine OCD symptom severity, the Yale-Brown Obsessive Compulsive Scale (Y-BOCS) and image rating assessments were used before and after NF. The purpose of this study is to compare the Y-BOCS scores and image rating assessment scores before and after NF to determine possible correlation. Y-BOCS scores and image rating assessment scores were collected and collated. Overall average scores before and after NF for both measurement methods were compared. Scores were then analyzed by comparing the average scores for OCD patients with symptoms in different domains. Scores were also analyzed by comparing the average scores for OCD patients that experienced either real or sham feedback. It was projected that there would be a correlation between Y-BOCS scores and image rating assessment scores for OCD NF patients before and after NF. The findings of this study may help improve the process of NF with patients. The symptom severity assessments taken before and after NF suggest whether symptoms have improved, remained constant, or worsened. Thus, the conclusions reached in this project will allow researchers to determine whether both methods of symptom assessments are effective. If this conclusion is reached, image rating assessments may be used more frequently in OCD NF studies, as these are more easily understood by patients. The findings of this study may help make NF a more effective process.

Amity Regional High School
Teacher: Catherine Piscitelli

Chen, Caroline — Project # 43

Evaluating the fMRI Neurofeedback Experiences of Obsessive Compulsive Disorder and Tourette's Syndrome Patients

Neurofeedback (NF) with functional magnetic resonance imaging (fMRI) is a type of biofeedback used to teach modulation of brain functioning with real-time displays of brain activity. An fMRI measures changes in brain activity by analyzing blood flow. It has been found in past studies that NF may be an effective way to noninvasively improve control over disorders such as Tourette's Syndrome. The purpose of this study is to analyze qualitative data regarding patients' experiences during NF to form hypotheses which may help improve future patients' NF experiences. Qualitative data regarding patients' NF experiences was provided by the patients following NF in a previous Tourette's Syndrome NF study and a current Obsessive Compulsive Disorder (OCD) NF study. The qualitative data from these two NF studies were analyzed and trends in qualitative data were identified. Hypotheses based on trends were formed. Hypotheses related to patients' NF experiences, including if patients found a way to effectively learn to control brain activity with NF. These hypotheses will be tested in future NF studies. The findings of this study may help future NF patients through the NF process and make NF a more effective practice. This will allow patients to more effectively use NF to learn to control symptoms of certain disorders. The findings of this study will also allow for a deeper understanding of NF as a whole, which will help NF become more widely used.

Amity Regional High School
Teacher: Catherine Piscitelli

Chen, Cindy   Project # 44

Completed Project, Science, Behavioral

Effect of Paternal Alcohol Exposure on Alcohol Acceptance and Anxiety Levels in Offspring

Approximately 107 million people have an alcohol use disorder (AUD), which can lead to injuries and fatal illnesses. Parental alcohol intake even harms progeny, who generally like alcohol more than peers, exhibit less motivation, and have physiological and neurodevelopmental shortfalls. In this study, the effects of paternal alcohol binging before procreation on the offsprings' alcohol acceptance and anxiety levels during adolescence were assessed. One experimental group had offspring with alcohol-intubated fathers, the other had water-intubated fathers, and controls had alcohol-naive, nonintubated fathers. All had alcohol-naive mothers. Infants were cannulated on PD 14 to test alcohol acceptance. Some were given alcohol, others, water, and the amount they each drank was calculated. Another set was in an elevated plus maze and light-dark box to measure anxiety during adolescence. It was hypothesized that if male rats are exposed to alcohol before breeding, then their offspring will enjoy alcohol more during childhood and have higher anxiety levels during adolescence than rats whose fathers were not exposed to alcohol. Rats whose parents had alcohol drank more ethanol in previous studies, and alcohol-sired rats were more aggressive with fewer risk assessments, indicating anxiolysis. The results can provide insight on the effect of paternal alcohol exposure on the likelihood of the progeny to initiate and continue drinking, which can lead to an increased risk for alcohol use disorders (AUDs), and decreased anxiety, which may lead to more risk-taking and aggression. AUDs increase the chance of liver failure, pancreatic cancer, and sudden cardiac death, among other issues.

Amity Regional High School
Teacher: Catherine Piscitelli

Chmiel, Claire
DeConcini, Lily   Project # 45

Completed Project, Science, Health and Medical

Using DNA Barcoding to Detect Mislabeling in the Sushi Industry

It is estimated that 30% of the seafood entering the United States is mislabeled, creating a potentially dangerous issue in relationship to allergies, species endangerment, and toxins. The research question deals with comparing the potential mislabeling of sushi in restaurants, fish markets, and supermarkets. While studies have been conducted, many are outdated and none have specifically focused on the difference in fish quality between store-bought sushi, restaurants, and fish markets. We obtained sushi samples from various restaurants and fish markets. Then, using DNA barcoding, we deciphered whether or not they are labeled correctly. Restaurants we are sampling: Fogama - a local restaurant known for its sushi; Nikkei of Peru - local Japanese restaurant; Whole Foods - American supermarket chain, known for its high quality, organic produce; June and Ho - local fish market; and Stop and Shop - an American supermarket chain. Results are pending, however, it is expected that supermarkets will have the highest percentage of mislabeling due to past studies describing mislabeling. In our experiment, will be testing local, organic markets as well as established retail shops, in comparison to restaurants, to conclude whether or not there is a difference in mislabeling among vendors. We will inform people of the danger of such mislabeling, if any. This study will make consumers aware about the possibility of mislabeling in food. Especially with our testing of supermarkets, fish markets, and high-end restaurant sushi, we desire to indicate our findings to all audiences. We hope that this study will shed light on the issue of fish mislabeling and possibly put an end to the potentially dangerous issue.

Sacred Heart Greenwich
Teacher: Mary Musolino

Choi, Kenneth   Project # 46

Towards Privacy-Preserving Artificial Intelligence: Differential Privacy in Deep Learning

In the post-industrial world, digital data privacy has gained paramount importance. Massive data breaches, like the 2016 presidential election, compromise large amounts of user data. Recently, researchers have been developing differentially private mechanisms, such as Laplace and Privelet, that add randomly distributed noise to datasets or queries but also retain statistical integrity for machine learning. However, there is yet to be a major privacy-preserving mechanism that utilizes higher-level quantum technology. We develop three privacy-preserving mechanisms that add noise to datasets by first using the Discrete M-band Wavelet Transform. Our first two mechanisms (LS and LS+) add noise through a hybrid "Laplace-Sigmoid" distribution, and our third mechanism utilizes pseudo-quantum steganography to embed noise. We then test our mechanisms for both differential privacy and learnability in five machine learning environments. As more noise is added to a dataset, greater privacy is preserved, but machine learning models become less accurate. Nonetheless, all five machine learning models using datasets after noise addition from our mechanisms yield accuracies greater than 94%. Logistic Regression and Neural Networks achieve greater than 99% classification accuracy with our LS and LS+ mechanisms. Our pseudo-quantum mechanism consistently scores high machine learning accuracies, the lowest being 94.8%. All three of our mechanisms successfully preserve privacy while retaining statistical integrity. Moreover, our pseudo-quantum mechanism is a pioneer in using higher computational power. As data privacy becomes an important issue and quantum computing emerges, our research links the two branches and demonstrates what data privacy could potentially look like in the future.

Ridgefield High School
Teacher: Xiaodi Wang

Clifford, Caroline
Grey, Julia   Project # 47

Evaluating the Compatibility of Scaffolds to Promote In vitro and In Vivo Degradation for Achilles Tendon Repair

In tendon tissue engineering, many unknowns remain regarding the host response to biomaterial implantation. This is a relatively new method of tendon repair that has the potential to reduce the biomechanical weakness of tendons significantly. There are currently numerous issues with the biocompatibility of scaffolds that will be addressed through experimentation. The purpose is to test the ideal biocompatibility of scaffolds with various ratios of polymers. The degradation of poly(butylene succinate) and chitosan in vitro using lipase and lysozyme enzymes will be studied. The subcutaneous implantation of the scaffolds into a mouse model Achilles tendon will be performed to determine tissue response. The type of inflammatory cells present in the surrounding tissue, as well as within the scaffold, will be determined histologically and by immunohistochemistry. The experiment should yield that the degradation rate of the scaffold matches the rate of in vivo tissue regeneration. The polymer should have strong mechanical properties that gradually decline in the course of degradation. When potentially implanted in vivo, there should be a normal inflammatory response, with vascularization in the implant as well as the surrounding tissue. This research is essential in developing a solidified understanding of the degradation of polybutylene succinate and chitosan using various growth factors. The degradation of the tissue-engineered scaffold must be at the same rate of tissue regeneration in the body. The research will provide a more successful and predictable solution for tendon repair. This is significant to prevent the tendon from tearing again after the initial repair.

Ridgefield High School
Teacher: Patrick Hughes

Coakley, Emma — Project # 48

Effect of Social Environment on Evolution

Treatment specialization in specific areas based on environmental factors like access to medical resources have been identified as important topics of study for researchers. Learning about differences in how people in different environments function could be important in determining specialized treatments for these different areas of the globe. My goal is to examine the ways these patterns affect influenza in different environments by examining similarities and differences in variables. I plan to collect data from the CDC website which gives weekly updates on influenza. I would like to find data on how long patients had influenza, and symptoms they had. I would like to gather this data from an upper class area and from a lower class area. I believe the differences in economic status will explain how adaptation and evolution affect ability to resist illness with available treatments. I believe those in lower class areas be sick less and recover faster because they don't always have the medicine to recover. they will recover faster because they are often depended upon for their income making it hard to be sick. In upper class areas, people can afford a sick day and the help needed. Those in upper class areas recover slower because their body feels less urgency to recover. This research is important because it helps understand how humans have evolved because of technology we have developed. It will explain human dependence upon these technologies because we are dependent upon them. Without medicine those used to having access to it will struggle to recover at a reasonable rate. Those who are accustomed to not depending on these resources will recover quicker as they are not dependent on new technologies.

Ridgefield High School
Teacher: Ryan Gleason

Coale, Grace — Project # 49

Testing for the Presence of Antibiotics in Poultry

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 PremiTest was used in several trials of popular and supermarket brands of poultry. A positive control, poultry with added antibiotics, 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. Thus far, there has been some 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 thus far 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 are 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.

Sacred Heart Greenwich
Teacher: Mary Musolino

Coelho, Victor — Project # 50

Use of BNMI and AMI in Upper Extremity Prostheses to Restore Normative Prosthetic Control and Sensations

Current prosthetics do not model natural movements and sensations that are necessary to accomplish many simple tasks. To resolve this issue, this study aims to restore kinesthesia and improve control. It is expected that the use of a bidirectional neural-machine interface (BNMI) and an agonist antagonist myoneural interface (AMI) will restore natural kinesthetic sensations and increase control. There is a total of 15 subjects, 3 with AMI and BNMI, 3 for each method, 3 unaltered amputees, and 3 non-amputees. Amputees will grasp a cherry with their prosthetic, and the damage to the cherry will be rated. The non-amputees and subjects will perform a virtual test; EMGs from the subjects are translated to virtual movement in a computer. With this the subject is asked to complete certain motions, and their percent error is recorded.

Is is expected that subjects that employ both methods will cause less damage to the cherry. It is expected that the percent error of amputees with both methods will closely model the amount of error exhibited by a non-amputee. Both these tests depict acute control of the prosthetic and that the subjects with both methods are able to sense their prosthetic's movements.

Improved control and sensations makes amputees feel like their prosthetic is part of their body, which means that amputees come a step closer to natural motion. In addition, amputees can live a more comfortable life, being able to complete tasks unaided and with ease.

Darien High School
Teacher: Pratt Guy

Colman, Alexander — Project # 51

How the Proximity from Roadways Affects the Levels of Heavy Metals in Fresh Water Ways.

The purpose of this study is to distinguish the levels of heavy metals that automobiles emit into fresh waterways. Although the testing locations are highly protected and monitored from human activity, there are no records of the amounts of pollution from roadways near waterways. Heavy metals are very dangerous as studies prove heavy metals can lead to muscular, physical and neurological degenerative diseases. I began with academic research to determine what previous research existed on related topics. I chose four waterways with varying distances to roads. I tested for three of the biggest auto polluting heavy metals. Every other week, I took samples from each body of water, test those samples with the appropriate test strips for each heavy metal, recorded my answers, sanitized the containers, and prepared for the next tests. Generally, my results support my hypothesis that the closer a waterway is to a road, the more heavy metals that water contains. On multiple occasions, I found higher levels of chromium in my samples than the EPA deems safe. This is dangerous and deserves attention. I have also found levels of zinc near the high alert EPA level, again, this should be noted. Although cars pollute less than they have historically, they still pollute our waterways at levels that are concerning. The EPA has set limits for maximum levels of heavy metals and many of the waterways are exceeding those levels. As most water systems are connected, this is dangerous not just to the local body of water but anything that flows out of it or any living creature that depends on it.

Weston High School
Teacher: Stacey Greenberg

Connolly, Emma   Project # 52

Surveying Public Opinion on Nuclear Energy with an Emphasis on Fusion

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. The survey will demonstrate 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 collected information about people's views on nuclear energy and more specifically, on nuclear fusion. Demographic information was also collected. It was administered to 350 adults and teenagers and it was expected that approximately 200 individuals would participate. The survey was administered over Google Forms and was anonymous, asking only general information such as age and gender. Results are still pending but it is anticipated that due to a lack of information, as well as misinformation, nuclear energy and fusion will not be in favor with the majority of participants. The results will likely demonstrate that the public will need additional information on nuclear energy and fusion, in order to make informed opinions. Since the most recent survey on nuclear energy was completed four years ago, this survey served to update public opinion on nuclear energy and get specific information on the public's perception of fusion energy. Advances have been made in the use of nuclear energy, particularly with fusion and the Tokamak Fusion Test Reactor, a machine designed to harness the energy of fusion, and greater public awareness and education are needed.

Sacred Heart Greenwich
Teacher: Mary Musolino

Correya, Sandra   Project # 53

Determining the Effects of Obstructive Sleep Apnea on Atrial Fibrillation, Heart Attacks (Myocardial Infarctions), and Heart Failure

Obstructive Sleep Apnea (OSA) is a sleep disorder where muscles at the back of the throat relax, causing a person to lose their ability to breathe. Studies have shown that it has a connection with Atrial Fibrillation (A-Fib), where the heartbeat is quivering and is irregularly beating at a rapid pace. The objective was to determine if OSA has a correlation with A-Fib, Heart Attacks, Heart Failure or a combination of each. The data for this project is provided by the mentor or taken from previous studies with the help of the mentor. Data collection was done at school or at home and was analyzed by the student through machine learning and statistical analysis. It was hypothesized that if OSA is tested to have a connection with any of the heart conditions, then it will show a positive correlation with them. The independent variable is the presence of OSA. The dependent variable is the amount of occurrences, severity, and overall risk of A-Fib, heart attacks, heart failure, or the combination of any of these conditions. The control is patients with mentioned heart conditions, but without OSA. Data trends thus far support the hypothesis. OSA's correlation to each heart problem has been researched before, but there has been limited research about its effect on patients having multiple conditions. As a result, determining the correlation between all of these conditions will give us better insight on how each condition is connected to the other.

Amity Regional High School
Teacher: Catherine Piscitelli

Crombie, Shealeigh   Project # 54

A Study of Genetically Transfected Immortalized Primate Hepatocytes to Treat Acute Liver Failure

The organ donation shortage is a national problem; liver donation shortages are particularly drastic. Each year an average of 15,000 patients are on the national liver donation waiting list, and the number of people on that list that die while waiting for a transplant has risen by 30% in the last decade.

Greens Farm Academy
Teacher: Mathieu Freeman

Cummings, Audrey   Project # 55

The Effect of Added Iron on Phytoplankton Growth as a Method to Reduce Atmospheric CO2

Carbon dioxide is one of the main greenhouse gases impacting the environment. Researchers are working to reduce levels of CO_2 in natural, efficient, and non-polluting ways. One of the ideas suggested is to fertilize the ocean using iron, therefore stimulating the growth of phytoplankton which plays a role in removing carbon dioxide from the atmosphere. This project aims to determine how adding iron to the ocean can solve this issue. The hypothesis was, if iron is added to a replicated ocean environment, then phytoplankton and algal growth will increase and take in more carbon dioxide from the air, therefore decreasing the levels of carbon dioxide in the atmosphere. The independent variable was the amount of added iron. The dependent variable was the amount of phytoplankton and algal growth. To test this, four containers of ocean water were taken from the same location for each experimental group for a total of sixteen. In the control container, no extra iron was added. In experimental group one, there was untreated ocean water. In group two, it was twenty-five percent saturated with the iron. In group two, it was fifty percent saturated, and in group three, it was one-hundred percent saturated. Every five days for a period of four weeks, the amount of phytoplankton and algae was measured. Data so far shows some change between experimental groups. This data could be used to find ways to help slow down the effects greenhouse gases are having on the Earth's climate.

Amity Regional High School
Teacher: Catherine Piscitelli

Dan, Huaxu — Project # 56

Completed Project, Engineering, Physical Science

Two-Dimensional Topology Optimization of a Horn Antenna

Antennas are used extensively in our lives. For many applications, antennas need to concentrate their power output to a particular direction; the parameter used to describe how concentrated the power is is "gain". Among many types of antennas, horn antennas have particularly high gain, and this research was conducted to find a way to achieve an even higher gain for a horn antenna. Instead of finding a new structure for a horn antenna, this research applied numerical topology optimization to obtain an optimal material distribution. To simplify the model, a two-dimensional horn antenna was employed. By assigning each point in the "horn" an eta variable, the material used at the point could be determined according to its eta value. In the same manner, the overall material configuration for the antenna was settled. The resulting material distribution was very unintuitive. A distribution of strips of air and polyimide occurring alternatingly provided a high gain for the horn antenna in this study. The gain optimized was indeed higher than that of the original, unoptimized antenna. This research has three implications. First, for a horn antenna, a distribution of strips of air and polyimide occurring alternatingly is the optimal material configuration. Second, since the resulting distribution is not intuitive, numerical topology optimization can be a very handy tool in antenna design. Last, material distribution could be a new perspective for optimization of antenna performance.

Kingswood Oxford School
Teacher: Kathleen DiSanto

Daugherty, Emma — Project # 57

Research Proposal, Science, Health and Medical

The Effects of Exercise on the Risk of Alzheimer's Disease

An increasing amount of people are developing Alzheimer's Disease (AD). AD affects the brain, specifically memory. Many people develop AD due to the presence of a gene, APOE-e4. One factor that has been shown to help slow down the progression of the disease and potentially decrease risk is exercise. Exercise has the potential to decrease the amount of people with AD. In order to perform this meta-analysis, data will be collected from multiple studies or databases that measure exercise and its effect on cognition. The data would be analyzed for trends and differences between the variables of age at which a person is actively exercising and the level of activity. The results will provide information regarding the potential to decrease the risk of developing AD dependent upon the age when routine exercise begins. It is expected that the results will support other studies by showing that exercise will be beneficial to cognition, and possibly decrease risk of AD if exercise is started at a younger age and persists throughout the lifetime. This is significant to people of all ages around the world, as AD is a prominent and destructive disease. In the future, people will be able to decrease their risk of AD with routine exercise. This is especially true for those carrying APOE-e4 who will be able to decrease their already elevated risk of developing AD. Although AD is only one type of dementia, it is imperative to find a solution to this growing problem.

Ridgefield High School
Teacher: Patrick Hughes

Davenport, Katherine — Project # 58

Canines demonstrate a bias to communicative cues over non-communicative cues

Finding out which communicative cues are more effective in the training of canines is crucial to understanding both basic cognition, as well as more efficient forms of communication. By understanding whether communicative cues or non-communicative cues are better interpreted by canines, we can more efficiently train, as well as increase the long-term retention of skills in canines. To produce this experiment, I will test the canines' ability to find a treat within a cup based on either a communicative or non-communicative cue. To portray a communicative cue, I will point to the cup holding the treat, and to portray a non-communicative cue, I will place a wooden marker on the cup holding the treat. I hypothesize that canines will better interpret communicative cues, therefore having a higher success rate at finding the treat when communicated the location through pointing, rather than a wooden marker. Because of the canines' evolutionary domestication through their relationship with humans, they will have a better sense of interpreting communicative cues because of their experience with training and submission. Using this research, we can determine more efficient ways to train canines to retain skills longer and understand them much quicker- overall improving communication. By figuring out which cues are better understood by canines, we can potentially apply that information to similar species to understand the basic cognition of communication in other domestic animals as well.

Darien High School
Teacher: Christine Leventhal

Davi, Makena — Project # 59

Fecal Transplant in ASD Patients

Dysbiosis, or the microbial imbalance inside of the body, is the root of many illnesses such as autism, irritable bowel disease, and other autoimmune diseases. When the microbiome becomes less bacterially diverse, inflammatory T-Cells are stimulated. The immune system becomes overactive, causing irregular immune responses throughout the body. By diversifying the gut bacteria, T-Cells are not as inflamed, meaning symptoms of autism and autoimmune disease will decrease. Helminth therapy and HDC use is the ingestion of parasitic worms in the form of eggs, which regulates immune responses throughout the body. This regulation leads to a more diverse microbiome, which decreases gastrointestinal symptoms. Therefore, if kids with autism and autoimmune diseases underwent helminth therapy, their symptoms would decrease because of the enriched microbiome. If my hypothesis is correct, my results will show that helminth therapy and HDC use first lessens gastrointestinal symptoms, and later, cognitive and behavioral abilities will be enhanced.

 After the data is collected and analyzed, the overall efficiency of helminth therapy is determined. This is done through a reevaluation of prior symptoms of children with autoimmune diseases or autism spectrum disorder. Depending on patterns of alleviated symptoms, I will be able to conclude the relationship helminths have to bacteria diversity, the microbiome, gastrointestinal and cognitive symptoms.

Ridgefield High School
Teacher: Ryan Gleason

Davis, Gillian   Project # 60

How Unsuspected Performance Feedback Influences the Individual: A Potential Catalyst of Change in Metacognitive Confidence Levels and Performance Accuracy on a Perceptual Metacognition Task

Captivated by Robert Rosenthal's work with the pygmalion effect in students' IQs', after my recent diagnosis with adhd and several different memory difficulties, I was curious as to how I was able to perform as well as I have in difficult classes at my high school. I had noticed that there has never been a study that looks at the correlation between metacognitive confidence levels and performance in a perceptual metacognition task. Thus, I decided on answering the question, what happens to an individual's metacognitive confidence and performance levels on future tasks, after unsuspected failure or success occurs? I will administer a perceptual metacognition tasks that will measure baseline metacognitive confidence and performance on the task. Based on data collected, I will separate the subjects into groups that differ by performance on the initial task, and will vary by which subjects of those groups are told the truth of their performance. I will then re-administer the task and measure the final performance and metacognitive confidence levels, calculating the change of the metacognitive confidence and performance levels. I believe that the type of feedback received will not only impact the performance of the individual, but metacognitive confidence levels as well. This study will greatly impact the knowledge of feedback on the minds of students, providing guidance for how performance feedback placed on the individuals acts as a catalyst of adaption or change in thinking and performance. It will also provide insight into the reliability of metacognitive confidence on accuracy of performance.

Ridgefield High School
Teacher: Ryan Gleason

Desai, Shriya   Project # 61

Dual Targeting of ARK5 and CDK4 to Induce Cell Death in Triple-Negative Breast Cancer

Triple-Negative Breast Cancer is a form of breast cancer that tests negative for estrogen, progesterone, and HER2 receptors, and accounts for over 7,500 deaths in the United States annually. There are limited therapies available, as hormone treatment is ineffective, which leads to more patients succumbing to the disease in relation to the number of diagnoses. There has been a modest response to selective CDK4/6 inhibitors, which could be a result of incomplete targeting of kinases. AMPK-related protein kinase 5 (ARK5), is expressed in Triple-Negative Breast Cancer lines and is associated with tumor growth and invasion. In this study, we examined whether the dual targeting and inhibition of CDK4 and ARK5 using the drug ON1223300 would result in a better therapeutic outcome. The treatment of the Triple-Negative Breast Cancer cell lines with ON123300 in vitro resulted in cell-cycle arrest closely followed by apoptosis. ARK5 inhibition led to the inhibition of the mTOR/S6K pathway along with the upregulation of the AMPK cascade, which resulted in the destabilization of the steady-state MYC protein and increased SIRT1 levels. This research provides preclinical evidence that ON1223300 is unique from other drugs in inhibiting oncogenic pathways in Triple-Negative Breast Cancer and supports the development of dual CDK4 and ARK5 inhibition as a therapeutic approach to Triple-Negative Breast Cancer.

Darien High School
Teacher: Christine Leventhal

Dexter, Aniela   Project # 62

The Relation of Fractal Dimension to Water Absorption and Adsorption of Various Moss Species

The purpose of this investigation is to determine the relationship between the fractal dimension of various moss species' shoot and community structures and their respective water absorbency and adsorbency. Procedure:

Mass moss sample

Take digital images of different moss species samples

Add water to moss sample until fully saturated

Mass moss sample

Take digital images of moss sample

Oven or air dry moss sample

Mass moss sample

Take digital images of moss sample

Upload images to FDdim to convert to grayscale and determine their fractal dimension If the results of this project suggest a correlation between fractal dimension of the moss and water absorbency, then it may inform decisions about what type of materials are appropriate for clean-up endeavors. This project would also provide insight into the species of the mosses, and, if the correlation is supported, why some mosses have a more fractal structure based on their needs and natural environment.

Weston High School
Teacher: Stacey Greenberg

Dey, Rhea   Project # 63

Determining the Effect of Rapamycin on Ventricular Volume of Post Hemorrhagic and Post Infectious Hydrocephalus Wistar Rats

Hydrocephalus is a neurological condition where an excess of cerebrospinal fluid (CSF) accumulates in the cerebral ventricles. Two of the most common causes of this condition in infants are intraventricular hemorrhage, a brain bleed, or bacterial infection. Standard treatment is an invasive surgery called a ventricular-shunt and this treatment often fails. Therefore, drug-related therapies are needed in order to reduce inflammation and treat hydrocephalus. In preliminary studies, the kinase mTOR, is significantly up-regulated following post-hemorrhagic and post-infectious hydrocephalus. Therefore, in this study, mTOR was inhibited using Rapamycin. The purpose was to determine if targeting this inflammatory pathway could treat hydrocephalus by limiting the flow of CSF. To test this, five groups were analyzed. The groups were the control that had no hydrocephalus, posthemorrhagic hydrocephalus, post-infectious hydrocephalus, treated posthemorrhagic hydrocephalus, and treated post-infectious hydrocephalus. Ventricular volume was measured in each group by using photoshop and it was compared to the healthy control rats. The administration of the drug is the independent variable. The dependent variable is the ventricular volume. The tissue was obtained by harvesting the brains and sectioning them using a cryostat. Hematoxylin and eosin staining was performed to obtain better images of the structure of the brain. It is hypothesized the brains with treatment would have significantly smaller ventricles because rapamycin would control the CSF fluid into the brain. The next step would be to test this drug after a longer time period of induced hydrocephalus to see if it could prevent further hypersecretion of CSF. This new discovery would provide a noninvasive treatment of hydrocephalus to provide a better quality of life for patients with hydrocephalus.

Amity Regional High School
Teacher: Catherine Piscitelli

DiCapua, Jennifer — Project # 64

Assessing Barriers to Healthcare Access Among Undocumented Immigrants and Developing a Solution to Improve Acccess

This project investigates barriers to healthcare that undocumented immigrants face due to documentation status, cost, lack of transportation, and language barriers. The hypothesis is that an app may be created to help deliver needed information, and that fear will be reduced if healthcare is provided in safe locations such a sanctuaries (faith-based environments). This is an important study because this issue affects approximately 10 million people in the United States. The proposed techniques for this study will be surveying people in the Westchester region to understand the issues of healthcare access facing immigrants today. Then using this information, the goal is to create and test the effectiveness of an app designed to provide information and access to healthcare opportunities easily and effectively. In this app, different languages and faith-based sanctuaries will be included to make people feel safe while getting healthcare. During this research, it is expected that important information will be learned regarding issues facing undocumented immigrants. It is expected that the app will be helpful, but there will also be challenges experienced along the way. The challenges will be creating an app that is user friendly and collecting the survey research with a large enough group to get significant and reliable data. This research is important because it affects the health of a large group of people in the United States. Opportunities for proper healthcare for undocumented immigrants are more challenging than for United States citizens and documented immigrants, and therefore should be studied and improved to make healthcare accessible for all.

Sacred Heart Greenwich
Teacher: Mary Musolino

Dillon, Taylor — Project # 65

Developing an App to Increase Oncology Patients' Communication With Caregivers

The purpose of this project was to develop an app to help increase communication between patients and caregivers.This app includes all symptoms oncology patients may experience and act as a direct communication to doctors for breast, prostate and lung cancer.. In order to create this, the common symptoms cancer patients experience along with information from Yale New Haven Hospital Patient Distress Tool were analyzed and put into the app. A new distress tool was created and given to actual patients at Griffin Hospital. Secondly, the app was drafted and designed as to what format would work best. Then, the app was coded using Xcode. Lastly, the app was tested and any adjustments that needed to be fixed were corrected. This app cannot be tested in a real life patients to doctor relationship so fictional patients with symptoms a real oncology patient may experience were used to test it. Radiologist Joyce Chung provided realistic symptoms and other information that oncology patients may experience while going through treatment to put into the app. Dr. Chung also provided the fictional patients so the symptoms were as close to a real patient as it can be. The student designed , coded and put all collected information into the app. This app will decrease the amount of office visits patients need; saving oncology patients and doctors time and money.

Amity Regional High School
Teacher: Catherine Piscitelli

Dillon, Erin — Project # 66

3D Printed Talonavicular Joint Replacements and How They Supersede Talonavicular Fusion

I am proposing a 3D printed talonavicular joint replacement as an alternative operative solution for talonavicular joint pain. My own experience with ankle pain and the series of operations I went through to avoid the common talonavicular fusion procedure is what motivates me to explore this area. My hope is that one day I can relieve others of this pain in the most effective way possible. To create the joint replacement model, I am using a 3D computer modeling program and then 3D printing the model. Because there are no human subjects involved in my study, I cannot measure pain as data. Therefore, I will be measuring the range of motion of a 3D foot model before and after the joint replacement is inserted and compare the numbers to see if any motion was lost. Once I print and insert the joint into the foot model, I will compare the range of motion measurements I took of the 3D foot model before the joint was inserted to the measurements I will take after the joint replacement is inserted. If the measurements are equal, I will know that the joint replacement does not result in a loss of motion like the current talonavicular fusion procedure does. I believe that the talonavicular joint replacement I am proposing will supersede the current operation of talonavicular fusion. This modern, innovative approach not only eliminates pain but avoids all of the postoperative complications that commonly result from talonavicular fusion. I have experienced the effects of talonavicular joint pain and how it impacts everyday life. My hope is that one day I can relieve others of this pain.

Weston High School
Teacher: Stacey Greenberg

Donzeiser, Lily — Project # 67

The Evolutionary Adaptability of the Piranha Olivacea to Climate Change

Climate change is affecting the evolutionary cycles and adaptations of many species, and many will have a difficult time with evolutionarily adapting. The environments and temperatures certain birds are living in, such as the Scarlet Tanager, known as the Piranga Olivacea, cannot sustain their species. It is hypothesized that though the Scarlet Tanager will show signs of a shifting breeding cycle and phenotypic changes, Piranga Olivacea will not be able to adapt in time and will need to shift its habitat range to survive. Through observations at specific sites where Scarlet Tanagers live in New England during the summer season, it can be determined if the Piranga Olivacea, or Scarlet Tanager, is phenotypically adapting, their breeding cycles are shifting, and if this species will adapt in time. By comparing the observed changes to Piranga Olivacea's life history and past adaptation and in addition, predicting its future adaptations, it can be determined whether the Scarlet Tanager will be able to adapt to keep up with climate change.

It is predicted that the Scarlet Tanager will not be able to adapt in time due to overlap with its breeding cycle into other important parts of its seasonal cycle, and will need to shift its breeding grounds and summer location to survive. The ability of species to adapt to climate change keeps the food chain in check. However, if many species lose their habitats and begin to go extinct, there will be many consequences for the environment and for the human population.

Darien High School
Teacher: Christine Leventhal

Drake, Ethan   Project # 68

The Effects of Oxo-M and 4-PPBP on the Recovery of the Proximal Tendon Pulley in Mice

The A4 tendon pulley is one which many climbers fear injuring, as the recovery process can take months, with any strenuous activity only prolongating that recovery time. The A4 flexor tendon pulley is crucial to the proper function of the fingers, and without its proper recovery, the flexor tendon may bowstring along the finger, reducing both strength and functionality. In order to decrease recovery time of a ruptured A4 tendon pulley, a combination of Oxo-M and 4-PPBP should be delivered in a controlled manner. Previous studies using mice as a model have shown that the combination of Oxo-M and 4-PPBP will decrease the time it takes for tendon tissue to heal fully, and may also improve the quality of tissues. The injury will be inflicted on the proximal pulley on the mouse's right index finger, which will remain immobilized for the duration of the experiment. It is predicted that the introduction of Oxo-M and 4-PPBP will decrease the time it takes for the full recovery of the tendon, and will also result in a higher quality of tissue. Researchers can conclude that the combination of drugs will accelerate the tendon recovery of the proximal pulleys in mice, and that a trial in humans would be worthwhile. The application, while somewhat limited, would help people who have suffered from blown pulleys into a more rapid recovery.

Darien High School
Teacher: Christine Leventhal

Dunphy, Megan   Project # 69

Using Recycled Materials as Substrates in Oyster Reef Restoration

Oyster populations are declining worldwide. Oysters play a vital role in aquatic ecosystems as they filter their food from water and ultimately improve water quality. However, oysters are in danger of extinction because of human activities such as overharvesting. Restoration efforts such as oyster reefs and gardens have been created to foster growth. The purpose of this experiment is to investigate using recycled materials as substrates in oyster reefs. Different reef structures will be created each made out of different recycled materials. Possible materials that will be used are tires, hard plastics, and glass bottles. These structures will be placed on the edge of a dock and taken up after a period of months. The number of oysters adhered to or set on the structure will be recorded. The results will show the effectiveness of each recycled material in maintaining and supporting oyster growth. The surfaces with glass that contains calcium carbonate will yield the most growth. Oysters are vital to ecosystems but are at great risk of extinction. Therefore, it is important to restore populations. Research has already been done on using materials like limestone, granite, or oyster shells but it is important to consider other options that may be easily accessible like recycled materials that can be put back into the ecosystem.

Ridgefield High School
Teacher: Patrick Hughes

Easterbrook, Kayla   Project # 70

Protein nanoparticle embedded hydrogel bioprinting

Using 3D printed hydrogels embedded with nanoparticles composed of proteins is the next step in medicine. Bioprinting will allow doctors to print tissues custom for the patient's needs and blood type. If the length of the amino acid chain embedded in the hydrogel is changed then the hydrogel with the longest peptide will best thrive as real human tissue. The developed peptide chains will allow essential nutrients from outside the hydrogel to migrate into the gel and nourish it. This experiment can be conducted by creating a mixture of hydrogels, which closely mimic human tissue, phosphate-buffered saline to control pH, and protein nanoparticles. Nanoparticles are created by utilizing microfluidics to create the particles and then dehydrating them for the printing process. The solution is extruded through a nozzle onto a glass coverslip to allow for imaging of results. It is expected that the results will show that the samples with longer amino acid chains will be more like real human tissue and will have a homogenous scattering and distribution of particles and particle size. Electron microscopy is used to image the hydrogel, ensuring no proteins were damaged by the printing, for comparison between samples. Dynamic light scattering is used to observe the particles. Bioprinting will allow tissues to be made with a person's cells, fighting rejection and solving some issues with the transplant list. This technology allows organs to be engineered specifically for patients allowing them to receive organs when they are in need.

Darien High School
Teacher: David Lewis

Ebrahimi, Kiran   Project # 71

Probiotic pancreatic cancer therapy through indirect out population of oral pathogens Porphyromonas gingivalis and Aggregatibacter

Pancreatic cancer is one of the most lethal forms of cancer with approximately 93% of patients dying within the first five years of diagnosis. Pancreatic cancer can be caused by a multitude of factors including genetic predisposition, smoking, obesity and pancreatitis. Furthermore, recent studies have linked the presence of oral pathogens Porphyromonas gingivalis and Aggregatibacter in the oral microbiome to an increased risk of pancreatic cancer. How does out populating the oral pathogens Porphyromonas gingivalis and Aggregatibacter effect the survivability of pancreatic cancer patients? Early detection of pancreatic cancer would help in the development of therapeutic procedures. However, no bio-markers have yet been identified, although indirect evidence linking certain oral pathogens with pancreatic cancer has been obtained. Also elevated levels of antibodies to P. gingivalis in the serum were associated with a two-fold increased risk of pancreatic cancer in a European study. By out-populating Porphyromonas gingivalis and Aggregatibacter in the oral microbiome with probiotics such as Bifidobacterium, Lactobacillus and Saccharomyces this investigation intends to reduce the migration of oral pathogens to the pancreas, leading to pancreatic ductal adenocarcinoma. This study intends to sample the oral microbiome by supplying the experimental group with probiotic species, Bifidobacterium, Lactobacillus and Saccharomyces, and subsequently collecting oral wash samples and analyzing bacterial DNA. Probiotic species will be introduced into the oral microbiome with Prebiotics. Appropriate controls will also be carried out. We predict that out populating oral pathogens with pro bionics will increase the survivability of pancreatic cancer. If the hypothesis that oral pathogens somehow either cause or promote pancreatic cancer by suppressing the immune system, then by interfering with that pathway by eliminating or minimizing such pathogens through appropriate modification of the oral cavity microbiome we can monitor bacterial population in the mouth and then devise some therapeutic procedures.

Darien High School
Teacher: Guy Pratt

El-Masry, Claudia   Project # 72

Testing Vaping Pods, Tanks, and Pens for Microbial Endotoxin Contamination

As of last year, approximately 41 million Americans vaped and the numbers are growing at a steady pace. This project seeks to test if there is hazardous microbial endotoxin contamination in vaping pods, tanks, and pens. This contamination has been found in the e-juice, but pods, tanks, and pens have not been tested. It is hypothesized that endotoxins will be found in these devices. For this experiment, I will be testing the devices for endotoxins using a ToxinSensor Gel Clot Endotoxin Assay Kit. This uses the Limulus Amebocyte Lysate (LAL) assay and reagent, which is formulated from the specialized blood cells of Atlantic horseshoe crabs. These cells clot when they encounter endotoxins and other pathogens. The LAL reagent uses this clotting response to accurately detect endotoxins. In the presence of endotoxin, gelation occurs and in the absence, gelation does not occur. Testing is currently underway but what I expect to determine from this research is that the tanks, pods, and pens will contain endotoxins, which will make them even more detrimental to your health. In doing this research I hope to shed light on another hazardous aspect of vaping.

Sacred Heart Greenwich
Teacher: Mary Musolino

Enters, Alison   Project # 73

Microplastics Are Ingested by Various Marine Organisms

Microplastics are a growing problem in the marine environment. Not only are organisms ingesting the microplastics affected, but their predators are as well through the trophic transfer of microplastics. It is possible that humans might also be ingesting microplastics while eating seafood, but the effects of microplastics on organisms are unknown. The purpose of this experiment is to determine how numbers of ingested microplastics differ throughout two varying species, one being a filter feeder and one being a bulk feeder. If two organisms are tested, it is expected that the number of microplastics will be greater in filter feeders because they are unable to differentiate foods and waste. Organisms will be dissected and their digestive tracts examined to see if ingestion of microplastics occurred. The data will be analyzed by comparing the species and the average number of microplastics found in them in data tables and graphs. With the results of this research, scientists will know which organisms are more likely to ingest microplastics, which will enable them to further their research on how these organisms are affected by ingestion. It is then possible to test the differences between certain species of the same feeding style or the effects of trophic transfer of microplastics using the organism that ingests more microplastics. It is crucial to look at this further research after this experiment to enhance our knowledge on the effects of microplastics on organisms.

Darien High School
Teacher: David Lewis

Feuerstein, Joshua Project # 74

Development of A Serious Game for Flood Mitigation: Game Engine Development

The number and amount of devastating impacts of natural disasters have grown significantly worldwide. Recent studies emphasize the importance of public awareness and training of first responders in disaster preparedness and response activities. However, the strategy of increasing awareness of disaster risks in communities is not a complete solution. Developments in Serious Games, the genre of video games with a focus other than entertainment, have shown the capacity to be a medium to fulfill this need. The genre of serious games has existed for many years and has made impacts on areas such as mental health, design, safety, and construction. Furthermore, the Stop Disasters Game has proven the feasibility of a serious game of this subject area, with proven historical successes. This project aimed to create a serious game geared towards educating the public, students, and stakeholders on flood prevention and mitigation techniques, such that they are more aptly prepared for future flooding events. This project also aimed to incorporate global flood data for an accurate flood simulation as well as utilize the Google Maps API to allow the user to play the game using any location as the game area. To account for these factors, the game was designed in JavaScript, not within a premade game engine. Aspects of the game, such as its global adaptability and usage of real time data allows it to be a customizable and accurate experience with the ability to educate the masses on a global issue.

Amity Regional High School
Teacher: Catherine Piscitelli

Ford, Skylar Project # 75

Single-cell transcriptomic interrogation of genetic interactions through CRISPR-Cpf1

Genetic screens are revolutionary in their ability to analyze the comprehensive transcriptome of a cell; however, they are limited to relatively simple readouts. CRISPR-driven transcriptomics and CRISPR screens are effective, economically advantageous methods for analyzing complex cell populations and systems, yet current methods of CRISPR screening coupled with transcriptomic profiling are limited. Methods such as Perturb-seq, MOSAIC-seq, or CRISP-seq, and CROP-seq either are restricted to targeting only one gene for perturbation, or are subject to issues involving lentiviral reproduction. Their use of a genetic Ç£barcode Ç¥ to associate guide RNAs with the construct causes mispairing and loss of viable constructs during lentiviral reproduction. In order to improve sensitivity and allow for multiple gene targets, we designed a construct without the presence of a Ç£barcode Ç¥ that utilized the CRISPR-associated protein Cpf1. Cas9, the protein ortholog used by the other CRISPR screens, is restricted to one genetic target per promoter. Cpf1 is unique in the fact that it allows for multiple genetic targets with the use of a single promoter, allowing for a less complicated and more viable construct. Our construct successfully cut two genetic targets in the genes Nf2 and Cd43, and underwent reverse-transcriptase PCR, a transcriptomic profiling technique. Our high-throughput method of analyzing a complex transcriptome has the potential to help identify innumerable gene signature, targets, processes, and interactions associated with individual or multiple perturbations in future research.

Darien High School
Teacher: Guy Pratt

Gadhachanda, Koushik — Project #76

The Study of Silver Nano-Particles on Life in a Pond

If nano-silver contaminates the ecosystem of a pond, will the organisms in the pond die because the nano-silver has harmful affects on the pond-life? I will add Dalphia Magna to pond water that has been contaminated with different concentrations of nano-silver particles and I will record the effect it has on the Dalphia Magna. The Dalphia Magna "habitats" will be representative of life in pond-like ecosystems that are affected by silver nano-particles. According to my hypothesis, more and more Dalphia Magna should die as time goes on in these "habitats." Furthermore the higher the concentration of silver nano-particles in the pond water is, the more it will affect the Dalphia Magna and will result in their demise. This implies that silver nano-particles are detrimental to life in pond-like ecosystems. Everyday consumer products such as food contact materials, cosmetics, wall paints, textiles, laundry detergents, bio-cide sprays and medical devices, could all pollute a pond-like ecosystem and prove to be fatal to all of the life in that ecosystem.

Cheshire High School
Teacher: Julie Barker

Garcia-Fischer, Isabelle — Project #77

Auricular Vagal Nerve Stimulation in Brain and Gastric Outcomes in Functional Dyspepsia Patients

Roughly 60-70 million people are affected by gastro-intestinal (GI) disorders in the United States alone. Functional Dyspepsia (FD) affects 20% of this population and costs more than $8 billion in health care expenditures in the United States. FD patients are mainly affected by the symptoms of early satiation, bloating, nausea, belching, and abdominal pain, which are exacerbated by the consumption of meals. The goal of this study was to evaluate the ability of transcutaneous vagus nerve stimulation (tVNS) to attenuate FD symptoms, thus creating a better quality of life. tVNS is a noninvasive medical treatment that delivers electrical impulses to the auricular branch of the vagus nerve to attenuate medical symptoms. Healthy controls (HC) and functional dyspepsia (FD) patients were recruited and completed a screening visit, two behavioral visits, and two Magnetic Resonance Imaging (MRI) visits. The behavioral visits consisted of multiple questionnaires, a nutrient drink test (NDT), and a visual analog scale (VAS). Sham or active tVNS was applied during the behavioral and MRI visits. Currently, the population size for this study is still small. However, there are trends suggesting that tVNS attenuates the symptoms of FD patients by increasing parasympathetic nervous system activity, creating more balance within the autonomic nervous system. This study suggests that tVNS may increase parasympathetic activity and therefore reduce symptoms in FD patients. Continued research into this question may confirm this result and indicate whether tVNS represents a non-invasive means to increase the quality of life of patients.

Wooster School
Teacher: Evelyn Fetridge

Gavriilidis, Julia
Project # 78

Research Proposal, Science, Health and Medical

The Effects of Sodium Benzoate on the Response Time to Light Stimuli of Caenorhabditis elegans

Sodium Benzoate is a chemical used as a food preservative that has been linked to carcinogenic, and mutagenic and cytotoxic toxicity in white blood cells. In relation to this preservative, little research has been done about its generational effects and it's effect on neurotransmitters. 1. Grow a lawn of E. coli on Nematode Growth agar and incubate for 24 hours at 37°C.

2. Transfer C. Elegans onto the plate with E coli and incubate at 25°C for 72 hours.

3. Transfer one adult worm onto a plate with E coli and briefly flash the worm with blue light, being careful to record the time between the light flash and the phototaxis response.

4. Repeat steps 1 & 2 and inoculate plate with a .1% concentration solution of Sodium Benzoate.

5. Repeat step 3.

6. Repeat all steps per trial. Experimental research has not been completed and therefore quantitative data analysis has not been completed for this proposal. Experimental research has not been completed and therefore quantitative data analysis has not been completed for this proposal.

Bridgeport Regional Aquaculture
Teacher: Kirk Shadle

Gazal, Giovanna
Project # 79

Research Proposal, Science, Behavioral

The Effects of Heightened Emotions on Cognitive Flexibility

Cognitive flexibility is one's ability to switch between thinking about two different concepts, thinking about different concepts at the same time, and the capacity of performing many tasks. This project seeks to test the effect of heightened emotions on one's cognitive flexibility. It is hypothesized that cognitive flexibility will be affected by significantly heightened emotions. Despite whether these heightened emotions are positive or negative, cognitive flexibility will be adversely affected. This study would first get IRB approval to recruit participants and have them look at certain images, which would lead to significantly heightened negative and positive emotions. The effects would later be shown through conducting a series of cognitive flexibility tests and later checking results through fMRI scans. Results would also be shown when looking at the participants' reaction times. It is expected that after testing significantly heightened emotions, the results would show that one's reaction time would be much lower when comparing it to someone with neutral emotions. Having an emotional overflow will lower one's ability to switch between tasks and comprehend different concepts. fMRI analysis will show that the anterior cingulate cortex (ACC), which is involved in task switching and cognitive flexibility, will monitor information regarding conflict and demands fMRI will also respond to negative emotions, such as loss, pain, and negative feedback.This study will inform people on the importance of keeping your emotions somewhat neutral when in the process of making large decisions. These results will most likely point to further avenues of research, such as how having more cognitive flexibility can help eliminate very radical beliefs and build more tolerant societies.

Sacred Heart Greenwich
Teacher: Mary Musolino

Ghavami, Leyli   Project # 80

Research Proposal, Science, Physical Science

The effect of various plant based substances on the UV degradation of exterior house paints

The bombardment of house paint with UV rays can lead to paint degradation (the alteration of chemical bonds within the paint). Degradation can result in the alteration of color, and the exposure of harmful chemicals to the environment that would normally be encased in binder/firmly attached to the painted surface. House paints contain many toxic pollutants such as xylene, ethyl acetate, methylene chloride and more. While there are some UV resistant sprays on the market, they're highly toxic, and are generally used for smaller drawings and paintings. Brands like Krylon have UV resistant products that are skin, eye, and respiratory irritants, flammable, and at level 2 carcinogenicity, and can contain several types of VOCs. There are also protective sprays for murals, but they're essentially the same as Krylons product. Currently, a more natural option is not available on the market.

I want to research the application of flavonoids (specifically quercetin and rutin) for UV protection of exterior house paints. Flavonoids are found naturally in many plants and fungi, and already have some applications in Ç£natural Ç¥ sunscreens and as nutritional supplements. I plan to mix these substances (which generally can be found in powder form) with an acrylic binder and paint the mixture over a swatch of ECOS house paint (a brand that provides a full list of its ingredients). I will be looking for any differences in paint color, any reactions between the substances used, and compare the UV absorption spectra of uncoated and coated paint samples.

Here is a step-by-step procedure:

Use ECOS house paint, and paint 12 samples onto the wood panel. Each sample should cover a surface area of about 4 cm^2, and be comprised of 2 layers. Allow 3 days of drying time after each layer.

Place weighing paper on a mass, and set it to 0. Place about 1 mg of quercetin on mass and record the exact amount.

Place quercetin on a plexiglass slab. Add 1 drop of water and mix in with a palette knife to smooth out the powder.

Place beaker on mass and set it to 0. Place about 2 mg of acrylic binder and record the exact amount. Mix the acrylic binder with quercetin. Continue adding acrylic binder in 1 mg increments, until paint appears smooth, firm, and glossy.

Coat 1 of the previously painted samples with one layer of the mixture. Allow a few days to fully dry.

Repeat steps 2-5 twice more with the same substance.

Repeat steps 2-6 for rutin

Record any visual inconsistencies between samples (i.e. gloss, color, texture)

Use spectrophotometer at UConn Lab to measure UV absorbance of samples.

I hope to find which of the aforementioned substances will best protect exterior house paints from UV radiation when used as a coating. I hope that the demonstrated use of these chemicals as "paint sunscreens" will one day eradicate the use of the more harmful (to the body and environment), traditional alternatives.

Joel Barlow High School
Teacher: Katherine Nuzzo

Gilbert, Piper — Project # 81

The Effect of MSG-1 Mars Global Simulant Soil on the Growth Rates of Plants

Space exploration allows the human race to determine its place in the universe and progress towards an advanced civilization. This project aids Martian colonization by determining growth rates of plants in simulated Martian soil mixed with Earth soil in different ratios. It was hypothesized that if there is a difference in pH and macronutrients in Earth and Martian soil, there will also be differences in growth rates of specific plants. It was hypothesized that a 1:1 ratio of Earth to Martian soil will yield optimal plant growth. The macronutrients (potassium, nitrogen, phosphorus) and the pH of Earth and simulated Martian soil were tested using nutrient test kits and pH strips. Plant growth tests followed. Thirty-two planters were filled with four different ratios of Earth and simulated Martian soil. This allowed for duplicates of each soil and seed combination. Five of each seed type (radish, potato, tomato, and mizuna lettuce) were planted in each soil mix, duplicated, and placed in a lighted greenhouse. Watering occurred regularly. The growth rates, determined by the number of germinated seeds, length of germination time, and plant height were measured over thirty days. Results thus far show differences in pH and macronutrients between Earth and Martian soil. The plant growth results are still pending. The implications of these results are immense; they allow for further research in refining survival techniques in space, what types of plants work best with Martian soil, and other avenues as technology continues to advance. Mars' surface conditions make life incredibly difficult and, as such, NASA has not yet sponsored a human mission. This experiment can support the possibility of Martian colonization and furthers the possibilities of future space exploration.

Sacred Heart Greenwich
Teacher: Mary Musolino

Griffin, Claire
Greco, Gianna — Project # 82

Utilizing CRISPR-Cas9 to Target and Eliminate E.Coli Bacteria with Puromycin Resistance

Antibiotic resistant bacteria can survive in the presence of certain antibiotics. Using the gene editing technology, CRISPR-Cas9, it is possible to target and kill bacteria cells with antibiotic resistance. If the CRISPR system was able to successfully eliminate bacteria cells with antibiotic resistance, this would allow for the development of a sequence specific antimicrobial technique using CRISPR. In our experiment, we will use two plasmids. One plasmid will contain the puromycin resistance gene and the other will encode for the Cas9 enzyme and contain kanamycin resistance. We will clone a gRNA that matches the puromycin resistance sequence into our CRISPR plasmid. Next, we will transform the two plasmids into our e. coli cells. Our final step would be to plate the transformed e.coli first onto a dish with kanamycin to prove successful CRISPR integration. Then, the cells will be plated onto puromycin to test the effectiveness of CRISPR editing. The results of our experiment should be E. Coli bacteria transformed with the CRISPR plasmid. After CRISPR expression, the cells should continue to grow on a kanamycin plate but die when exposed to puromycin. Ultimately, the research will confirm the potential of CRISPR-Cas9 to target and kill bacteria cells with antibiotic resistance. Efficient editing of bacterial genomes marks the beginning of the development of sequence specific antibiotics. Without antibiotic resistance, it is possible to make the treatment of various infections and illnesses much easier.

Ridgefield High School
Teacher: Ryan Gleason

Griffith, Isabel   Project # 83

Testing Conformity in Dogs in Relation to Conspecific Behaviors

A common topic of research today is dog behavior. However, experiments regarding conformity in dogs is a subject that has yet to be fully looked into. The question at hand is whether or not dogs, when trained to perform a certain task, will conform to what another does or deviate from the majority behavior.

A large group of dogs would be taken and trained to perform certain tasks including moving around an object or going through different tunnels. Then, the dogs would be put into a group where they would either conform to the majority behavior or stick to what they have been taught. These results will determine whether or not dogs are drawn to conformist behaviors.

Since dogs have always been considered pack animals, the results would most likely reflect the following. Dogs would likely conform to a majority behavior because they are genetically wired to be a part of a group. However, the dogs might also show aspects of being independent and nonconformity since they are self-sufficient.

The research that will be performed is important to better understand animals that are prominent in many people's lives today and in the future. Greater advancements to better understand dogs will benefit things such as their treatment. Conformity is common in humans, as well as other animals, so finding whether or not it can be found in dogs will completely change the way dog behavior is viewed.

Ridgefield High School
Teacher: Patrick Hughes

Gross, Ava   Project # 84

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

Every day in the Yale Dental Residency program, dentists in training practice placing implants. However, a large portion of the implants tend to fail during the healing period of 6-8 weeks. It is hypothesized that 3i has the lowest amount of bone integration. The purpose of this experiment was to compare bone integration from one implant system to another. By looking at the x-rays of the patients, a pattern between the amount of bone loss and implant type were developed. The four types of implants reviewed were Astra, 3i, Nobel, and Strauman. The x-rays were provided by the student's mentor, Dr. Thomas Duplinsky, a professor at the Yale dental residency program and practicing general dentist. Findings thus far support the hypothesis.

Over 200 patient x-rays were reviewed and no real patient names were used in this study in order to respect the privacy of the patients.The findings of this study helped dentists determine which implants have the least amount of bone loss, making them the most successful, and therefore should be used.

Amity Regional High School
Teacher: Catherine Piscitelli

Grosso, Nicole — Project # 85

The Effect of Artificial Versus Natural Light on the Mortality Rate of Littorina littorea

Littorina irrorata are known for their ability to adapt and tolerate changes in their climate such as salinity change and desiccation. But, how will the salt marsh periwinkle adapt to life in an environment with artificial light? The purpose of this project was to determine the effect of artificial versus natural light on the mortality rate of the periwinkle snail. The independent variable in this study was the type of light (artificial or natural), and the dependent variable was the mortality rate of the periwinkle snail. The hypothesis of this experiment was that artificial light would decrease the mortality rate of the snails. In this experiment, I kept four tanks at my house, each containing the same amount of periwinkle snails, keeping constant variables that could have impacted survival rate. I monitored the tanks daily at the same time and recorded observations on various differences among the snails as well as the amount of surviving snails. No control was in place for this project, as it was a comparison. My mentor provided me with suggestions on how to best take care of the snails. To analyze this data, an analysis of variance, or ANOVA, was run on the mortality rate. The importance of this project is that periwinkles are a common source of food for many marine specimens; they have been recognized as a keystone species in Northern Atlantic waters. However, they are suspected to decrease in population as global warming increases. Because they are essential to many marine ecosystems, cultivating them in captivity may be necessary. This project determined the best way to do so.

Amity Regional High School
Teacher: Catherine Piscitelli

Hall, Aidan — Project # 86

A Quantitative Analysis of Wild and Stocked Rainbow Trout (Oncorhynchus mykiss) Populations

Trout are a very heavily stocked fish, and wild and stocked populations can vary heavily. The goal of this experiment is to determine population numbers in local watersheds of both stocked wild trout. This experiment will be conducted by using catch and release methods in local watersheds. Populations will be determined stocked or wild based on information and connection with the Trout Unlimited organization. DEEP also has specific ratings on watersheds, with designated wild trout locations as well as common stocked bodies of water. When fish are caught photographic evidence will be made as well as DNA samples possibly in future experimentation, from either the fins or bodily fluids of the fish. Fish will then be released back into the body of water from which they were caught. I have not yet collected any data. However I have projected that data collection will begin in the coming weeks. Conducting this experiment will increase insight into population numbers of both stocked and wild populations.

Newtown High School
Teacher: Tim Dejulio

Heaton, Ryan — Project # 87

Classifying Subtypes of Renal Cell Carcinoma Using Convolutional Neural Networks

Kidney cancer is the sixth most common type of cancer found in men, and the eighth most common type found in women. Because of this, and the importance that subtyping plays in diagnosis, I designed a deep learning algorithm to classify different subtypes of renal cell carcinoma (RCC). This program eliminates the need for a second opinion and, with improved pathological accuracy, ensures that patients receive the correct treatment sooner. Using the python library PyTorch, a pre-trained ResNet18 was tested on a dataset of 69 histology images of RCC collected by Memorial Sloan-Kettering Cancer Center (MSKCC) spanning three different subtypes (CC, CCP, ONC). Different parameters were tested on the network, and it was trained using MSKCC's High Performance Compute (HPC) Cluster. Following initial testing, the network was expanded by four more subtypes. Both networks were found to be most accurate when run with a crop number of 2000, a batch size of 50, and a learning rate of 0.001. Methods of data augmentation were also used to artificially inflate the dataset. The network for the first three subtypes reached a patient-wise accuracy of 97.10%. The network that could classify all seven subtypes reached an accuracy of 80.74% The network, with further optimization, could potentially have use in the clinical realm. A success rate of over 90% is considered very successful, and these findings could contribute to the progress in the field of computational pathology to eliminate uncertainties in diagnoses caused by pathologists' inherent subjectivity.

King School
Teacher: Victoria Schulman

Hebbar, Shreya — Project # 88

Color's Effect on Positivity

Research has been done on the psychology behind color and its effect on our mind. Studies have shown that the color red gives off energetic vibes, yellow is often associated with friendship and happiness, grey symbolizes depression, and lighter shades of blue represent peace and focus. The purpose of my experiment was to test the effect of various colors on positivity. The hypothesis was, if the colors yellow and blue are tested in a survey asking to view some pattern images of that color and rate their mood from 1-10, then more positive results will show up compared to the other colors tested since yellow represents happiness and blue represents peace. Technology is a major part of learning today and knowing which color brings out more positivity will be helpful when doing online work. This experiment was conducted by sending the same survey to those who have given consent, and randomizing the colors of the survey background. Participants received a survey with the various colors and images of patterns containing each color. Data has shown that yellow results in more positivity. With these results, the average was calculated before and after they viewed the images and compared these results to my control. Since technology is such as major part of learning in schools today, by knowing which color brings out more positivity, it may be helpful when taking online tests or doing any type of online work.

Amity Regional High School
Teacher: Catherine Piscitelli

Hidy, Evelyn — Project # 89

The Localized and Controlled Treatment of Brain Tumors Through the Use of Multi-layered Core-sheath Fiber Membranes with PCV

The use of cytotoxic agents and their successful delivery is vital to the treatment of glioblastoma multiforme (GBM), which is an extremely aggressive and the most common form of primary brain cancer. This type of brain cancer originates from star-shaped glial cells and is referred to as a grade IV astrocytoma due to its severity. The use of a hydrophobic polymer membrane with hydrophilic chemotherapy elongates the period of time over which the drugs are released and increases successful outcomes. Electrospun nanofiber membranes or NanoMesh membrane discs will be filled with PCV which is a type of chemotherapy consisting of three different drugs. The different layers that form the NanoMesh, will each individually be filled with the PCV drugs of Procarbazine, Lomustine, and Vincristine. This fabrication process also allows for the delivery of a potent dose of the PCV drugs immediately or over time. These discs are then implanted into the resection site of glioblastoma multiforme in mice models and are tested for the ongoing treatment of GBM. An empty NanoMesh disc will be implanted as a control and also insured the safety of the implant. If successful, this new treatment combining localized chemotherapy with the use of NanoMesh implants could potentially be a new treatment for glioblastoma multiforme allowing for uniform diffusion lengths of PCV over time resulting in a promising treatment of GBM.

Darien High School
Teacher: David Lewis

Hisiger, Luke — Project # 90

Using axolotls as a model for regeneration in humans with induced pluripotent stem cells derived in vivo

Many diseases and physical conditions are caused by a lack of healthy cells. The current methods of reducing the symptoms involve in vitro stem cell growth and grafting of healthy tissues, which is expensive and inefficient. In addition, the procedure requires tissue grafting which has complications of its own. The purpose of this experiment is to regrow healthy skin tissue in vivo like axolotls. CDNA viral vectors with reprogramming proteins will be used to create pluripotent/ multipotent cells from a small number of skin cells. TeSR will be injected into the blastema's center. An AAV containing CRISPR/CAS9 that will cut out the reprogrammed parts of DNA will be injected, returning the cells to their original somatic state as shown in axolotls. Skin cells that received the reprogramming proteins will form a small mass of pluripotent and multipotent cells known as a blastema, which will remain intact with special junctions. After CRISPR/CAS9 injection, the mass will begin reducing in size as many of the cells return to their original state. If a small mass remains it can be removed or injected again. In vivo stem cell therapy can be applied to any type of cell in the body. A slightly modified version of this experiment could be used to replenish cells of different types. Entire organs could be regrown, or white blood cell counts could be replenished. Another interesting application would involve combining different types of cells, in this case, an entire limb could be regrown.

Ridgefield High School
Teacher: Patrick Hughes

Hisler, Caroline
Maloney, Megan   Project # 91

The Presence of Chromium-6 in Municipal and Well Water Along The East Coast of the United States

Water sources along the east coast have been known to contain pollutants, but one chemical, chromium-6, has not been thoroughly tested. Chromium-6 is a known carcinogen. It was hypothesized that the amount of chromium-6 in east coast water sources will be higher than in west coast water sources due to the heavy urbanization of the east coast, and more specifically, that the water from municipal sources will have lower levels. To test this hypothesis, water samples from both municipal water sources and buildings that have well water across the east coast of the United States will be collected. It is expected that the water sources closer to industrial cities will have a higher concentration of chromium-6. To test the concentration between all the samples, we are going to use chromium-6 detecting test strips and the eXact iDip photometer.

Tests are underway with samples being tested from Maine, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Virginia. It is expected that chromium-6 will be found in most tap water sources along the east coast. It is also expected to find higher levels of chromium-6 in well-water sources than municipal sources due to the various industrial projects that occur along the east coast that causes groundwater to be contaminated.

This study could lead to a regulation of chromium-6 along the east coast, as well as raise awareness of possible contamination. It is extremely important for people to be aware of what is in their drinking water, especially if their water is harmful.

Sacred Heart Greenwich
Teacher: Mary Musolino

Hong, Eun   Project # 92

Potential Treatment to Chronic Wounds using Anti-Quorum Sensing activity from Calendula Officinalis.

Wounds that are not able to heal in a predictable amount time are called chronic wounds. 60% of chronic wounds are often caused by the formation of biofilm on the surface of the wound. The biofilm creates the extracellular substance that protects the bacteria from potential threat, such as antibiotics. Due to the antibiotic resistance problem rising, the process of quorum sensing is gaining more attention as an alternative treatment for chronic wounds. Quorum sensing is a bacteria communication method, where the signal molecules alerts the bacteria when they are enough to carry out certain actions. The purpose of this experiment is to create an ointment, which can be easily made at home, that have the anti-quorum sensing ability to prevent the biofilm formation on chronic wounds.

1. Grow the bacteria in the broth agar for overnight.

2. Transfer 1.5 mL to the centrifuge tube.

3. Centrifuge at 10,000 rpm for 15 min.

4. Filter through membrane filters and get rid of the cell pellets.

5. Repeat the procedure 3 and 4.

6. Mix with ethyl acetate for 10 minutes and wait for the mixture to divide in the separatory funnel.

7. Put in the oven to dry at 40 degrees.

8. Identify the signal molecule using the Fourier Transform Infrared Spectroscopy (FT-IR) to ensure that there are quorum sensing activity present.

9. Divide the nutrient agar into four sections.

10. Flame the inoculating loop and flame the test tube with the E.coli culture.

Bridgeport Regional Aquaculture Center
Teacher: Kirk Shadle

Hyland, Chelsea
Hounsell, Justine   Project # 93

Comparing the Prevalence of Microplastics in the Hudson River, Long Island Sound, and Mianus River

While microplastics in the oceans is a worldwide issue, there is no comparative study about the prevalence of microplastics in the Hudson River, Long Island Sound, the Mianus River. This study will test the number of microplastics in each body of water at similar locations. It is hypothesized that the greatest amount of plastic is in the Hudson River because of the population and specific industries surrounding the river.

 Water will be collected from an industrial, beach, and isolated sections in the three bodies of water. After the samples are collected, they will be tested for microplastics by adding Nile Red Dye to the water to cling to the plastics, and also straining the water through a fine-mesh net. The number of microplastics will be counted and the type determined from a specific quantity of water at each site. It is expected that the greatest number of microplastics will be found in the Hudson River because of the specific industries and activities along the shore. Hudson River is in close proximity to NYC, which is a contributor to plastic waste that pollutes the River. It is predicted that the Mianus River will have the lowest number of microplastic particles because all sites will have less human and industrial activity.

 This study will hopefully lead to microplastic pollution knowledge in the bodies of water surrounding the residents of New York and Connecticut. It is hoped that the knowledge gained from this study will include which body of water contains the most.

Sacred Heart Greenwich
Teacher: Mary Musolino

Jain, Swastika   Project # 94

The Impact of Acinetobacter venetianus and Pseudomonas putida strain (BTP1) on Rapid Sand Filtration

Rapid sand filtration is a type of water filtration system that is easy to maintain and use, and very cost-efficient. Currently, rapid sand filtration(RSF) systems are used, primarily, in rural communities in Eastern Asia who don't have access to clean, filtered water. Creating a more efficient RSF system would be a more reliable way to create an emergency supply of filtered water.

 For this experiment I used six sets of rapid sand filters, which I created, and they each were connected to two other containers, one for the raw water and the other for the filtered water. I measured the purity and safety of the water using a 14-in-1 Drinking Water Test Kit, and a TDS Meter Digital Water Tester. The filter types' outputs will be measured by the amount of contaminants left in the filtered water. The two regular rapid sand filtration systems that don't have "new" bacteria in them. Data shows, the A. Venetianus filters water better than the regular and P. putida strain (BPT1). When compared to the normal filter, the filters with P. putida strain (BPT1) did better at filtering water than the regular ones. Based off of the preliminary research, A. Venetianus can be used in future RSFs to increase the filtration quality of the filter.

Amity Regional High School
Teacher: Nicholas Shamp

Jiang, Kevin Project # 95

The Effect of Extending the Peptide Chain of a Rigid Bis-alkyne Tungsten Complex on the Interior Hydrogen Bonding

Proteins typically exhibit two main types of secondary structure: -sheets and -helices. -sheets are typically 2 strands of 3-10 amino acids. The two strands are side by side and hydrogen bond with one another.

The problem with modeling localized areas of proteins is that they often do not retain their secondary structure. When these localized segments are isolated, they change their secondary structure Thus, this study aims to find a replicable method of modeling secondary structures to facilitate further protein research.

The study will be an extension of previous research in the Curran Lab. Preliminary studies have shown when a two amino acid chain is added to alkynes coordinated to tungsten, there's hydrogen bonding between the interior amino acids. The experiment remains whether lengthening that protein chain will result in increased hydrogen bonding. My experiment will do this by synthesizing two identical three amino acid (Gly-Val-Ala) chains and attaching them to the aforementioned alkynes. A rigid ferrocene derivative ring system will also be synthesized to prevent the free rotation. This will create in a ferrocene-tungsten complex, which can hold peptide chains at an ideal distance for hydrogen bonding. I will then analyze the degree to which the amino acids hydrogen bond with each other within the complex, utilizing a DMSO titration by looking at the change in chemical shift. Sufficient evidence of increased hydrogen bonding will support the theory the peptides have adopted a -sheet conformation. N/a N/a

Glastonbury High School
Teacher: Diane Pintavalle

Jog, Niharika Project # 96

Effectiveness of organic materials combined with an aloe vera sunscreen base in protecting skin against UVA and UVB rays

UVA rays penetrate the skin's deeper layers but cause damage on its surface, while UVB rays touch the skin's surface but leave more serious damage. The purpose of this project was to determine which organic materials can defend the skin from damage to develop a more natural sunscreen. It was hypothesized that if hyaluronic acid was mixed with a lotion base, then it would reflect UVA and UVB rays. Three organic materials, allantoin, hyaluronic acid, and coconut oil, were mixed with the same aloe vera lotion base, with water and plain aloe vera base as the controls. Allantoin soothes the skin, so it could protect the skin from UVA and UVB rays. Furthermore, hyaluronic acid can be used to treat burns, so it might prevent burn damage as well. Coconut oil is widely used in homemade sunscreens. Each of the three mixtures was applied to a square cloth from a white cotton t-shirt with an insignificant UVF. 3 g of each mixture were spread on their cloth squares prior to experimentation and placed over paper with cyanotype solution under a UV light. This was counted as one trial, and five trials were conducted for each mixture under parental supervision, with gloves, safety goggles, and an apron. The independent variable was the organic mixture, and the dependent variable was the effect they had on the cyanotype solution. The organic ingredient with strong protective properties could provide an additional option for protecting the skin, especially as temperatures are reaching an all-time high.

Amity Regional High School
Teacher: Catherine Piscitelli

Kadimi, Srilekha Project # 97

Completed Project, Science, Health and Medical

Analyzing the Efficacy of a New Method for Inserting Transgenes In Mice

Transgenesis, the process of introducing a gene of one organism into another, is complex and inefficient. The purpose of the project was to analyze the effect of the new transgening method of green fluorescent protein (GFP) in mice. The IV was whether parent mice are injected or not injected with the transgene. The DV was the presence of the transgene in offspring.

 It was hypothesized that if mice are injected with GFP, then the method will be effective and mice will possess the transgene. Buffer, dNTP, water, primers, and polymerase were combined to create a master mix. DNA injected with the transgene was placed in one tube labeled "positive" and DNA not injected with the transgene was placed in another tube labeled "negative", which are the controls. Each of the different sample's DNA were placed into separate tubes with the mix. After the mixtures were run through the PCR, the mentor created a gel to conduct a gel electrophoresis. Process was repeated for sets of offspring and parents. A qualitative analysis was taken to examine what happened during the procedure. Data thus far has shown that the positive and negative controls are working. However, the parent mice are not exhibiting expected results which suggests that the transgene was not effective in that first generation. Samples from later litters mostly exhibit expected results. The results will provide a deeper understanding on the role of genes in disease. If successful, this newly developed process can be implemented in humans.

Amity Regional High School
Teacher: Catherine Piscitelli

Karl, Lila Project # 98

Completed Project, Science, Environmental

Concentration of Microplastics in Different Bodies of Water in Darien, CT

Microplastics are small particles of plastic that have been broken down from larger types of plastic. Plastics easily enter different bodies of water due to runoff. Microplastics are extremely toxic to animals and the marine ecosystem as a whole. It was tested how different bodies of water would impact microplastic concentrations. Two bodies of water, Goodwives River, a fresh-water stream, and Holly Pond, a brackish inlet of Long Island Sound, were tested for microplastic amounts. For each of the 12 sample days, a 150 mL water sample was collected in both bodies of water. Then a dye, hematoxylin delafield, was put into the water sample that highlighted the amount of microplastics in that sample. The microplastics were counted using a microscope. Holly Pond had a higher amount of microplastics because it is a still-moving body of water that accumulates microplastics. Goodwives River is a running body of water so microplastics are constantly flowing through the river. Holly Pond collects the freshwater from rivers, so it had a larger accumulation of microplastics. It was found that Holly Pond, on average, had around double the concentration of microplastics than Goodwives River. Also, Holly Pond had higher averages on days after it rained. With these results, my community will hopefully become more aware of the relevance of plastic pollution and establish more laws limiting plastic usage.

Darien High School
Teacher: David Lewis

Kassapidis, Zoe — Project # 99

Testing Natural and Synthetic Substances for Oil Spill Clean-Up

The issue addressed in this study is oil spill remediation to reduce negative effects on marine life. As oil latches onto birds' feathers, it impairs the waterproof characteristics of the feathers, exposing birds' skin to extreme temperatures. The overall goal of this study was to discover a novel, effective, and natural oil-absorbing substance that can be used in oil-spill cleanup. It was hypothesized that sorbitol could be a successful option.

This study began with measuring a 3:1 ratio of water to oil for each sorbent and placing into separate containers. A variety of both natural and synthetic oil sorbents were tested. Each sorbent was soaked in the water/oil mixture for a set amount of time. The remaining water/oil mixture was separated using a separatory funnel and a new water to oil ratio was calculated to determine success.

The higher the water to oil ratio, the better the oil-absorbing power of the sorbent. Out of the test substances, coco fiber, salvinia plant, sorbitol in filter, oil-absorbing polymer, nylon, and sorbitol in nylon, it was found that the three most effective substances included the oil-absorbing polymer (ratio of 5.20:1), sorbitol with filter (ratio of 5.63:1), and nylon (ratio of 7.67:1).

Combining the two most effective substances together, preferably sorbitol and nylon, and manufacturing them into a boat sleeve that lines the underside of ships, may play a huge role in oil-spill cleanup. It will be even more effective.

Sacred Heart Greenwich
Teacher: Mary Musolino

Kim, Andrew — Project # 100

The Effect of Spoken Heritage and Second Languages on Memory Retention and Organization

The purpose is to investigate the relationship between spoken language and improvement in memory retention and organization. It was hypothesized that there will be a significant difference between the participants' levels of comfort with their languages and improvement correlated with higher comfort levels of languages. The independent variable was language, and the dependent variable was participants' memory. After returning signed consent forms, participants were placed into one of five groups: a double-English (EE) group, two passive bilingual (PB) groups, and two active bilingual (AB) groups. All groups were shown a complex figure and were told to narrate their actions when copying the figure. The participants then filled out a questionnaire, which measured familiarity and comfort of the language. After the survey, they quietly drew the figure from memory, which was collected. The participants repeated this procedure but using another language, except the EE group. Statistical differences were assessed using a t-test. Current trends show that there is a strong correlation between comfort levels of languages and improvement of memory retention and organization.

If the hypothesis is supported, it would support the idea that there are benefits to incorporating spoken language into studying processes.

Amity Regional High School
Teacher: Catherine Piscitelli

Kim, Mina   Project # 101

Impact of Diisocyanate on Lung Gene Expression in a Mouse Model of Occupational Asthma

Diisocyanates, chemicals to make polyurethane, can cause asthma. Polyurethane is widely used industrially to make polyurethane foams, insecticides, and elastomers. Important differences between diisocyanate and environmental asthma prompt the hypothesis that the disease involves distinct mechanisms of pathogenesis. One difference is lack of immunoglobulins (Ig) of the epsilon subclass (IgE) that bind diisocyanate in the blood of affected workers, as allergen-specific IgE plays a primary role in allergic reactions. Diisocyanate asthma likely occurs through IgE-independent mechanisms that remain unclear, hampering screening, diagnosis, and therapy. The purpose of this experiment was to determine key gene expression differences in diisocyanate asthma. Animal models were best suited for research because chemicals cannot ethically access tissues in humans needed to better understand pathogenesis. Gene expression patterns may differ from environmental asthma and involve distinct cell types and mediators. The independent variable was skin and/or respiratory tract exposure to diisocyanate. The dependent variables were levels of gene expression, percent of airway fluid eosinophilia and mucus, and enrichment of biological pathways. Experimental groups included: (1) mice with an exposed respiratory tract and prior skin exposure; (2) mice with an exposed respiratory tract without prior skin exposure; (3) mice with B-cell knockout (same as group one); (4) mice with IL-12 knockout (same as group three). Student used bioinformatic software programs to analyze gene expression and determine significantly altered biological pathways. Implications of this project included developing a deeper understanding of the pathogenic mechanisms of diisocyanate asthma, leading to better approaches for disease screening, identification, and treatment.

Amity Regional High School
Teacher: Catherine Piscitelli

Kongani, Adarsh   Project # 102

Redesign of a Genetic Algorithm Framework Replacement For Time-Shifted Air Traffic Scenario Generation

This project is a continuation project based on research done by the FAA and with the help of Fairfield University senior students. The FAA has created a time-shifted genetic algorithm to simulate air traffic conflict probes called JavaCat. A conflict probe monitors flights in the air and looks along their predicted paths for potential violation of separation standards and potential crashes. A genetic algorithm is a type of algorithm that uses elements from the theory of evolution to optimize solutions to a problem This project created a genetic algorithm that is based on open source genetic framework Jenetics. The program must utilize another means of manipulating flight data, and utilize the parallelization framework in Jenetics. To meet this criteria we are considering adding mutation to manipulate the flight data in Jenetics. Most of the algorithm will be developed in the IDE (Integrated Device Electronic) IntelliJ. The program was successful in reaching its goals, as it was able to create pairs of flight conflicts and correctly create viable conflicts that can be helpful in preventing future conflicts. This project is very important because it uses a computer program to predict possible air traffic conflicts before they happen, to help air traffic control workers to anticipate different scenarios. Making this open source, helps keep up with new methodology and ideas. Revising this program makes it easier to support other methods of inducing conflicts to create different scenarios that can help air traffic control watch for scenarios and create a safer national airspace.

Amity Regional High School
Teacher: Catherine Piscitelli

Kongani, Keerthi   Project # 103

Designing a Cost Effective Insulin Pump in Conjunction with an Artificial Pancreas System

Today in America more than 100 million people suffer from some form of diabetes or prediabetes and this number is steadily rising. Today's insulin pumps are very expensive ranging from 4,000 dollars to 8,000 dollars not to mention that they have to be replaced every 2-3 years. Recently users have found a way to modify a select number of insulin pumps to act as an artificial pancreas which automatically adjusts insulin levels. The company Medtronic made an insulin pump that was similar to the modify system except it costs 7,000 dollars for one pump. Furthermore users will not have to constantly check their blood glucose levels throughout the night and day. In order to build the artificial pancreas system I used a Raspberry pi, a rechargeable battery, continuous glucose monitor, a carelink USB and a custom built Insulin Pump, a motor, piston, and battery charger. The prototype was tested in different case scenarios. The blood glucose levels and the insulin were graphed as a line graph.

  The insulin pump itself cost around 80 dollars to make. Most of the applications that the insulin pump was programmed to do was able to work.   In the future this prototype will be cost effective. Additionally, more can be done with this insulin pump in reference to customization options for the user.

Amity Regional High School
Teacher: Catherine Piscitelli

Krukar, Jade   Project # 104

Building an Interactive Map Application to Navigate Large Medical Centers

Studies have found that one of the main problems visitors encounter in hospitals is needing directions. Most hospitals have to rely on confusing printed maps and the assistance of passing employees. The goal was to create an application to provide a more effective way for visitors to navigate medical centers. The solution to the problem was to create an Android app with a main map system.

 The app was created in Android Studio. Using Indoor Atlas, the school was mapped out and the route code was added into the code. People unfamiliar with the building participated in the study and individuals were asked to navigate a set of places with the app, with a map of the building, or with no direction at all.

 Each individual filled out a questionnaire on their experience navigating the building. The data from the questionnaire was analyzed to determine whether the app proved to be useful and effective. The questionnaire data showed that the app was the most helpful in navigation.

 This app reduces the stressful environment of hospitals by aiding navigation and preventing patients and visitors from getting lost. It has the potential to be applied to department stores, college campuses, and other large places.

Amity Regional High School
Teacher: Nicholas Shamp

Kucher, Nadia   Project # 105

Body movement patterns are impacted by the ablation of layer-specific neurons in the motor cortex that project to CSNs

It is estimated that one in six people have had a stroke worldwide. Strokes can cause damage to the motor cortex, which can cause motor deficits, leaving patients with a limited range of motion even after intense rehabilitation. These injuries can lead to a loss of skilled hand movements when the corticospinal tract becomes impaired. Studies have shown that there is an increase in motor function with rehabilitation, but it is unclear how movement patterns change after an injury. In the following study, we ablated layer V corticospinal neurons (CSNs) in the caudal forelimb area to determine how movement is affected after a loss of CSNs.

Mice performed a skilled reaching task before and after injury, and their movement patterns were studied using a machine learning system. We observed a change in functional movement, meaning that the movement patterns of the mouse were altered after injury. These results indicate that injury to the motor cortex affects movement patterns, which expands our knowledge of how injury affects movement patterns.

These data will help create more specific rehabilitation regimens for stroke patients, which will allow for faster and better recovery in a shorter period of time, leading to a better quality of life after injury, and less time and money spent on physical therapy.

King School
Teacher: Victoria Schulman

Lam, Juliet   Project # 106

Arthrospira Platensis Ability to Absorb Lead Given Differing Ammonia Levels

Leachate is filled with heavy metals such as lead, as well as toxic chemicals such as ammonia. Algae is capable of growing in solutions containing high concentrations of ammonia, and the species Arthrospira Platensis is capable of absorbing lead, and since leachate can't support life, Platensis can be filtered off afterwards. This is a way to treat wastewater. - Create four solutions of differing ammonia levels, with the same concentration of dissolved lead ions into each solution

- put the flasks under a UV lamp(s) in an airtight container (12 hours a day), at the same temperature (28°C), and keep conditions constant for three weeks

- precipitate the lead out of the solution (after algae is filtered out) to find out how much has not been absorbed by the algae

N/A The concentration of ammonia which makes the platensis absorb the most amount of lead should be used by algae leachate treatment centers.

Joel Barlow High School
Teacher: Katherine Nuzzo

Lapierre, Lucca   Project # 107

Solar Powered Autonomous Robotic Pool Skimmer with Obstacle Detection Sensors

Currently, the most widely used method of clearing surface debris from pools is accomplished manually, usually with a net fastened to a long telescoping pole. This method of cleaning produces acceptable results but at the cost of having a homeowner take time out of their day to clean their pool. The purpose of this project will be to design a robotic pool skimmer that efficiently removes surface debris and eliminates having it to be done manually. In this proposed project, a 3-D model of the device will be made using a CAD(Computer Aided Design) software to have a visual representation. This 3-D model will then be put into a simulation software to determine if any component needs to be changed in order to make the end product more efficient. The final product will be made out of carbon fiber as it is a durable, lightweight material. The expected results from this engineering project will be a robotic device that can float on the surface of a pool and collect floating debris. The device should be able to produce results that the homeowner finds sufficient enough that they do not have to go back to manual cleaning. If this project is successful it will provide an alternate method of cleaning the surface of pools and allowing pool owners to accomplish other tasks that they might have. Another implication of this project is to scale up the size of the robot so that is can be used on lakes or ponds.

Newtown High School
Teacher: Timothy DeJulio

Larkin, Emily   Project # 108

The Effect of Various Enzymes on the Biofilm of Staphylococcus Epidermidis

Approximately 80% of nosocomial infections are caused by Staphylococcus Epidermidis, a common bacteria found on the human flora. Through experimentation, it will be determined which enzyme (protease, amylase or nuclease) will more effectively break down the biofilm to help develop new medicinal practices that will be faster, more cost effective methods to treatment of these infections.

The procedure entails culturing the bacteria using tryptic soy broth at 37°C, the optimal growth temperature, for 24 hours on an orbital shaker at 180rpm. Afterwards, the bacteria cultures will be transferred into 4 petri dishes with additional broth and one of each of the enzymes; nuclease, protease and amylase. One dish will be the control group. This will be left for an additional 24 hours under the same conditions. The next day, the cultures will be decanted, washed with phosphate buffered saline (pH 7.2) and left to dry (at room temperature). Violet crystal stain will be added to the Petri dishes; these Petri dishes will be rotated (to ensure uniform staining) then decanted again. The petri dishes will be viewed under a light microscope to observe the biofilm.

No current experimental data collected. If I can find a way to disrupt biofilm formation using enzymes, I could potentially design a new type of medicine utilizing these enzymes and antibiotics to kill off the bacteria. Combined with other research, my findings could help to develop new medication to speed up the recovery time for many patients.

Joel Barlow High School
Teacher: Dr. Katherine Nuzzo

Lauria, Gabrielle
Finn, Regina   Project # 109

The Effects of Anthropogenic Sounds on the Behavior of Sharks

Anthropogenic sounds are negatively affecting marine life. These sounds are human-made and are carried throughout the ocean because of boats, seaports, and military ships. Previous research has focused on marine life that uses echolocation. This project focuses on how sounds affect sharks since they do not use echolocation. Even though sharks do not use echolocation for survival, it is hypothesized that anthropogenic sounds will still negatively affect the sharks. To test this hypothesis, work would be conducted at a shark lab using lemon sharks. The next step would be to get speakers that would convey the different sounds and underwater cameras that would record the shark's behavior. Different sounds will be created by changing the frequency, pitch, or amplitude of the sound wave. The speakers would be placed in different sections underwater and cameras will record how the sharks react to the anthropogenic sounds. Results will likely demonstrate that both the louder and higher frequency sounds will cause a greater change in behavior in the sharks that have not adapted to anthropogenic sounds. The sound waves will affect the shark's way of living in their environment and behavioral patterns. It is expected that this will show that marine animals that do not use echolocation would still be negatively affected by these types of sounds. This work can lead to additional research. Applying this research to different animals and situations may improve their lives. In addition, this research can be beneficial in learning how to use sounds in a positive way.

Sacred Heart Greenwich
Teacher: Mary Musolino

Lavi, Ethan   Project # 110

Improving the Efficacy of PARP Inhibitors through Combination with NHEJ Inhibitors in Ovarian Cancer

PARP inhibitors are an emerging novel therapy, utilizing synthetic lethality to effectively treat ovarian cancer cells. This is seen especially in BRCA-mutated cancer cells which struggle to perform HR (DNA damage) repair. They survive solely through the use of another type of repair, involving PARP. Synthetic lethality involves inhibiting this other type of repair, in this case with the PARP inhibitor, so the cancer cells die. Over a long period of time, the treatment loses its efficacy as a result of secondary mutations. The purpose of this experiment is to eradicate the development of resistance. It was initially hypothesized that the use of NHEJ (another type of repair) inhibitors in combination with PARP inhibitors would reduce secondary mutations. Treatment groups of BRCA-mutated cancer cells are used to test a solution. A no treatment group is used as a control. The dependent variable is the percent survival over 6 weeks, measured with a cell toxicity assay. The dose response curve (percent survival vs concentration) at each time interval is used to indicate efficacy of the treatment. Comparison of Preliminary data supports the predicted trend. The implications of this experiment is more knowledge about NHEJ repair. This experiment shows that NHEJ, being an error prone repair process, has the ability to reverse the quality of BRCA-ness (the phenotype resulting in dysfunctional HR repair) meaning that the cancer develops resistance to the PARP inhibitor. Additionally, the use of an NHEJ inhibiting drug could prevent resistance from developing by preventing the reversal of BRCA-ness.

Amity Regional High School
Teacher: Catherine Piscitelli

Leao, Isabella — Project # 111

Testing Graphene, Graphene Oxide, and Boron-doped Graphene Oxide in Clothing to Block Mosquitoes from Biting and Transmitting Diseases

Malaria is a disease that is commonly found in mosquitoes, often affecting the health of humans when bit. This project will test graphene oxide and other graphene membranes in clothing as a way to prevent mosquitoes from biting. It is hypothesized that the boron-doped graphene oxide will block the mosquito's sense to detect human odor, and therefore stop the biting. To test the different materials, cheesecloth, wet and dry graphene oxide, wet and dry boron-doped graphene oxide, and wet and dry graphene will be put on skin inside a container with mosquitoes to test to see which cloth prevents the most number of bites. No cloth will be an additional control. Next, graphene-lined clothing with each material will be tested. Effectiveness after washing the materials will also be tested. It will likely be found that dry boron-doped graphene oxide will be the most effective in preventing mosquito bites. It will also be found that the mosquitoes will act differently around this material since they would no longer come close to the skin since the boron doping in the graphene oxide will block their sense to detect the human odor. Washing is not expected to change the effectiveness of the clothing. This study will help stop the spread of mosquito-borne diseases, such as malaria and West Nile virus. It will help people who know they will be exposed to mosquitoes to protect themselves against bites and potentially harmful diseases.

Sacred Heart Greenwich
Teacher: Mary Musolino

Lee, Danielle — Project # 112

Developing Polymer-Enabled Hydrogels Using Advanced Functional Materials for Improved Efficiency of Solar-Thermal Desalination

Water scarcity is one of the foremost challenges of the 21st century. A promising sustainable method to extract freshwater from saltwater is solar-thermal desalination (STD). Solar-thermal desalination channels solar heat to distill saltwater, but its conversion efficiency is restricted due to the thermodynamic limit of the heat of vaporization. Addressing this problem is crucial to the commercial viability of STD. A possible solution to this problem is to synthesize a polymeric material that would be placed over large bodies of saltwater so that these bodies of water will evaporate with higher efficiency during solar desalination. A black hydrogel was synthesized using chitosan, polyvinyl acetate, and polypyrrolidone. The energy consumption per mass of released vapor of the water with the hydrogel on top was calculated and compared to bulk water. Data trends thus far are supporting the hypothesis. The water with the hydrogel placed on top is showing lower energy consumption per mass of released vapor compared to bulk water. Also, when observed under an infrared camera, the surface of the water, which absorbs heat during STD, the hydrogel shows less parasitic heat losses that also limit the efficiency of STD. This hydrogel has the potential to dramatically improve the efficiency of STD when it is placed over water. Because STD is a much more sustainable way to desalinate water compared to current methods, the improvement of its efficiency through the enhanced harnessing of solar heat and resulting commercial viability is a very promising approach to address the global water crisis.

Amity Regional High School
Teacher: Catherine Piscitelli

Lee, Owen — Project # 113

Finding if Social Media is Beneficial or Detrimental to Teens' Overall Daily Moods

This research project is to determine the impact social media has on the daily moods of teens enrolled in a local regional high school. The motivation behind this project is because teens utilized social media the most. A multi-question survey was created that shows what impact social media has on the mood of the respondents, and how many people use these apps/platforms. The statistical analysis/data through google sheets will display whether the answers reflect a mostly positive or negative mood towards these social media apps. Data gathered from the multi-question mood survey indicated that social media is overall, beneficial to the moods of teens. Based on the data, social media boosts mood rather than suppressing it. Therefore, this data will be used to inform teenage students everywhere to use social media's many benefits to boost their mood if they are not feeling great.

Amity Regional High School
Teacher: Nicholas Shamp

Lee, Sean
Sugarmann, David — Project # 114

Optimizing the Design of the Lateral Reconstruction Nail with the use of Finite Element Analysis in Order to Improve the Healing Process of Subtrochanteric Femur Fractures

The lateral reconstruction nail (LRN) is an implant device that has been designed to aid the healing process of subtrochanteric femur fractures. The current LRN model has failed to support patients' weights before the fracture is able to fully heal. This problem developed the goal of this research, which is to use Finite Element Analysis (FEA), an analytical technique used to calculate and identify an object's areas of weaknesses, in order to optimize the reliability and effectiveness of the LRN. It was hypothesized that if modifications are made to the LRN based on identified weak areas, then the nail's durability will increase. The independent variable of the study was the modifications made to the LRN. The dependent variable was the strength of the model, measured using stress and strain data. To conduct this study, a series of FEA tests were run on a CAD model of the current LRN through the computer program "Solidworks." With the combination of this data and literature review, individual modifications were made to the implant's CAD model. The new design was then imported into "Solidworks" to run the same tests again. This study has designed a new LRN with increased durability. Future research includes making a physical version of the LRN and testing it using cadaver femurs. With this research, patients that suffer from subtrochanteric femur fractures of all weights and bone strengths will have the opportunity to experience a more reliable and safe healing process.

Amity Regional High School
Teacher: Catherine Piscitelli

Levinson, Reed — Project # 115

Controlling Robotic Hand Prosthetics using EEG and Computer Modeling of Movement

The motivation for my project is my fascination of neurorobotics and their application to the development robotics of any scale: micro, human, or macro. The development and study of this field can lead to the advancement of a multitude of useful robotics, such as neurally controlled nano surgeon robots or hand controlled cranes. My objective is to develop a prosthetic hand that is controlled by neural waves from the brain that map out and simulate identical movement from a simulator's hand. One completed experiment that is similar to my study was "Decoding Imagined 3D Arm Movement Trajectories From EEG to Control Two Virtual Arms" by Attila Korik et. al. The objective of this study was to accurately map arm movement of a simulator using decoded electrical transmissions from the brain. EEG translation will be a technique used in my study in order to depict and simulate the modeling of the hand. In the study, the data recorded will be the accuracy of the prosthetic's movement in relation to the real-world, simulated hand's movement (i.e. response time, accuracy of movement, etc.). From this experiment, I hope to learn more about the relation between neural communication from brain to limbs and its applications. If the objective is accomplished, the technology used to control the movement of the prosthetic can be adjusted to apply for other prosthetic limbs. The research would allow for further development into neurally controlled robotics that simulate human interaction with the world on a smaller or larger scale.

Darien High School
Teacher: Christine Leventhal

Levinson, Nick — Project # 116

Responses of black bear behavior and movement patterns to human development in Connecticut

With increasing population of humans and the growing rate of urbanization, large mammals have an increasing likelihood of human/wildlife conflicts. Understanding the behavior and movement of large mammals around new human development is essential to creating effective conservation and management plans. The results of this study will provide a better understanding of bears perceptions and use of human developments and give information to create better wildlife policy. GPS collar data from American black bears will be used to see how food sources and human development affected the movement patterns and resource use across the state of Connecticut. It is expected that the data will show a positive correlation between the level of human development and avoidance radius of the area. The data is also expected to reflect a positive correlation between an increased need for food and the willingness of bears to enter into human developments. Data from this study will show bears are exhibiting altered movement patterns as they avoid human developments during the day. They will also show an increased interest in entering human developments when food sources are scarce. The information from this study will be able to help create predictions of how the increasing bear population will continue to move through the state.

Darien High School
Teacher: Guy Pratt

Li, Daniel
Bachman, Jeremy — Project # 117

Computational Design of the Alcohol Dehydrogenase Enzyme

Methanol and ethanol are widely used in industrial and household settings, both metabolized by the alcohol dehydrogenase (ADH) enzyme. When metabolized by ADH, methanol and ethanol produce formaldehyde and acetaldehyde, respectively. These highly toxic agents can produce can permanently damage the body. The purpose of this project is to develop a competitive inhibitor of ADH that will delay the production of formaldehyde and acetaldehyde, reducing the toxicity in the process. Tested inhibitors will be selected from manually modified molecules derived from methanol and ethanol. These molecules will have their inhibitory properties tested by VEGA ZZ, a computer-based molecular modeling toolkit that can calculate how effective the molecule inhibits the ADH active site. Data analysis will be completed on the results produced from VEGA ZZ, and an ideal inhibitor will be selected based on the calculated efficacy of inhibition. Several potential competitive inhibitors have been determined by the VEGA ZZ program. Data trends thus far show that the binding affinity and effectiveness of the most promising competitive inhibitors are derivatives of the ethanol molecule. The constraints for bio-availability and toxicity will be applied to determine the best inhibitor.

By creating an orally bio-available ADH inhibitor, treatment can be efficiently administered to patients without risking ethanol poisoning or an IV delivery. Due to the magnitude and intensity of alcohol poisonings, preventing these poisonings will save the lives of many.

Amity Regional High School
Teacher: Catherine Piscitelli

Lim, Alexander — Project # 118

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

Each year, hundreds of school shootings occur and, subsequently, hundreds of deaths. Along with this, a multitude of public schools are severely under-budgeted meaning that security might not be an utmost priority. The use of automated drones could provide a solution to public schools' limited budget by replacing and or utilizing the presence of an already existing security personnel. I will build a single drone that will function in tandem with an integrated camera system during short tests. The tests would show the drone and camera system's effectiveness in person identification, flight duration with different batteries and weather conditions, and overall practicality. The tests would also show possible issues to troubleshoot and improve upon in order to make the drone perform more optimally. In this experiment I expect to have a drone and camera system working in tandem to detect and track an assailant. I will test battery life, tracking and detection ability, and GPS tracking to provide a proof of concept that such a system can be effective in providing near autonomous security.

Using drones would provide security for a school while eliminating the necessity to pay recursively for security. In addition to being able to intercept an assailant without utilizing a human, response time would be reduced. A drone could also track an assailant until that person is, at a minimum, warded away. Combined, all of these factors would reduce the number of school shootings in a cost effective manner.

King School
Teacher: Victoria Schulman

Lin, Andrew   Project # 119

The effect of colony size on social immunity in Atta Texana Leafcutter Ants.

Leafcutter ants must constantly compete with Escovopsis, a parasitical fungus that infects fungal gardens. Leafcutter ants have developed many ways of reducing the infection of this pathogen. Few studies have shown the relationship between these methods and their effectiveness based on the size of a colony. This experiment aims to show the relationship between the size of a colony of genus Atta leafcutter ants and the infection rate of the Escovopis. In this research proposal, Colonies of Atta Texana will be used. Colony size will be determined by volume of fungal gardens. Colonies will be given a week period to adapt to a housing unit before a cultivated Escovopsis fungus will be added to the fungal gardens. Results will be measured by counting the amount of dead ants infected with the Escovopsis fungus by the end of a one week period. In this study, it is expected that colonies of a greater colony size will have a smaller fungal death ratio. Social immunity to diseases and pathogens tends to be more effective as the amount of individuals of a group increases. Ants, and especially leaf cutter ants, show many similarities with human society. The results of this experiment may shed light on the similarities of eusocial insect social immunity and social immunity present in our society.

Darien High School
Teacher: Christine Levanthal

Lindell, Samantha
McTigue, Katherine   Project # 120

The Distribution and Fluctuations of Dissolved Oxygen at Different Locations Northeast of New York City along the Long Island Sound

Hypoxia is low dissolved oxygen (DO) which reduces habitat quality and can result in an aquatic life decline. Low DO levels in water are caused by the decay of excessive amounts of organic matter and pollution. The increase in sewage and greenhouse gases is causing a decrease in dissolved oxygen, also resulting in mass fish kills along the Long Island Sound. It is predicted that as water is collected every 15 miles from New York City to Fairfield County, the amount of DO in each collection will show a significant increase because the DO in New York City is still depleted; Long Island Sound nitrogen and temperature levels (especially in NYC) are increasing which can be detrimental to aquatic life and in turn increase algae blooms. This research will show the public the consequences of our ecological footprint and the importance of spreading awareness on the subject, while furthering research toward understanding dissolved oxygen levels and treatments.

Darien High School
Teacher: Christine Leventhal

Liu, Daniel   Project # 121

Determining the Optimal Time Interval Between Visual Reminders to Maximize the Retention of Memory Determining the Optimal Time Interval Between Visual Reminders to Maximize the Retention of Memory

Many people struggle to remember things daily and lack a method to maximize the retention of new-learned facts or assigned tasks. There has been little research conducted on the impact of the time between reminders on the retention of new knowledge. The purpose of this experiment was to find the optimal time between reminders for an individual to recall information.

 First, the participants were separated into a control group (with no visual reminders) and 5 test groups. Next, they were instructed to look at a paper copy of their assigned sequence at given time intervals that varied for each group. After going through their assigned reminders, each group waited an hour before taking a 7-question quiz on the sequence. The participant's results were scored out of 7. Data trends thus far indicate that the time between each reminder doesn't significantly impact one's ability to remember a sequence. At the moment, the majority of the participants had perfect scores on the test despite having different reminder intervals. This study can help people to better retain new information and to recall previous facts. It may establish a specific method in the memorization process that will benefit students or anyone else devoted to learning.

Amity Regional High School
Teacher: Katherine Pisicitelli

Liu, Allen   Project # 122

A Bluetooth Blocker Box to Protect Bluetooth Devices in Cars

With the development of bluetooth scanners to be cheaper and easier to use than ever, burglars can easily detect bluetooth devices in a vehicle. The solution created is a box, 10" long, 15" wide, and 3" tall bluetooth blocker. The blocker is used to easily store devices, without the risk of a burglar detecting it. The box is made out of ¼" stainless steel, which is layered interiorly with copper foil. All of the sheets of steel are connected with 3 steel screws on each perpendicular angle. However, the uppermost part of the box is connected by a hinge, with a hook latch to close and secure the box. The most interior layer is lined with a soft silk sheet, protecting devices from scratches. The most exterior layer is layered with a black rubber mat, making the appearance of the box subtle. The box is used in the feet area of the passenger seat, and is small and strong enough to comfortably support a person's feet in the car. Data trends thus far show that a bluetooth speaker is not able to detect a bluetooth device in the box as near as 1 foot away, where as without the box, the device can be detected from over 30 feet away. This solution will help reduce the amount of burglaries with the use of a bluetooth scanner, creating a safe and affordable solution to an ever-growing problem.

Amity Regional High School
Teacher: Nicholas Shamp

Liu, Yuqi   Project # 123

Seawater and Sunlight: Constructing A More Efficient Solar Still by Increasing the Movement of Water

The global water crisis is the biggest resource threat our world faces today. Unfortunately, 98% of our water is salty and undrinkable. Thermal distillation, an effective desalination method, purifies water by simulating the natural water cycle. However, it is an energy-costly process, because the water must be heated to high temperatures. A solar still is a thermal distillator that uses radiant energy, therefore saving power at the cost of its efficiency. This project used a novel approach to increase the still's evaporation rate by increasing the surface area of the water with a submersible aquarium pump. The still used a fill valve, so it could run without frequent human intervention, and its walls were acrylic sheets. A small-scale prototype of this still was tested using a heat lamp and a large container of water mixed with salt (to mimic ocean water). Its efficiency was judged by the amount of water it could produce proportionally compared to commercial stills; for the still's size, it produced a significantly larger amount with the pump than the 4 liters per 5 kWh per m2 of the commercial standard. Most importantly, the salinity of the water (which was measured using a hydrometer) was less than 1 ppt in all trials. The still worked as intended. It effectively provides a medium between energy-inefficient thermal distillators and production-inefficient solar stills.

Amity Regional High School
Teacher: Nicholas Shamp

Liu, Maggie   Project # 124

The Effect of Duckweed and Frogbit through Phosphate Phytoremediation

Phosphates are essential for plant growth, however, when they amass and become too concentrated in a water source it causes eutrophication. This causes the algae overgrowth, which depletes the oxygen from the water source, resulting in harming wildlife. The purpose of this research is to determine which free-floating plants (duckweed [Lemna minor] or frogbit [Limnobium laevigatum]) is best suited at removing phosphates from fertilizer runoff and their maximum removal efficiency.

I measured the amount of phosphate in the water after 15 days. There were two control groups that only contained plants. All groups were kept in the same location. Three trials were conducted for each experimental group and one for the controls. Each trial had 1 cups (8 in total) filled with water (.2 L), 10 pp/m (Humboldt Bloom Natural 0-10-0), and 50g of plant matter.

Data trends thus far shows that frogbit is more efficient at removing phosphates, because their longer roots allows them to have access to the phosphates far below the surface levels. Henceforth, frogbit can be used to phytoremediate aquatic environments that are currently suffering from eutrophication through time increments, to assure that the dissolved oxygen level will not drop harshly.

Amity Regional High School
Teacher: Nicholas Shamp

Liu, Nicholas   Project # 125

Testing the Viability of Native Plant Revegetation for the Supression of Invasive Japanese Barberry (Berberis thunbergii) in Connecticut Meadows

The control of invasive species can sometimes be assisted through active revegetation of native species, but not for all invasive species. One invasive species of concern in Connecticut is Japanese Barberry (Berberis thunbergii), known for its impact on soil biota (i.e. increasing nitrification and pH) and the public health threat it poses as a host of the tick species (Ixodes scapularis) capable of spreading Lyme disease (Borrelia burgdoferi). While methods for its removal have been developed, whether or not active revegetation can assist in the prevention of its regrowth has not been widely studied. This study aims to find if the planting of seeds from native species in areas affected by B. thunbergii can aid in the control of B. thunbergii. During the growing season, all B. thunbergii in a Connecticut property called Mathe Meadows will be cut. On one meadow, seeds of the native plants chosen will be planted where the B. thunbergii is removed, while on the other, no treatment will be given. The biomass of B. thunbergii at the end of the growing season at both locations will be measured and compared. It is expected that the biomass of B. thunbergii in areas where native seeds are sewn will be significantly lower than in areas where native seeds are not sewn. The results of the study will potentially aid in the methodology of ecosystem restoration efforts in local areas impacted by B. thunbergii.

Darien High School
Teacher: David Lewis

London, Philip   Project # 126

Developing and Testing a 3D Printed Structure for Use as a Sea Ice Substitute

The Arctic is melting fast; it is projected to be nearly gone by 2035. The rapid loss of sea ice has become a growing problem for marine mammals and ecosystems of the Arctic and surrounding regions. The goal of this project is to create a baseline 3D printed structure that can serve as a substitute for sea ice when extrapolated to a larger scale with practical materials.

The optimal design was created using information collected from research articles and an element analysis software (SAP 2000). Multiple methods of testing were then used to analyze the printed structure. A comprehensive buoyancy test was performed, a strength test to determine structural integrity, as well as a puncture test to determine the designs ability to remain buoyant when compromised.

The results of these tests were analyzed mathematically to determine the specifications of the model. With the results from the buoyancy test, weight capacity of any sized print can be determined. An analysis of the prints' structural integrity and puncture test results as completed and compiled. It is predicted that these experiments will provide an accurate standard for artificial sea ice design, which can be improved upon with further development. If applied, effective applications of this 3D printed structure include strategically placing platforms in targeted areas with at risk marine mammals. By doing this, the platforms would use funds and resources efficiently while still having have the greatest impact on arctic ecosystems. Additionally, this design could be used in future ocean based construction projects.

Amity Regional High School
Teacher: Catherine Piscitelli

Lopez del Punta, Ana Project # 127

The Effect of Blue Light on The Cerebral White Matter Integrity of Children Whose Mothers Were Exposed While Pregnant

Most people today are exposed to blue light through electronic devices. While studies have shown that exposure to blue light decreases melatonin and white matter integrity, this study will look specifically at mothers who were exposed to blue light when they were pregnant, in order to discover if the baby's brain experienced decreased white matter integrity. It is hypothesized that there will be a decrease in integrity in the baby's brain due to reduced melatonin in the mother. This will be tested in two different parts. The first part will be to survey mothers for information on how many hours they were exposed to blue light when they were pregnant.

 Secondly, scans of the babies' brains will be examined to see if there has been decreased volume to their white matter. This will be correlated to the hours the accompanying mothers have been exposed to blue light while pregnant. Studies have shown that the brain is affected by blue light even if it does not have direct contact with the eyes, which proves that the baby might be affected even if they are not looking at the light.

 Moreover, blue light lowers melatonin in the mother, which might have the same implications in the newborn. Overall, this study will shed additional light on the potential implications of the use of electronics in today's society, and how it may not only affect the user, but also the user's unborn child.

Sacred Heart Greenwich
Teacher: Mary Musolino

Lowder, Scott Project # 128

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

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 has become an increasing issue of concern. Currently, statistics in the United States detailing car crash-related reports have specifically highlighted the texting crisis as one of the leading causes of death for teen drivers with cellular devices being responsible for eleven deaths daily. To restrain individuals from their phones, a prototype was developed for last year's project to require the driver's phone to be stored within a container before driving to prevent any attempt of distraction on the road. As a continuation project, the main focus of this year was to install the locking container into an automobile and to collect data on the project as well as make it manufacturable. For installation purposes, the locking container was now constructed into layers using 3D printing. Additionally, for organizational purposes, the wiring used in the prototype for separating the ignition switch's energy from the car starter as well as other components were now replaced with PCB boards. Finally, to test the performance of the final product, several trials were conducted to ensure that the phone was locked while driving. The main implication for this project is to prevent future teen driving-related car crashes involving the distraction from their cellular device and save lives. However, there are several other implications for this project besides teenagers.

Amity Regional High School
Teacher: Catherine Piscitelli

Lowe, Daniel
Project # 129

CD141(+) stimulation to induce CD4(+) release of IL-4 and IL-13 to fight a multitude of diseases

Immunotherapy can be used to fight many different types of threats, making it a very versatile form of disease treatment. By utilizing drugs or other methods, the immune system can be boosted or modified in order to fight a disease more effectively. A previous study has shown that when exposed to influenza, CD141 is stimulated, which subsequently leads to CD4 releasing IL-4 and IL-13. IL-4 and IL-13 are secretions released from CD4 that initiate a potent B cell and T cell response to a foreign bacterium or virus. This study aims to see if CD141 can induce a similar immune system response when exposed to many types of diseases. To test this, humanized mouse lung tissue with CD141 extracted from human blood and lung tissue samples, will be exposed to small cell lung cancer tumor, ebola, influenza, and pneumonia. It is expected that the influenza will increase the IL-4 and IL-13 secretion the most. This proposed research could be repeated with many different forms of diseases to see which disease elicits the greatest immune system response. This research is important as it is a basis to the formulation of a drug that could mimic the antibodies of a disease in order to elicit an effective immune system response to fight a foreign virus or bacterium.

Darien High School
Teacher: Guy Pratt

Lu, Kevin
Project # 130

Analyzing The Relationship Between Stress, Electronic Usage, and Mood With Regards To The Fear of Missing Out and Social Anxiety

The Fear of Missing Out (FOMO) is a recent concept describing one's degree of proneness to anxiety caused by the perception that others are engaging in activities one cannot. Other measures such as social anxiety (SA) and stress have also been shown closely relate to FOMO levels. Collectively, these social factors are often attributed to the rising epidemics of electronic usage in contemporary society. The aim of this experiment is to evaluate the degree of relationship between social factors like stress, mood, and electronic usage (independent variables) with regards to trait moderators such as FOMO and social anxiety proneness. To achieve this, a group of participants was assembled with informed consent and an anonymous online survey was distributed to each containing compiled questions from standard psychological tests collectively measuring FOMO, SA, and personality valances. A series of three short surveys measuring mood, stress, and smartphone usage were successively distributed over a week. Participants were disbanded, and multivariable regressions were subsequently run on each independent variable to determine its relationship with other IVs. This degree of change (the dependent variable) was then measured against strong and low valance FOMO and social anxiety groups to determine the relative correlation. Current data trends suggest that participants with high FOMO and SA experienced greater degrees of relationship between stress, mood, and electronic usage levels. The implication that FOMO and social anxiety are trait moderators on stress and electronic usage could allow for future research devising means to reduce these factors and remedy the effects

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Raymond — Project # 131

Using Pure and Copper-doped Catalysts to Degrade Lignin Polymers into Biofuel

As scientists search for renewable energy sources to replace fossil fuels, biofuel presents a sustainable and clean alternative that is derived from dry plant matter. This lignocellulosic biomass is composed of cellulose, hemicellulose, and lignin. Lignin polymers compose around 30% of plant biomass but are largely discarded in biofuel conversion due to their complicated structure and rigidity. The purpose of this experiment was to determine the most effective and efficient catalyst to use in a reaction for degrading lignin polymers into biofuel. Lignin from poplar sawdust was dissolved in methanol and mixed with 0.5 g of catalyst. This mixture was heated to 200 degrees C for 4 hours, cooled, and then filtered through vacuum filtration. The solids were dried and massed to determine degradation yield, and the liquid was distilled using a rotary evaporator to remove methanol. The remaining oil was massed to determine the final fuel yield. Gas chromatography-mass spectrometry (GC-MS) data collected on the liquid oil was then analyzed to determine the chemical makeup and oxygen content of the products. Current data trends show that reactions done with pure HZSM-5 have higher oil yields and degradation yields, contrary to previous studies supporting the good catalytic qualities of copper. However, GC-MS data on chemical content is currently being processed, so it has not been analyzed yet. Once cheap and efficient industrial methods of producing liquid biofuel are refined, these renewable sources can potentially replace fossil fuels, reducing CO_2 emissions and atmospheric pollution.

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Tracy — Project # 132

Using Protein Core Density to Predict Model Accuracy

Accurately modeling proteins is essential for understanding their functions and features. Critical assessment of protein structure prediction (CASP) is a database models created using any modeling method. Model accuracy is measured using root-mean-square deviation (RMSD) and global distance test (GDT). The protein core has consistent density between different proteins. Density can be measured by packing fraction (PF) and overlap energy (OE). There are two primary aims of this project: 1. To compare accuracy of older CASP results from 2004 to newer results from 2014, 2016, and 2018. 2. To determine if there a relationship between modeled protein core accuracy and model accuracy. The independent variable is the year the model was created. The dependent variable is model accuracy measured by RMSD and GDT, ang PF and OE accuracy. It is hypothesized that newer models will have greater accuracy compared to older ones. PF and OE for data from various years will be calculated and plotted against actual values. This will be used to determine the similarities and differences between the old and new CASP results, showing any improvement. A machine learning algorithm will then be developed using Python that relates PF and OE with the RMSD and GDT. This will help determine how the accuracy of protein modeling has changed over time and identify possible improvements. The machine learning algorithm can be used to predict how accurate a prediction is when a finalized model has not yet been created.

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Brodey — Project # 133

Analyzing the Capacity of VA Health Centers to Properly Treat Neurological Diseases Based on Veteran Needs using Survey Data

The Veterans' Administration (VA) provides medical care to many veterans through a system of Health Centers distributed across the United States. A sizeable proportion of the veteran population at the VA suffer from neurological diseases. Despite the amount of people who need treatment, their access to proper neurological care is unknown. This study sought to find and identify gaps in healthcare for the veterans.

First, a literature review was conducted to define a best practice standard regarding neurological care. Afterwards, data from VA health centers was analyzed to determine if the VA has enough capacity to properly treat neurological diseases. Further analysis was done for regional and socioeconomic differences on neurological care capacity. Efficacy of the treatment of each disease was based on whether the values in the survey were meeting best practice values.

In addition to general population statistics, trends in results thus far show that the VA lacks adequate neurologists and treatment equipment to properly manage disorders like headache, stroke, epilepsy, Parkinson's, and ALS, which means that the demand for treatment is higher than the supply. Diseases were chosen for prevalence at the VA.

The results of this study will help provide an outlook on the state of neurological healthcare at the VA by highlighting gaps in neurological healthcare. Furthermore, the findings can give a clear direction for future improvements and investments in the VA Health Centers.

Amity Regional High School
Teacher: Catherine Piscitelli

Lu, Melinda — Project # 134

Creating a Salt Water Battery with Easily-Accessible Materials

Properly disposing regular lithium-ion batteries is more costly than manufacturing them, so most get thrown into landfills and take hundreds of years to decompose. Because of this, there are already batteries made out of more biodegradable materials such as wood and sugar. However, the materials used to make these bio-batteries are expensive and hard to get access to. In this project, a battery made with easily-accessible and affordable materials was created. For the first phase, it was created using aluminum as the anode (usually zinc but aluminum is more easily-accessible than zinc), copper as the cathode, and a saltwater electrolyte. The solution was determined by testing different types of salts: sodium chloride, magnesium sulfate, and potassium chloride fully dissolved in water at a three to ten ratio, salt to water, in grams. The sodium chloride solution generated around 0.3V which was the second highest voltage, and it's more easily accessible than the other salts. In the second phase, the battery was developed to generate 1.5V using a salt slurry. Additionally, it was made the similar weight and size as a regular, household battery. These batteries can be used for conventional household devices (flashlights, radios, etc). Additionally, this project creates a convenient, eco-friendly option to the harmful normal batteries.

Amity Regional High School
Teacher: Nicholas Shamp

Luo, Ningxin   Project # 135

Investigating the Roles of Astrocytes on Shaping T-cell Function in the Human Brain

Tissue-resident T-cells are responsible for immune surveillance but can differ in behavior depending on the tissue's unique, homeostatic immune state. In the absence of disease, many peripheral cells in the CNS are suppressed to prevent unnecessary inflammation. Astrocytes are abundant cells in the brain that have a variety of tasks, such as axon guidance and synaptic support. Therefore, metabolites, cytokines, and other factors produced by astrocytes may impact T-cells that enter the brain, resulting in a tissue-specific T-cell state. The purpose of this project is to understand the physiological impact of astrocytes by examining how astrocyte conditioned media (ACM) affects T-cell function in the absence of disease. Because astrocytes play an important role in brain homeostasis, it is hypothesized that their presence will induce coinhibitory expression in CD4+ and CD8+ T-cell receptors to prevent inflammation. Astrocytes will be cultured in media to yield the ACM. Isolated CD4+ and CD8+ memory T cells will be cultured for 48 hours in increasing amounts of ACM to measure a dose-response. For data analysis, qPCR will yield relative gene expression, extracellular and intracellular surface staining of flow cytometry will measure proliferation, and ELISA will be used to quantify cytokine secretion. By examining what factors affect immune surveillance in the absence of disease, this project can provide a greater understanding of processes in neuroinflammatory diseases and determine what types of metabolic environments and cytokines exist to better model T-cells in vitro.

Amity Regional High School
Teacher: Catherine Piscitelli

Luo, Margaret   Project # 136

Investigating the impact of mitochondrial genome stability on cancer proliferation by observing correlations between mitochondrial degradosome levels in cancerous and non-cancerous cells

Cancer is uncontrolled cell proliferation caused by genome instability that leads to accumulation of genetic damage. Previous studies have observed links between mitochondrial health and cancer development. One contributor to mitochondrial health is the mitochondrial degradosome, an exoribonuclease complex composed of hSUV3 helicase and PNPase. This complex regulates mitochondrial genome stability by preventing mitochondrial mRNA accumulation. The purpose of this project is to investigate the impact of mitochondrial genome stability on cancer by observing correlations between mtDegradosome levels in cancerous and non-cancerous cells. It is hypothesized that if a cell is cancerous, then it will have lower levels of mtDegradosomes than healthy cells and its mitochondrial genome will be unstable. The independent variable of this project is whether the cells being studied are taken from a tumor or from healthy tissue, and the dependent variable is the mtDegradosome expression in the sample. This will be tested by using a qPCR analysis to indirectly measure the amount of degradosomes in a cell by measuring the mRNA precursors to the complex. Samples of both cancerous and non-cancerous cells will be analyzed. If time allows, a PCR-SSCP analysis will also be used to measure genomic stability in both sample types. Samples will then be compared to evaluate possible correlations. All this will be done by the student experimenter. Projected outcomes are expected to show that cancerous samples have lower levels of mtDegradosomes than healthy samples. This study would contribute toward our understanding of cancer and how it is impacted by mitochondrial genome stability.

Amity Regional High School
Teacher: Catherine Piscitelli

Luo, Danlin   Project # 137

Research Proposal, Engineering, Physical Science

Using a Computer Model to Optimize the Number of Autonomous Vehicles Required to Send Students to School

With the spread of self-driving cars, it will become common for people to use them every day. However, models must be used to ensure the safety and efficiency of these cars. This research will focus on finding the optimal number of self-driving cars needed to send students to school in the morning within a certain time range. Using C#, a computer model with major simplifications will be created to simulate the process of autonomous cars picking up and dropping off students at school. The map will be substituted for a simple grid with cars traveling along a linear path. Cars will be sent out from the school and adjusted to find the least number of cars needed. It is predicted that the least amount of cars needed to send all students to school within a certain time frame will be found. This type of system can later be used for not only school systems but also car rental companies with the spread of self-driving cars to maximize profits and minimize costs of transportation. This system may also be applied to other forms of transportation such as buses, revolutionizing the way people travel.

Ridgefield High School
Teacher: Ryan Gleason

Ma, Peien   Project # 138

Research Proposal, Science, Health and Medical

Investigation of the differential gene expression and its regulation in prostate cancer

Most men develop prostate cancer after 60 years old, but many are benign and do not require chemotherapy, radiation or surgery. Current diagnosis of prostate cancer uses prostate-specific antigen technique. It has a high false positive rate which causes over-treatment and unnecessary suffering for patients. We hope to address this problem by using epigenetics methods.

In this research, we expect to find the key gene whose over-expression could play an important role in the progression of prostate cancer.

By identifying molecular markers for early stage of prostate cancer and determining its potential malignancy, current problems of high false positive rate can be addressed. Based on our research, more precise treatment of prostate cancer can be developed.

Hamden Hall Country Day School
Teacher: Lei Gu

Maerean, Ellen — Project # 139

The effect of rhythmic complexity in rhythmic auditory stimulation on the duration and number of freezing episodes in PD Patients

As patients reach the later stages of Parkinson's Disease (PD), they are more likely to experience episodes of freezing of gait, which is the decreased ability to walk. To prevent freezing episodes, patients undergo rehabilitation using rhythmic auditory stimulation (RAS), where patients who typically do not experience freezing walk to a metronomic pulse to increase gait velocity. RAS could be made more effective for patients who already experience freezing episodes.

The purpose of this research is to determine the most effective set of rhythmic complexities for patients with freezing episodes. The initial number and duration of episodes will be measured before the experiment, and multiple groups of PD patients each go through RAS with a set of composed music, each differing in rhythmic complexity. After going through months of RAS, the number and duration of freezing episodes will be measured.

It is hypothesized that as complexity of music in RAS increases, the number and duration of freezing episodes will decrease. Prior research has supported the idea that the rhythm in RAS replaces the impaired internal stimuli of the Parkinsonian brain. The increasing rhythmic complexity will also provide a feedback system as the brain responds to the increasing levels. By determining the most effective set of rhythmic complexities for PD patients, Rhythmic Auditory Stimulation therapy can be made even more effective. This research can be implemented in physical therapy, and could further prevent freezing of gait and potential falls or injuries.

Ridgefield High School
Teacher: Patrick Hughes

Malik, Aamnah — Project # 140

Creating an Application To Help Researchers More Efficiently Calculate Tumor Control Index

In 2017, the Tumor Control Index method of measuring tumor growth was developed and has since been used by many laboratories around the world. This index is comprised of three distinct values, the Tumor Progression Score, Tumor Regression Score, and Tumor Stability Score, which provide a complete picture of nearly every aspect of tumor growth in large numbers of animals.

However, the method is difficult to use and this is limiting its application. The purpose is to develop an application that enables smooth and easy usage of this important tool. The constraint is that the TCI tool is not easy to enter data, to use, and to obtain a TCI value. The criterion for success is that as a result of my work, it should become easier to use.

Under the guidance of Dr. Pramod Srivastava and others if necessary, I will improve the TCI tool and write appropriate code for its usage. My mentors will help me determine what needs to be fixed in terms of how the method to determine TCI can be improved. My role in the project will be to code the app so that it is effective/efficient.

We will provide the application prototype to members of the Srivastava Lab and other labs who work with mouse tumors. The ease and accuracy of use will be determined for the application as the work progresses. This project will help many labs to calculate the TCI score to use in data analysis more easily.

Amity Regional High School
Teacher: Catherine Piscitelli

Mansourian, Emma
Pardo, Taryn   Project # 141

Completed Project, Science, Physical Science

An Evaluation of Fluid Multi-Drug Screening Kit for Preliminary Drug Detection

Within the last decade, the number of automobile accidents caused by a driver under-the-influence has doubled. In response to these drug-related accidents, disposable drug tests have been developed for on-road detection. The purpose of drug testing is to prevent future drug-related automobile accidents. This drug test is designed for preliminary drug detection as it is both fast and simple. This drug test is designed for preliminary drug detection as it is both fast and simple. The hypothesis of this experiment states that the Saliva Confirm Oral Fluid Multi-Screening Drug Kit will be most accurate when testing samples containing the highest concentrations of drugs. The test was used to evaluate fluid samples containing drugs from the following classifications: barbiturates, benzodiazepines, cannabinoids, opioids, and ethanol. Certified drug free saliva samples were spiked using a variety of drug concentrations, including 100, 1000, 10,000 and 1,000,000 microL/ng. Analytes were spiked by mixing the saliva and the concentrations in a petri-dish. The results of the experiment indicated many of the metabolites that derive from the original drug were not able to be detected. While the higher concentrations were found to test positive more often than lower concentrations, the dosages were too high to be found in a human and therefore did not reflect the true accuracy of the test. This oral fluid drug test is not an adequate tool for preliminary substance detection because it did not respond accurately to both high and low concentrations of drugs.

Darien High School
Teacher: Christine Leventhal

Marin, Ella   Project # 142

Completed Project, Science, Environmental

Evaluating Sea Level Trends Across the United States East Coast Over the Past Century

As Climate change continues to intensify, there is an increased threat to coastal regions from sea-level rise. Coastal cities around the globe struggle to plan for the future as the sea level rise rates have been different in different cities. Further, it is unknown how the sea levels will change in relation to new emissions reductions. Although new standards have been agreed upon from the Global Climate Summit, it is unclear whether or not countries will actually meet these standards. The purpose of this study is to examine previous trends of sea-level rise and use those trends to then model future trends based on various scenarios. These scenarios would be specific to different global emission trajectories to account for the unpredictability of the future. It is hypothesized that when modeling based on the new standards, sea levels will remain stagnant whereas when modeling emission levels above the new standards, sea levels will accelerate. The NOAA Tides and Currents database was used. Data from previous decades were collected in all available locations along the East Coast. These models were made using the USDA Climate Change Resource. These models were run under the various emission reduction plans. All data was evaluated for statistical significance using a T-test and $R2$ values were used to assess the linear relationship. Thus far, findings are consistent with the hypothesis. The results of this project will help policymakers understand the outcomes of various emission reduction plans and help cities prepare for sea level rise.

Amity Regional High School
Teacher: Catherine Piscitelli

Marin, Audrey   Project # 143

Completed Project, Science, Health and Medical

Developing an Assay to Identify a New Class of Anti-HIV Drugs

According to the Centers for Disease Control and Prevention (CDC), an estimated 1.1 million American citizens were infected with Human Immunodeficiency Virus (HIV) at the end of 2016. HIV is a retrovirus that requires multimerization of the regulatory protein Rev to replicate and infect other cells. The firefly split-luciferase complementation assay was used because the luciferase enzyme can produce light when the two parts of the enzyme (A and B) are brought together. Plasmids were constructed by fusing luciferase (A or B) to Rev (wild-type or mutant). These plasmids were inserted into human (293T) cells. If the Rev molecules bonded to each other, then luciferase A and B were brought together, producing light. To detect the light, the cells were lysed and exposed to reagents to trigger light production. The amount of light produced from the assay indicated the degree of Rev multimerization. A variety of Rev proteins were fused to luciferase and tested in a multitude of trials. This variety included non-functional Rev, genetic mutated Rev, and wild-type Rev. The positive control, wild-type Rev, was found to produce the highest RLU (relative light unit) values. Mutated Rev struggled to produce any light at all. Trends thus far show that the firefly split-luciferase complementation assay was consistent in testing Rev multimerization. Without Rev multimerization, the HIV virus remains dormant within the nucleus of the cell. The implication of this research is to develop a medication that can disrupt Rev-Rev multimerization through use of the complementation assay.

Amity Regional High School
Teacher: Catherine Piscitelli

Martinez, Nicholas, Ayeleke, Ibukun, Escoba, Jhon, Mateo, Jelenna, Depina, Jaida and Henry, Caree   Project # 144

Completed Project, Science, Environmental

Syrian Soil Case Study: Employing Hamster Manure as an Answer Towards Soil Erosion through Examinations of Modified Diets

Last year, one of the Wolves Society of Agricultural & Biological Engineer's (WSABE) members was Syrian and educated us on the various environmental concerns there - one of which is soil erosion. Since WSABE aims to solve international environmental issues, we choose to concentrate in Syria using hamster manure as a potentially cost-effective alternative to brands. Our examination consists of 4 dwarf hamsters on modified diet treatments (grains, proteins, vegetables, and fruits). We obtained manure from each hamster and applied it to plants with one control (without manure). For a month, we measured the growth rate of the plants to render results. We found hamster manure to be an appropriate solution to soil erosion. Though a higher protein diet produced the most nutritious soil which was defined by producing the highest average growth rates, all 4 diet treatments rendered higher growth rates than the control. Some implications associated with our investigation is the lack of protein in Syria's environment due to climate change which has already occurred. Therefore, a Hamster diet protein plan may not be as viable. However, a high protein based manure could be a cost-effective soil fertilizer.

Achievement First: Amistad High School
Teacher: Anne Johnson

May, Katherine Project # 145

Uncovering Abnormalities in Asteroids Using Asteroid Occultation

Space is widely unexplored and there is a need to define the shape of asteroids in space. This project will determine the shape of asteroids using occultation analysis to potentially discover abnormalities. It is hypothesized that asteroid occultation can be used to discover asteroid irregularities because accurately timing and combining the occultation duration from multiple locations can determine the shape and abnormalities of the asteroid. A PlaneWave 14-INCH CDK F/7.2 telescope, a WATEC 910HX camera, and a video time inserter will be used. The video time inserter uses GPS satellites for extremely accurate time. To observe and analyze an occultation, an observing site and target star will be located. Computer programs will be used to accurately measure changes in brightness of the star/asteroid during the occultation event. Continuous observing will occur and the target star will be recorded for up to two minutes after the occultation. It is believed that the shapes and sizes of asteroids will be precisely measured using asteroid occultation. It is also believed that the discovered shapes and sizes may accurately discover an abnormality in an asteroid such as an asteroid with a moonlet, a contact binary asteroid, or a double asteroid. This study will create an opportunity to study the nature of objects in space and perhaps discover a characteristic or feature previously unknown by using relatively new techniques in space exploration. If the hypothesis is supported, occultation research can be done on other space bodies, such as stars and exoplanets.

Sacred Heart Greenwich
Teacher: Mary Musolino

McCloskey, Avery, DiBiase, Gabby Ulmer, Kellie Project # 146

Ceramic Solutions: Creating a Novel Ceramic Filter for Water Purification and Testing Effectiveness Using Microbiome Analysis

It is estimated that 780 million people in the world are without clean drinking water. This study will help solve the problem of impure drinking water in developing countries by creating and testing a novel porous ceramic filter. It is hypothesized that this affordable and easy-to-use filter will reduce the number of bacterial species in a sample of pond water, thereby also reducing bacterial species in polluted drinking water. Several specialized porous filter pots that could filter water through its microscopic holes were created. Not only did the water filter through the porous ceramic, but the pot's capabilities were enhanced by additional features incorporated within the pot. We tested effectiveness by filtering pond water through the uniquely designed porous filters and then used e-DNA filters and microbiome diversity analysis to determine the reduction in bacterial species. Total dissolved solids were also tested before and after filtering. Our results from the microbiome analysis suggest that one clay pot with specific enhancements had the greatest success in filtering bacteria. There were 5,414 bacterial species in the unfiltered pond water and 1534 bacterial species in the water after it was filtered through the pot with these enhancements. Therefore, bacterial species were reduced by approximately 72%. This study demonstrates an easy and affordable solution to reduce bacteria from drinking water in areas of the world that are in the greatest need for water purification. With its natural and cost-effective ingredients, the enhanced filter pot provides an option for people in developing countries.

Sacred Heart Greenwich
Teacher: Mary Musolino

McGearey, Sadie — Project # 147

Correlation Between Increased Loss Aversion and Patients with Clinical Depression

Anxiety Disorders are known to be one of the most prevalent mental disorders in the United States. Children with behavioral inhibition (BI) face increased risk for social anxiety but not all with BI develop anxiety. Inhibitory control (IC) has been suggested as a moderator of the pathway between BI and social anxiety. This study will test the hypothesis that IC prevents associations between early BI and later social anxiety symptoms. Children will be assessed at a young age (2-3 years) and through a survey, it would be determined if they show symptoms of BI. From the ages 2 or 3 to 10, the children will receive training on enhancing IC through therapy. They will be assessed at age 5, 7, and 10 to determine if the BI symptoms improved or advanced to social anxiety. The results I expect to see is that the symptoms of BI will decrease. This would mean that there would be a way to prevent social anxiety from developing from BI. This study will focus on the prevention of social anxiety and use longitudinal data to determine how the development of IC through intervention will impact BI and later social anxiety symptoms. Even though there are many ways people develop social anxiety, this study could improve the lives of many people even if it does not solve the entire issue.

Darien High School
Teacher: Christine Leventhal

McGrath, Rory — Project # 148

Determining the Optimal Age for Gonadectomy in Dogs

My goal is to determine the optimal age for gonadectomy in dogs. The age at which this procedure is performed impacts the development of many different diseases and conditions. I will be looking for a correlation to find which age gonadectomy is performed at has the least detriments. I will also be weighting which conditions are of utmost importance to prevent in my conclusion. I have anonymously collected data through a survey. A digital copy has been distributed to various Facebook groups in Connecticut and New York. I have also collected data through a physical copy of the survey that has been distributed to different veterinary hospitals in these two states. The questionnaire was optional and anonymous.

It is predicted that in female dogs, gonadectomy performed after their first heat cycle will result in a higher occurrence of mammary carcinoma. In all dogs, early-age gonadectomy will result in acl injury and hip dysplasia. In female dogs, early-age gonadectomy will result in urinary incontinence. The optimal age is predicted to be after 2-3 months for males, but before 6 months in female dogs.

Thousands of unwanted litters can be prevented, allowing populations to stabilize. This can save the lives of many dogs, by preventing shelters from being forced to utilize euthanasia. Additionally, the chance of many injuries and diseases can be lessened. Quality of life can also be improved for pets that suffer from diseases or injuries. Eliminating such issues would also extinguish extra reasons to relinquish a pet.

Ridgefield High School
Teacher: Ryan Gleason

McLemore, Sammi   Project # 149

Research Proposal, Science, Health and Medical

Improving Technology Used to Non-Invasively Link the Brain to a Prosthetic

People around the world rely on prosthetics to complete daily tasks. However, many prosthetics fail to offer easy use. Researchers have started to devise methods that would allow neural connection between the robotic prosthetic and the amputee's brain. Benefits of an embodied prosthetic include increasing a person's sense of well-being and wholeness. The goal of this project is to improve the technology used to non-invasively link an amputee's brain to their prosthetic. An EEG headset with multiple sensors and Brain Control Interface (BCI) would be wirelessly connected to the prosthetic and an electronic device. Matlab, a computer program, with an improved signal classification would decode signals and transfer them to the RF module for control of the prosthetic. Trials would be conducted and the participants would be asked to complete two different tasks. Parameters, regarding time or execution, would be set for data collection. The expected findings is that compared to a headset with one EEG sensor, the improved technology will exhibit a higher accuracy. This would be due to the benefits of improved classification ranges and an altered headset. These findings would support the use of this technology in real world situations. Today, advancements in technology have provided humans with many solutions regarding the loss of a limb. Through improving non-invasive methods to link a brain to a prosthetic, more people will be able to use the technology due to low cost, increased accuracy, and greater safety than surgical implantation.

Ridgefield High School
Teacher: Patrick Hughes

McNeill, William   Project # 150

Research Proposal, Science, Environmental

Determining the Presence of the Selachimorpha in Northwest Atlantic Waters with the use of Environmental DNA

For decades identifying the location of sharks has been next to impossible. Shark spotters and using boats is an inefficient method for identifying sharks. Advances have been made by using tracking devices that connect to the shark's fins. They only work when you find a shark and then apply the tracker to them. The main problem with this method is it's an invasive method that requires capturing a shark. To approach this problem, I will set up an experiment that uses environmental DNA analysis to determine the presence of sharks. To perform the experiment, water samples will be taken from various points around the test site then the samples will be analyzed through eDNA metabarcoding to determine the specific DNA present in the water and that will determine whether or not sharks are present in that specific location. The findings will prove that environmental DNA metabarcoding is a successful method for detecting sharks. It will prove to be a more successful detection method than using shark spotters. It will also prove metabarcoding is a more effective method than using tags to track the sharks because it will show the presence of sharks and is a better judge of the number of sharks in that location.

Proving eDNA metabarcoding is a superior method for detecting sharks will lead to many advances. Using metabarcoding to detect sharks can take away the need for shark spotters can only see sharks when water is clear and if they aren't deep in the water.

Ridgefield High School
Teacher: Ryan Gleason

Meier, Stella   Project # 151

Colorectal cancer treatment in vivo targets cancer stem cells with MST-312, flavonoid morin, and fluorouracil

Colorectal cancer is the second leading cause of death from cancer. Previous studies have shown that cancer stem cells cause colorectal cancer chemotherapy treatments like fluorouracil to be ineffective. A new treatment using MST-312 and flavonoid morin has been shown to increase fluorouracil effectiveness by tests in vitro. This experiment will test this treatment in vivo in mice for possible human application. If a combined treatment of MST-312, flavonoid morin, and fluorouracil is used to treat colorectal cancer in mice, then the treatment will target cancer stem cells and thus be more effective than previous treatments. Apc min/+ mice will be tested due to their susceptibility to colorectal cancer. The mice will be divided equally into six groups with different treatments: no treatment, fluorouracil, fluorouracil and morin, fluorouracil and MST-312, MST-312 and morin, and fluorouracil and MST-312 and morin. The compounds will be injected into the mice tumors. After treatment, all mice, both alive and deceased, will be dissected to identify possible tumors. The data will be organized in multiple graphs comparing treatment type to ratio of living to deceased mice after treatment, and the other graphs comparing treatment with size and number of tumors in the mice. Based on previous data in vitro, the combined treatment is expected to be most effective in inhibiting cancer stem cells resulting in tumor degeneration. This research may lead to more advanced colorectal cancer chemotherapies and decrease the high death rate for colorectal cancer.

Darien High School
Teacher: David Lewis

Mendiratta, Isha   Project # 152

A System for Underwater Passive Identification of Acoustic Signatures of the Stenella clymene

There are pre-existing programs utilizing the Fourier Transform to recognize specific sounds of bats and aves, but there is yet to be a successful underwater contraption. This experiment is twofold in that it will be necessary to collect data on the acoustics of the Clymene dolphin (Stenella clymene) before using said data to identify clicks among an array of sounds. This experiment will be conducted through the programming of a modified AI recognition program, followed by the fashioning of an underwater, passive acoustic microphone which will recognize and record sound. Using a database of Clymene clicks, created through personal recording, as the control for distinction, the AI program will run analysis on the clicks to determine if they suggest another dolphin in proximity to be scaled up for an approximate total population of Clymenes from New Jersey to the Gulf of Mexico. The microphone is expected to record and identify Clymene dolphins. Based on the number of clicks identified by the program - and data extrapolated based off this number - an approximate population of the S. Clymene can be determined, giving two separate values: a known number of dolphins and a predicted value. Specifically for the Clymene, for which no populational value is known, this experiment will allow for an approximate population figure. From this number, it can be determined whether efforts must be made for this species to increase population. In a bigger scheme, this experiment will provide a new way to monitor population analysis of marine life.

Newtown High School
Teacher: Timothy DeJulio

Mengwall, Sebastian   Project # 153

On the possibility of combining multiple optical telescopes in very-long-baseline interferometry

Astronomers always have a desire for more powerful telescopes, but as larger telescopes become more difficult and expensive to build, the magnification power of telescopes is starting to plateau. One potential solution to this problem is to use multiple telescopes already created and combine them. The idea of astronomical interferometry has already been implemented within the same telescope lens or in short distances, such as ALMA, but very-long-baseline interferometry is primarily used only for the radio wave spectrum. This research will explore the potential uses and benefits of combining many optical telescopes at long distances to virtualize a larger lens and detector, one potentially as large as the earth. The study can be done by testing the benefits of combining images from professional observatories, smaller observatories and even amateur telescopes, as well as modeling, simulating and interpolating virtual viewpoints. If the magnification power results are promising, connecting multiple telescopes could result in faster sky surveys, which could lead to the detection of more exoplanets and transients. A program could then be created so that observatories and amateur astronomers could connect their telescope online to aid in scientific research, whether it be a sky survey with a specific variety of permitted wavelengths or a detailed image of a nebula.

Darien High School
Teacher: David Lewis

Meyer, Claudia   Project # 154

Evaluation of the Efficacy of Deacidification Agents Applied to Lignocellulosic Paper Samples

Historical records are important primary and secondary sources of information for historians. However, as they age, historical records decay. To ensure continued access to these mementos of the past, historical documents must be preserved for as long as possible. The length of time a document remains readable can be lengthened through chemical means.

This project studies historical record preservation through deacidification, the process of removing acid from paper. Lignocellulosic paper with iron-gall ink will be weathered in a weathering machine to simulate historical record aging; records become more acidic over time, causing degradation. Then, the pH of the paper and the areas of ink will be measured. An evenly distributed layer of a deacidification agent will be applied to the entire paper. To analyze the results, pH will be measured repeatedly after the deacidification agent is applied over the following days and weeks. The deacidification agent that, on average, most effectively increases the pH of the paper for the longest period of time will be the one most applicable to future historical record preservation studies.

Joel Barlow High School
Teacher: Katherine Nuzzo

Mills, Ethan — Project # 155

Climatic and Predatory Relationships Contributing to the Degradation of the Quaking Aspen Population

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 will be doing a data consolidation study. Through statistical analysis I will be capable of graphing out the independent variables against aspen growth. I have already acquired several databases of climatic variables which include precipitation, aspen growth, snow fall, temperature and I am working on getting elk population and altitude. The hypothesized results would 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

Mongillo, Nicole — Project # 156

The Effect of Diet Composition on Juvenile American Horseshoe Crab (Limulus polyphemus) Survival in Culture

As horseshoe crab populations decrease, conservationists have been turning to rearing them in culture to replenish their numbers. Because of the relative newness of horseshoe crab aquaculture, little is known about optimal rearing conditions, particularly regarding diet composition and balance between vegetation-based and prey-based, high protein food sources. Therefore, this project examined the effect of diet composition on the survival rate of juvenile horseshoe crabs. The independent variable was the percent of plant and prey-based food consumed. The dependent variable was crab survival rate. Brine shrimp were used for prey-based food, while nori algae was used for plant-based food. Juvenile horseshoe crabs were separated into two tanks with constant tank conditions, feeding frequency, and food. Group 1 consumed 60% prey-based and 40% plant-based food. Group 2 consumed 75% prey-based and 25% plant-based food. Diet percentages were broken down by mass. The total number of surviving crabs were counted at least three times a week for several months.

The student calculated survival percentages for each counting interval based on data sent by the mentor and collected herself. The student ran independent samples t-tests to compare survival percentages across each group. It was projected that the group fed the 60-40 diet would have a higher survival rate. Horseshoe crabs are essential parts of biomedicine, economics, and environmental balance, making it vital that scientists deeply understand optimal conditions under which to raise them in culture. This comprehension will help them send healthy horseshoe crabs to the environment to replenish their population.

Amity Regional High School
Teacher: Catherine Piscitelli

Morgan, Kayla   Project # 157

Degrees of Separation in Internet Personalities: Contributions of Fame and Fortune

With the advent of the internet revolution, most people are connected by four degrees of separation. The purpose of this study is to use social network analysis to better understand the factors that affect the dynamics in social networks.

It is hypothesized that two people with similar levels of fame or fortune will be connected through fewer degrees of separation than people with different levels of fame or fortune. It is also hypothesized that similarity in level of fortune will more strongly predict degrees of separation than similarity in level of fame. The independent variables are fame, which is determined by followers on Twitter, and fortune, which is determined by net worth. The dependent variable is the degree of separation. 20 individuals who have a wide range of fame and fortune and represent a mix of internet personalities will be chosen. A website called Galaxy Scope will be used to calculate the degrees of separation between each distinct pair of individuals. Fame and fortune variables will be normalized if appropriate so that similar comparisons can be made. DeltaFame and DeltaFortune will be calculated for each pair and will represent the difference between fame and fortune. Correlational analysis will be used to determine to what degree similarity in fame or fortune predicts degrees of separation. The student will be carrying out all aspects of this project. This research can be used to increase the understanding of important dynamics in social networks with possible wide-ranging effects on politics, economics, culture, and ethics.

Amity Regional High School
Teacher: Catherine Piscitelli

Morrow, Kristin   Project # 158

Discovering the Environmental Effects of Extracellular Polymeric Substance-Created Marine Snow with Crude Oil; Highlighting the Differences with and without the Oil Dispersant Corexit EC9500A

Marine snow is a vital part of deep sea life. This study researches the effects of crude oil and Corexit EC9500A, both of which are introduced during oil spills and create marine oil snow (MOS). It is hypothesized that there will be a difference in toxicity of MOS with crude oil and Corexit EC9500A versus crude oil alone; specifically MOS with dispersant will have a higher toxicity level than MOS without. This study will test the toxicity by recreating the exact conditions of the Deepwater Horizon oil spill in two tanks. The independent variable will be the presence of the dispersant and the dependent variable will be the level of oxygenation of the oil. Several of the controlled variables will be the amount of oil, the type of plankton, and the temperature of the tank.

The expected results of the research are that using a FTICR-MS test will show a higher oxygenation level of the crude oil after traveling through the water column of the tank with dispersant, which therefore will show a higher toxicity level. It is expected that this information about the toxicity and effects of Corexit EC9500A will lead to further research about the effects of the oil dispersant on marine environments.

These findings will help further research as they will show the effects of the dispersant, and will help to educate about the many issues that oil dispersants pose on the environment. It will also provide information about the effects they may have on the environment.

Sacred Heart Greenwich
Teacher: Mary Musolino

Mu, Aurora — Project # 159

A Hybrid Machine Learning Model with Cost-Function Based Outlier Removal and Its Application on Credit Rating

Banks have sizeable loan portfolios, making it necessary to develop accurate credit scoring models. Slight improvement in credit scoring accuracy can reduce lenders' risk and translate to significant future savings. Machine learning techniques such as support vector machines and logistic regression are widely explored. This research introduces a novel hybrid machine learning technique utilizing a cost-based outlier removal and logistic regression based feature treatment for a credit scoring application. Anonymous public loan data from LendingClub is collected and preprocessed to remove missing data. Feature redundancy was reduced using logistic regression. Three traditional models, support vector machine, logistic regression, and decision tree, were created as a benchmark to compare the hybrid models, which incorporated SVM, LR, and DT with the novel cost-based outlier removal technique. The 6 models were run and the results were compared. Generally, the performance of a learning model is improved with logistic-regression feature treatment and cost-based outlier removal. All hybrid models show a decrease in training time compared to original. DT has consistently the lowest AUC, demonstrating poor performance of models. In addition, LR has the highest accuracy increase among hybrid models, indicating that the hybrid LR model is better at predicting. The improvements seen in accuracy and recall after the cost-based outlier removal and logistic regression feature treatment indicate that this method successfully improves performance of models. Thus, this method can be tested and applied to other training models in different fields, such as medical, or environmental.

Ridgefield High School
Teacher: Patrick Hughes

Muchhal, Aria — Project # 160

The Impact of Targeted Modifications of SNPs rs265 And rs99 In iPSC Cells Using CRISPR/Cas9 on Obesogenic Gene Expression

In this study, the effect of modifying SNP rs 99 and SNP rs 265 in two enhancers is examined. As single nucleotide polymorphisms in enhancer regions have been linked to obesity, scientists examine the results of changing particular base pairs in the enhancers using CRISPR/Cas9 in iPSCs. Scientists used CRISPR/Cas9 in iPSCs to modify the enhancers, testing that the editing was successful using PCRs. One a colony was successfully edited, the cells were sequenced. Through RNA sequencing, scientists found the change in gene expression for a variety of genes between the cells with normal enhancers and the modified cells. Scientists found specific genes associated with the enhancers by examining fold change in the RNA seq, and--using GWAS databases--confirmed that the affected genes impacted obesity. By finding enhancers whose SNPs change genes that affect obesity, scientists were able to figure out if the enhancers increased or decreased a person's susceptibility to obesity by increasing or decreasing the transcription of genes that increase obesity. rs99 increased obesity expression and rs265 decreased it. Scientists have a better understanding of how obesity functions. As heart disease, caused by obesity, is the leading cause of death in America, an increased understanding of the disease could save many lives as scientists could use the information found in this study and use CRISPR/Cas9 to decrease Americans' susceptibility to obesity

Darien High School
Teacher: Guy Pratt

Munim, Sheehan   Project # 161

Creating a Wearable Device that Reduces Stress by Using Vibration Pulses

Stress is a reaction that can negatively affect many people. Using vibration pulses can lower stress by calming the user of the device. Research finds that a slow heartbeat pulse being emitted to the wrist has a calming effect on the physiological sense of the participant. The device that was created helps reduce stress for people that are negatively affected. To test the device, participants received vibrational pulses from the device while doing a stressful task. Participants read a 6-page article and wrote a summary of it in five minutes. One group was given the vibrational pulses, while the other group did not. After 5 minutes, a questionnaire was given to the participants on how they felt during the task, and how the device impacted their task. Analyzing the questionnaire and the overall correctness on the task, the preliminary data suggests that the group with a more positive feedback and score was the group which received the vibration pulses from the device. The questionnaire had 10 questions with a scale from 1-10, and the summary was out of 100 points. The group with the higher average points had a higher positive feedback. The greater implication of this device will be to have a heart rate sensor attached to have the vibration pulses send automatically and at a certain rhythm. The device may also be implemented into a watch, and an application for other devices that already exist could be created to make the technology available to more people.

Amity Regional High School
Teacher: Nicholas Shamp

Murphy, Ellis   Project # 162

The Effect of Proximity to an Urban Environment on Plant Growth and Development

How does the proximity of a plant to an urban environment affect the growth and development of the plant over time? This experiment is significant as it pertains to rapid industrialization that is happening in wealthy nations. There is little concern for the environment and this experiment would highlight the impact of pollution on plants in these locations. Planting plants, specifically common daylily, near an industrialized city with varying distances from the city. The growth of the plants will be measured as well as the development over time. Plant 5 common daylilies at equal 1000 foot increments heading away from an urban center. Measure growth and record observations every 2 days for four weeks. Compare growth between plants. The plants closest to the urban environment will have grown less than the plants further outside of the city. The acidity, which is a result of pollutants in the air, limits the ability of the plants to grow normally. Acids can prevent plants from receiving proper nutrients. There should be an increase in height as the plants get further from the city. Pollution from an urban environment can have a large effect on plant growth. Plants receiving water and nutrients without human care are vulnerable to pollutants in the air that limit their growth and development. This would likely have an effect on larger plants, too, though this would take much longer to test. The location of a plant has an affect on how the plant matures.

Darien High School
Teacher: Christine Leventhal

Murphy, Cole — Project # 163

The Risk of Fractures as a result of Military Service on Diesel Submarines.

Submarines provide an edge to the top naval fleets around the world, but what are the long-term effects on serving on these vessels. For my proposal, I will examine the impact of service on diesel submarines in correlation to the risk of fracture and decreased bone density. For this experiment, I intend to examine medical records of bone fractures in correlation to post-submarine service. In particular, I will focus on service on diesel submarines. As a control group, I will use regular navy shipmen who serve on the surface. Some factors will have to be taken into account, consisting of sex (Male or Female), drug use, time submerged, and genetics. To limit these factors, I will focus on Male sex with no past drug use that has served on a submarine for six to twelve months during their duty. I expect to find that the bone density will decrease while serving on the submarine. In past studies bone density has returned to its natural state once it has had time to recover and strengthen. If results show a decrease in bone density and mass, it will be essential to figure out a method or supplement that could help the soldiers maintain their bone density. Maintaining bone density yields stronger bones. Similarly, when weaker bones break, non-union is more prominent causing dangerous complications, specifically nonunions. Not only may nonunions lead to instability, but they can cut off blood supply causing limbs to die due to lack of nutrients, requiring amputation.

Darien High School
Teacher: Christine Leventhal

Murray, Kyle — Project # 164

Assessing the Efficacy of Bacteriophage Preservation in Bacillus cereus Endospores

Antibiotic Resistance is a growing concern in the medical community. Researchers are using bacteriophage therapy to combat it. The current storage of bacteriophages, predominantly at cold temperatures, leads to lower sample quality. To best preserve the viruses, they can be stored inside of a bacterial cell's endospore phase, limiting the impacts of the environment and best preserving the reagents. B. Cereus cells were infected by bacteriophages, incubated, and then sent into an endospore phase through starvation. Once sporulated, suspensions were placed into different harsh environments for periods of time ranging from one to five days. The bacteria were then washed and spread on agar nutrient media to be quantified and germinate until lysis. The experiment, once completed, will provide information on whether endospores can be used as an effective storage medium. If so, experiments that use bacteriophages can use stock that does not need freezers or is preserved at a higher quality.

Joel Barlow High School
Teacher: Katherine Nuzzo

Nemec, Grace — Project # 165

Determining the Effect of Lipids on the Aggregation of Alpha-synuclein Protein to Prevent the Formation of Lewy Bodies in Parkinson's Disease

Parkinson's disease (PD) affects nearly one million Americans and has no cure. It is a neurodegenerative disorder that predominantly affects dopamine-producing neurons in a specific area of the brain called the substantia nigra. Parkinson's patients have alpha-synuclein in their brains, which is a sticky protein that clumps in the brain of PD patients, producing Lewy bodies. It is hypothesized that several of the lipids tested will reduce alpha-synuclein clumping. In this study, various lipids were combined with alpha-synuclein and tested to determine the effectiveness of lipids to prevent aggregation or clumping of alpha-synuclein. After mixing the lipids and alpha-synuclein in a phosphate buffer, the amount of light transmittance was monitored and recorded using a spectrophotometer over time. The seven lipids tested were monitored and then recorded and analyzed. These results were then utilized to determine if a certain lipid could possibly reduce clumping within the brain and possibly slow or cure Parkinson's disease. After testing all of the lipids and testing the percent transmittance every five minutes, it was deduced that alpha-synuclein and fish oil created the greatest decrease in transmittance, decreasing from 96% to 80% over the time period tested, therefore potentially reducing the greatest level of clumping. These results confirm the potential for lipids to reduce clumping of alpha-synuclein, and also indicate that alpha-synuclein clumping can be altered, which can possibly lead to a reduction in the physical and mental effects of Parkinson's disease.

Sacred Heart Greenwich
Teacher: Mary Musolino

Nemec, Katherine — Project # 166

Using Tissue-Engineered Skin Cells to Test the Newly Discovered Chemical 6-HAP as a Treatment for Skin Cancer

Human skin cancer is one of the deadliest cancers in America caused by overexposure to UV-light radiation. Melanoma is the rarest form of skin cancer and is very invasive once diagnosed. Testing a new chemical that is compatible with other skin cells, but works to slow the process of DNA synthesis could diminish the expansion of skin cancers and open many doors for further treatment of deadly diseases. The newly discovered chemical 6-HAP, or 6-N-hydroxyaminopurine, produced by a strain of S. Epidermidis found in healthy skin is revolutionary in the world of skin treatment. Through the new advancements in tissue engineering, 6-HAP can be safely tested before exposed to actual patients. After engineering skin tissue, it would be exposed to melanoma and then further analyzed. Through the in vitro process, the artificial tissue would be treated with 6-HAP for several weeks and afterwards, data would be recorded on the size and reduction of tumors. This in vitro testing will allow the discovery of 6-HAP's ability to slow DNA synthesis and be an effective treatment for melanoma patients. If successful, the data would show a decrease in the growth of the tumors, and eventually eliminate them entirely. Furthermore, the data could reveal an alternative use for the powerful chemical compound, and bring it into other fields of medicine seeking new alternative approaches because this study is rather new. If slowing DNA synthesis is proven possible, it may open up research concerning other invasive diseases.

Sacred Heart Greenwich
Teacher: Mary Musolino

Newman, Jakob   Project # 167

Analysis of Nitrite levels after the introduction of Nitrifying Bacteria containing Heat Shock Proteins.

The use of soil transplants and the introduction of unaltered soil microbes into a brand new environment that has been affected by acid rain, does not allow the bacteria to start up the Nitrogen cycle right away as easily and results in them dying more frequently.

Making the stock solution:

1) Pour 995 ml of water into a beaker and measure out 5 g of Ammonium. Making a 5 ppt solution.

2) Extract 5 ml of the solution and insert it into 995 ml of water creating a 5 ppm solution.This is the stock solution.

3) Add one half cup of Biobooster into the stock solution.

Applying the Bacteria:

1) Divide the stock solution into 5 different beakers, each being 200 mL.

2) Insert 25 grams of biobeads into each beaker and attach the aerator into it.

3) Insert pH Up and Down to set the pH to 4.5, 4.0 3.0, 5.0, and 6.0.

4) Insert the bacteria into each beaker.

Heat Shocking the Bacteria:

1) Take one of the beakers for each pH, and put it in the incubator that is set to 37 °C for 5 minutes.

2) Immediately air dry it after.

Protein Electrophoresis (Adapted and Modified from O'Keefe 2018)

1) The gel is pre-run for 15 minutes at 100 volts.

1) 5:l of loading buffer is added to the contents of each tube.

3) The samples are incubated in a 40°C sand bath for 5 minutes.

Bridgeport Regional Aquaculture Science and Technology Education Center
Teacher: Kirk Shadle

Nomani, Wafa   Project # 168

Iron-oxide nanoparticles loaded with Gemcitabine and Paclitaxel have toxic effects in pancreatic cancer

Pancreatic ductal adenocarcinoma (PDAC) has a 5-year survival rate of less than 3%. Current treatments include chemotherapeutic agents, which often result in a decreased quality of life. To mitigate toxic side effects of free chemotherapeutic agents, we loaded them onto iron-oxide nanoparticles as cancer cell-targeting agents, which also have the possibility to kill cells via ROS death. 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 by non-covalently loading Gemcitabine, Paclitaxel, and the combination of both drugs. We next did an MTS viability assay between loaded and free drugs to determine which treatment groups are most effective at 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 by the cancer cells. Iron-oxide nanoparticles may not be taken up well by pancreatic cancer cells as determined by our experiments. However, the dual-loaded nanoparticle (with Gemcitabine and Paclitaxel) yielded low cell viability compared to the other treatment groups, suggesting it is promising as a cytotoxic agent. Loading chemotherapies onto nanoparticles would result in a more efficient and effective treatment regimen for pancreatic cancer that is less toxic to the surrounding healthy cells of the body resulting with an increased survival rate and better quality of life for the patient.

King School
Teacher: Victoria Schulman

Novak, Eric   Project # 169

The Effect of Plastics On The Quality of Fresh and Saltwater

The purpose of this research was to find out how plastic affected the quality of water, and therefore would potentially affect the health of aquatic life. The hypothesis was that plastics in fresh or saltwater will cause the water's pH to go up, and clarity of the water would decrease. The independent variable of this research was the type and amount of plastic straws, bags, and bottles that will be put in the water. The dependent variables of this research was the pH of the water, and the clarity of the water. The constants of this research was the amount of plastic per group, and the amount of water. The control was fresh water with no plastic. The next three groups had the three plastics in different buckets. The final group had a three plastics in one bucket. The procedure will then be repeated with saltwater. The fresh water will be taken from the pond in front of the Amity High School, the salt water will be taken from the coast line beach in West Haven. I tested the pH and clarity of the water every three days, the pH was tested by an electronic pH meter. All of these tests will be done in my basement at home. Based on the data taken I will determine how plastic's effect on the water quality could potentially affect life in water. This would change the way this problem is studied.

Amity Regional High School
Teacher: Catherine Piscitelli

Novak, Samantha
Lillis, Grace   Project # 170

Testing for Arsenic Contamination in Well Water versus Municipal Water in Connecticut and New York

Arsenic levels have been present in high levels in soil and water throughout New England due to both natural causes and man-made contamination. Due to the fact that arsenic is a known carcinogen, along with its proximity to Connecticut and New York, makes it a prominent issue in our area. In this study, the difference between levels of arsenic in well water versus municipal water in Connecticut and New York.

It is hypothesized that well water will have higher levels of arsenic when compared to municipal water because well water may be exposed to more contaminants in the ground. An arsenic test kit will be used and results compared from Connecticut and New York. A Hach arsenic test kit will be used to measure arsenic levels within a range of 0 - 500 ppb to assess compliance with EPA Arsenic Rules.

The results are pending. it is expected that they will demonstrate a higher level of arsenic in well water due to fewer regulations surrounding the testing of well water, and arsenic often occurs naturally in the ground. Furthermore, it is expected that the New York tap water in general will have lower arsenic levels than the well water because previous tests have shown that Connecticut tap water has more chemical contaminants.

 This study is important because arsenic can be extremely harmful, for example, it may cause skin, lung, bladder, and kidney cancer. Due to the fact that there may be high levels of arsenic in Stamford.

Sacred Heart Greenwich
Teacher: Mary Musolino

O'Brien, Lauren   Project # 171

Using DNA Barcoding to Determine the Biosafety Level of Bacteria in Automobiles

Not many people are aware of the bacteria in their car, as well as the biosafety level of the bacteria, which indicates its potential harm to human safety. To become more aware, this project seeks to swab multiple areas in different car types that are used for different purposes (passenger, Uber, taxi). It is hypothesized that the taxis and Ubers tested with have more harmful bacteria than a car used by a family. ESwabs will be used to collect the bacteria in different locations within each car type. The contents will then be tested and analyzed using DNA barcoding to identify the most prevalent type of bacteria present. Multiple cars for each type will be tested and the different areas in the car that will be swabbed include the seatbelts, water cup holder, door handles, and seats.

It is expected that the Uber will have the most harmful bacteria (Biosafety levels 2 and possibly 3) because it is used by a large population in between cleaning/detailing. It is expected that the family car will have the lowest Biosafety levels (1 and possibly 2) because it is used by a smaller group of people and experiences consistent use and cleaning. Some possible implications of this project's findings could be how important it is to clean your car after use, as well as how Uber use might expose people to bacteria with higher biosafety levels. This study is significant because no study has been conducted on bacteria biosafety levels in automobiles.

Sacred Heart Greenwich
Teacher: Mary Musolino

O'Brien, Francoise
Catalano, Lucy   Project # 172

Reducing the Use of Rock Salt: New Green Deicing Techniques to Provide an Environmentally Friendly Approach to Ice Melting

Seventy percent of rock salt applied to roads stays within that region's watershed. Rock salt pollution has been affecting ecosystems, forming salt pockets in lakes and creating biological dead zones. Green solutions, such as beet juice, can increase phosphorus levels and cause oxygen depletion in bodies of water, negatively affecting ecosystems. It is hypothesized that new deicers will be effective in melting ice, and will be safer for the environment. To test this hypothesis, the ability of different compounds to lower the freezing temperature of water, reduce corrosiveness, and have a reduced negative effect on the environment will be compared. We will test natural substances with potential deicing capabilities and compare the effects and potential advantages of each. The four deicers to be tested are beet juice, potato juice, pickle brine, and cheese brine. Beet juice and traditional deicers will be controls. Our results should demonstrate a decrease in negative environmental impacts, for example, the new deicers will not increase salinity levels or harm plants and wildlife. These alternatives for rock salt will each have unique environmental advantages, but may also vary in effectiveness in melting salt as well. Based on preliminary results, is expected that the most successful alternative based on price, effectiveness, and safety will be potato juice. This experiment could lead to the discovery of environmentally safe alternatives to rock salt being added to our environment, which would be beneficial in terms of preventing the environment from being further damaged by elevated salt levels.

Sacred Heart Greenwich
Teacher: Mary Musolino

O'Connor, Catherine   Project # 173

Completed Project, Science, Health and Medical

Evaluating Clinical Course and Outcomes in Patients with BRCA-Mutated Pancreatic Cancer at Memorial Sloan Kettering: A Retrospective Analysis

Pancreatic cancer is an extremely challenging malignancy to treat, with a median survival time of less than one year for patients diagnosed with advanced disease (stage III/ IV). Up to 10% of pancreatic cancer cases result from inherited cancer predisposition syndromes, of which BRCA mutations are the most common. The identification of BRCA mutations are valuable, as carriers demonstrate increased responsivity to platinum therapies and PARP inhibition (PARPi) therapies. While researched extensively in breast and ovarian cancers, there has been relatively little retrospective evaluation of platinum and PARPi therapies in BRCA-mutated pancreatic cancer patients. To further characterize patterns of treatment response in BRCA-mutated pancreatic cancer, patients with previously identified BRCA mutations were reviewed. Medication histories, genomic profiles, and overall outcomes of the patients were abstracted from institutional databases. Overall survival was estimated with Kaplan-Meier curves. 126 BRCA-mutated pancreatic cancer patients were identified. 87 patients had advanced stages of disease. The median overall survival time for patients with advanced disease was 22.7 months (95% Confidence Interval 18.0, 33.9). 74.7% of patients who received platinum therapy had a partial response to treatment (a decrease in the extent of the cancer). 34.1% of patients who received PARPi therapy had a partial response to treatment. BRCA mutation carriers constitute a small, but significant subgroup of pancreatic cancer patients. Improvement in median survival time for this cohort compared to national averages is notable, and outcomes are expected to improve with increasing integration of platinum and PARPi therapies into treatment paradigms.

Darien High School
Teacher: Guy Pratt

O'Connor, Laura   Project # 174

Research Proposal, Science, Environmental

Testing Soil and Agricultural Crops to See How They are Affected by Polyfluoroalkyl Substances

Polyfluoroalkyl Substances (PFAS) are a group of man-made chemicals that are often found in clothing, non-stick pans, and even fast-food wrappers. PFAS can cause cancer and there is data relating to PFAS-contaminated water, but there is little research regarding testing soil. The hypothesis is that agricultural crops that grow in soil that has been exposed to Polyfluoroalkyl Substances will also have traces of PFAS. In this study, soil in areas that may have exposed and possibly that is being used for agricultural purposes will be tested for the presence of PFAS using high resolution mass spectrometry. Then seeds will be planted in the soil that has been exposed will be compared to plants grown in PFAS-free soil and data will be collected regarding the differences between crops exposed and those not exposed. The expected results are that plants grown in soil that has been exposed to PFAS will have traces of PFAS and will not be able to grow as well as plants that are growing in soil that has never been exposed. Specifically, the plants' growth rate and height will be affected because of the chemicals they are in the soil. In addition, the exposed crops will contain traces of PFAS. This study will add to the research demonstrating the problems regarding PFAS in the environment, and will uncover how they are affecting the food we eat and not just the water we drink. The study will give more information on how PFAS move from soil to crops.

Sacred Heart Greenwich
Teacher: Mary Musolino

O'Meara, Taylor, Uygur, Arielle
Van Wagenen, Piper   Project # 175

Creating and Testing Novel Plant-Based Bioplastics for Strength and Biodegradability

Plant-based bioplastics are important because traditional plastics are derived from fossil fuels, take an extremely long time to decompose, and contribute to global warming. Bioplastics, however, have a faster decomposition rate, a much lower carbon footprint, are produced from renewable materials, and can be as versatile as traditional plastics. Bioplastics have lower energy costs to manufacture and do not use crude oil and break down naturally in the environment. In this study, novel plant-based materials were used to create and test bioplastic materials. When creating a new bioplastic, we experimented with different ingredients, particularly the plant-based starch, for example, kelp, tapioca starch, and psyllium husk. For the most successful bioplastic, the amount of plasticizer was varied to produce optimum results. A traditional polymer-based plastic was tested as a control, and a cornstarch-based bioplastic was used as the control bioplastic. The basic procedure included heating and allowing the mixture of plant-based starch, glycerin, water, and acetic acid to set. These bioplastic ingredients were combined in various proportions to determine the optimum mixture. Strength and decomposition testing followed. It was found that the psyllium bioplastic with a greater level of plasticizer was the strongest and most like traditional plastic. Decomposition testing to determine biodegradability is still underway. The need for sustainable materials for the preservation of future ecosystems is the motivation for bioplastic production. This study focused on finding a biodegradable plant-based plastic alternative to relieve landfill waste and pollution. Through our experimentation, we intend to create the most durable and flexible psyllium-based bioplastic.

Sacred Heart Greenwich
Teacher: Mary Musolino

Ochs, Benjamin   Project # 176

Autonomous, Modular, Robotic System for Life Preservation

Currently, there are robotic systems that replace human first responders, but they are small and have only one specific use. This project will design a robotic system to be able to replace first responders in a dangerous situation, no matter what the situation is. This will be done by making the robot modular. Multiple models will be needed to be made to create the final design. The first prototype would be a small robot about a half a meter tall, and 3D printed. It would use very similar electronics to the ones planned for the larger robot, one main computer and multiple smaller microprocessors running the extremities. To test the robot's ability to rescue, a course will be designed to test agility, manipulate objects, and open different types of doors. The hope for this robot is for it to be able to save people from fires, nuclear meltdowns, and other disasters where it is dangerous for personal and first responders to enter the building. This robotic system will be more useful than the other robots because it will be easier to maintain between departments, such as fire and police departments, because the robots are the same, even though they can be used for different things. This would also be a cheaper solution because of the ability of one robot to do many different things. The overall goal of this project is to save the lives of people in dangerous situations without risking other lives.

Newtown High School
Teacher: Timothy DeJulio

O'Connor, Colby — Project # 177

Utilizing Neurocognitive Assessments To Determine Relationships Between Time Since Injury and Cognitive vs Affective Symptoms Due To Exposure To Traumatic Brain Injury

The purpose of this project was to utilize neurocognitive assessments to determine relationships between time since injury and severity of the injury, and symptoms present of those exposed to TBIs previously. It was hypothesized that when people with prior exposure to brain injuries take neurocognitive and neuropsychological assessments, cognitive symptoms will be more enduring over time than affective symptoms. This was done by distributing Beck Anxiety and Depression Inventories over call to participants. Then distributed Montreal Cognitive Assessment(MOCA) to participants to analyze their current symptoms from TBI. Two groups for symptoms were developed: cognitive (memory, executive functioning, attention, word-finding, language, speed of mentation, visuospatial) and affective (psychological, anxiety, depression, behavioral, obsessive thoughts, insomnia, impulsivity). Moreover, the analyzations of relationships between time since injury and nature of both types of symptoms were found. These results were then inputted into Pearson's correlation coefficient analysis-measures the statistical relationship or the association between two continuous variables, and into a t-test which analyzed statistical significance in data. It was hypothesized that the cognitive symptoms are more enduring over time than the affective symptoms. Data analyses did support this hypothesis. Results thus far show that cognitive symptoms are more enduring over time than affective symptoms. People with higher severity injuries scored significantly higher in cognitive than affective symptoms. Furthermore, TBI often leads to much more persistent and detrimental disorders to your health. Relationships between symptoms can be used to categorize injuries, and also shows that there can be trends leading to a possible clinical diagnosis.

Amity Regional High School
Teacher: Catherine Piscitelli

Ogden, Spencer — Project # 178

How the Use of Fertilizer Affects Wildlife Activity on Private Property

I became motivated to do this research through my lifelong fondness for the natural world. Part of my motivation also came after visiting Banff National Park in Alberta, Canada, and learning about the wildlife corridors that they have there. My problem statement is: How does the use of fertilizer affect wildlife activity on one's property? I will set up trail cameras at a house with a yard that doesn't use fertilizer, and a house with a yard that uses fertilizer. I will then check the cameras every few weeks and record what wildlife the cameras captured. For this, I project there will be more wildlife spotted on the yard without fertilizer. I currently do not have results, as this is proposed research. I expect these results because I believe that the fertilizer would act as a poison and not taste good to wildlife that eats the grass. Therefore, the wildlife would stay away from lawns that are fertilized. This experiment will allow for others to manage the wildlife they have in their backyard. This is needed because this is an easy way for people to welcome animals onto their property by providing them with natural food and resources they may not have elsewhere.

Ridgefield High School
Teacher: Ryan Gleason

Orr, Josephine   Project # 179

Determining the Spatial Memory Capacity of Different Species of Crabs

Multiple studies have been conducted researching the spatial memory capacity of different animals, but marine animals, such as crabs, are not often studied. This investigation, conducted to learn more about the spatial memory of crabs, can help form the foundation for future neurological research on marine animals. The hypothesis is that there will be differences in the spatial memory capacity of the different species of crabs tested. The spatial memory capacity of animals is often tested by giving the animals a spatial reasoning test, such as a maze. The crabs will be timed as they find their way through a maze to a piece of food at the end. The test will be run again, several days later, with the experienced group and a new group of crabs that are unfamiliar with the maze. The average time taken for the groups to complete the maze will be compared. The memory of the crabs already exposed to the maze will be compared to the previously unexposed crabs to see if spatial memory is present. Multiple tests will be run so that the spatial memory capacity of different species can be compared. It is expected that there will be variations in the spatial memory of the individual species, but it will be interesting to discover which species have the best memory, and why. Researching the possible variations between the spatial memory capacities of different crab species and why they exist might help in the future research of marine animal migrations.

Sacred Heart Greenwich
Teacher: Mary Musolino

Paglia, Sage   Project # 180

The Effect of Car Horns with Different Tones and Lengths on Drivers and their Perception and the Expression of their Emotions

Drivers that operate vehicles today are only able to communicate with their vehicles using their car horn, their turn signals, high beams, and brake lights. The inability to communicate on the road, with variations of auditory tools, cause drivers to express anger verbally, physically, and through vehicular violations. How do car horns with different tones and lengths affect the perception and the expression of their emotions. A modified open source driving simulator created scenarios that provoked the need for using a car horn. Different length and toned horns were played to participants in a questionnaire before the simulation. In the simulation, participants used car horns. They were asked to determine the message of the horns. Questions appeared on the screen asking why the participant used the car horn, and if it impacted their stress. Data trends thus far show that people are more likely to use different car horns to express their emotions in a driving simulator, if given the opportunity, and this ability to further express emotions impacts the stress and emotions a participant was feeling. The use of a specific horn allowed drivers to better communicate with other drivers. In the future, that horn could be put into a car to create unambiguous communication on the road.

Amity Regional High School
Teacher: Nicholas Shamp

Paliwal, Arnav — Project # 181

Creating and Testing Different Designs of Titanium Dioxide Films in Perovskite Solar Cells

This aim is to improve electron transport layers in perovskite solar cells. The electron transport layer blocks the positive charges and lets negative charges through. The objective is to test different designs of this electron layer and to find out the most efficient one. The motivation is to improve solar power technology since perovskite cells are a much more affordable type of solar cell when compared to other alternatives. The electron transport layers will be made in two different ways and compared to a simple fluorine doped tin oxide glass. The layers are basically different designs of titanium dioxide layers onto these glasses. The two main methods used to make these layers are spin-coating and spray pyrolysis. These methods will be compared to each other. They will be evaluated using cyclic voltammetry to test their effectiveness. Progress thus far is on track to complete intended results. The implications of this research are more efficient perovskite solar cells. The impact of this is increasing the efficiency of a cheaper alternative to the standard solar cells used in the status quo. Increasing the cost effectiveness of solar cells means that we can actually implement these cells in more locations which is better for the environment on the long term. This is because one of the main limitations on using solar panels is the cost of them.

Amity Regional High School
Teacher: Catherine Piscitelli

Pascal, Gigi, Nemec, Caroline Augustine, Sarah — Project # 182

The Effect of Metals, Nutrients, and Other Compounds Released from Sunscreen into Seawater on the Lifespan of Marine Organisms

This study deals with the effects of how various substances found in sunscreens that have not yet been tested are affecting marine organisms. The hypothesis of this study focuses on the effects of specific concentrations of aluminum, phosphate, silica, and octocrylene compounds on the lifespan of marine organisms. It is hypothesized that these substances will have a significant impact on reducing the lifespan of organisms such as Daphnia. To test this hypothesis, pond water will be collected and separated into multiple containers. In each container, a different concentration of each substance will be added, and our control group will be a container with just pond water. Daphnia will be added to each container and their lifespan in each concentration will be noted. Additionally, alternative natural UV-absorbing substances will be tested to replace the harmful chemicals. The results should demonstrate that aluminium and phosphate will have the greatest risk to marine organisms in pond water. Aluminium can cause the cells of gill-breathing animals to lose or gain too much water and phosphate can result in the increase of algae and the reduction of dissolved oxygen in bodies of water. Increased concentrations of these substances will result in shorter lifespans of the marine organisms. It is also expected that kelp, acai, and cyanobacterial metabolites will be safer alternatives to the harmful chemicals found in sunscreen. This study will demonstrate how harmful aluminum, phosphate, silica, and octocrylene are to marine organisms. Further research can be done to test additional natural substances.

Sacred Heart Greenwich
Teacher: Mary Musolino

Patel, Armaan   Project # 183

Completed Project, Science, Health and Medical

The Effect of a Best Practice Informative Intervention on Surgeon Clip Usage in Breast-Conserving Surgery

Surgical clip placement during breast-conserving surgery (BCS) for breast cancer has been shown to improve target localization by the radiation oncologist for the tumor bed boost. Two radiation oncologists at a single institution gave a presentation to the primary breast surgeons regarding the importance of surgical clip placement during BCS. Our question is: Does a best practice informative intervention correlate with changes in the percentage of BCS during which surgical clip placement is performed? Our hypothesis is that we will see an increase in surgical clip placement during BCS. My mentor de-identified data regarding the number and percentage of cases of BCS during which surgical clips were placed during the 6 months prior to the presentation in 2017 and the same 6-month period in 2018 and 2019. I determined the proper statistical analyses (paired t-test and effect size calculations) to use and the organization of the data based on prior literature review and meetings with mentor. No statistical significance was found between the percentage of BCS during which surgical clips were placed prior to the intervention (2017) when compared to 2018 and 2019 using paired t-test. Effect size was found to be 0.38 between 2017 and 2018, and 1.214 between 2017 and 2019 when calculating Cohen's effect size. The robust Cohen's effect size between 2017 and 2019 indicates that there may be value in similar best practice presentations. Further research into best practice informative interventions on a larger scale is warranted.

Amity Regional High School
Teacher: Catherine Piscitelli

Patel, Ashwini   Project # 184

Completed Project, Science, Health and Medical

The Effect of Genetically-Altered Endothelial Cells on Metastasis of Breast Cancer to the Lung

Despite available therapies, the five-year overall survival rate of metastatic breast cancer is less than 30%. In recent years, studies have demonstrated that the environment that surrounds a tumor plays a crucial role in the formation of metastasis. Mutated endothelial cells, prominent in the tumor microenvironment, have been linked to metastasis in the lung, and understanding how these cells affect the progression can provide a potential target of therapy. For this project, two groups of BALB/c mice were generated. One group served as a control, while the other group had genetically-altered lung endothelial cells with different protein expression. Both groups were then injected with GFP-tagged 4T1 cells, a metastatic mouse breast cancer cell line. After 28 days, the lungs were collected, fixed, and slides were stained with Hematoxylin and Eosin (H&E) to view cell structures and cell density. Immunofluorescence (IF) was conducted to evaluate the expression of GFP and Ki-67. 4T1 live cells were cultured in vitro, which confirmed GFP viability. Overall, the number of metastases that occurred in the experimental group was greater than that of the control. Furthermore, Ki-67 positivity was higher in the HET group than the control. This proves that endothelial cells under normal conditions play a role in preventing metastasis. However, once endothelial cells become influenced by chemical signaling of cancer cells, they can then aid in metastasis. Overall, this supports the claim that protein expression in lung endothelial cells is a potential target for preventing and treating metastatic breast cancer.

Darien High School
Teacher: David Lewis

Paul, Akanksha   Project # 185

The Influence of Light and Branch Diameter Size on Ash Tree and Emerald Ash Borer (Agrilus Planipennis) Larvae Performance

Branch assays are used to examine how branch diameter and light may affect EAB development and ash resistance. In previously infested trees, larger diameter (4-10 cm) branches have more larvae than in newly infested trees. Potential reasons include more protection from desiccation and temperature extremes and more phloem for feeding. Alternatively, thinner bark could have more chemically protection and photosynthetic tissue, allowing a greater response to larval feeding.

 Independent variables include the presence of light and branch diameter (2 and 6 cm). The dependent variables are the ash tree performance and EAB larval performance (survival, size, ability to establish (presence and size of galleries)). Six 2 cm and six 6 cm diameter branches were selected from a white ash tree and planted in tubs holding floral foam. 3 pairs of EAB eggs were attached to each branch.

Three 2 cm and three 6 cm diameter branches were stored in a growth chamber at 25 C set to a long-day light dark regimen (L:D, 16:8). The other branches were stored in a dark growth chamber at 25 C. Once a week for five weeks, I checked on the branches and at the end of the five weeks, bark was removed to reveal larval survivorship and galleries.

 Chi-squares were used to determine if the larvae were more successful at establishing on larger or smaller branches and on branches kept in the light or dark. We used general linear models (GLM) in Systat to examine the relationships between various measures of larval success. We also used GLM to examine the relationship between size, light condition and the branches' ability to defend themselves, specifically frass color and callous formation.

Amity Regional High School
Teacher: Catherine Piscitelli

Peters, Liv   Project # 186

Intraspinal Microstimulation Implant Impact on Lumbosacral spinal Cord Injuries of Pan troglodytes

The Intraspinal Microstimulation Implant (ISMS) is geared towards restoring limb movement, breathing control and bladder movement in cases of the 17,730 spinal injuries that occur in the US per year. The ISMS will be just as effective in humans in the same way that it was in non-human primates when placed in the lumbar region of the spinal cord prior to a spinal cord injury. A laminectomy will be performed on a chimpanzee on the L2 or L3 vertebrae. Reflective markers will be placed on the hip knee and ankle, and bipolar intramuscular electrodes will be placed on the 8 hindleg muscles. The microelectrode would then be placed into the exposed region of the spinal cord. Movement in the muscles and observation of movement would then be monitored in the hindlegs. Predictions of joint movement in the hip and knee would likely result as well as flexion or extension of the muscles in the lower extremities. Researchers may conclude that the ISMS was successful in restoring limb movement to the lower extremities in Chimpanzees. This would be seen in the data by the movement in the muscle receptors in the lower hind limbs as well as observed movement. By implanting the ISMS in paraplegic patients in the result of injury to the spinal cord, function could be restored to the lower extremities. With further testing, the ISMS could also be applied to fractures in the cervical region of the spine, helping treat quadriplegics.

Darien High School
Teacher: Guy Prett

Pistone, Olivia — Project # 187

Molecular functions of DDX3X syndrome and its effects on brain development

DDX3X syndrome is newly found, rare genetic disorder that affects 2% females in particular. It is a rare form of x-linked syndromes. These females being affected are suffering many neurodevelopment and neurological symptoms. Because the syndrome was recently discovered these females are being majorly affected and are not being treated correctly because this syndrome has not been researched enough. Some current experiments are trying to figure out the molecular functions, and the developmental effects of DDX3X syndrome. A new mouse model of DDX3X syndrome is being used to understand the molecular functions and developmental effects. In this study, there will be two groups of mice, one group genetically modified with DDX3X syndrome and one without. It is expected that the mice with the syndrome will have significant developmental defects compared to the mouse without the syndrome. Also it is expected to find molecular targets to try to understand DDX3X more clearly. From the mice it is understood how this syndrome could affect humans, and the developmental issues that can arise. Also, trying to find a molecule that can be used to try to treat this syndrome. These things can help scientists understand this new neurological genetic disorder and try to help the small amount of females being affected.

Darien High School
Teacher: Christine Leventhal

Pittaro, Claire — Project # 188

Testing for the Presence of Microplastics in Consumer Products

There have been many cases of microplastics being detected in unsuspected consumer products, for example, in tea bags that are made of silk and plastic. Many plastics that are added to consumer products are unnecessary to the function of the product, and are used instead of natural ingredients because it is cheaper. These plastics may be released into bodies of water, and could potentially harm marine life. It is hypothesized that microplastics will be found in a variety of food and beauty products. In this experiment, Nile Red Dye will be used to test for microplastics in silk and plastic tea bags as well as other products. If the Nile Red Dye clings to the microplastics in the products, and is then placed under a blue light, it will fluoresce to indicate that microplastics were detected. Results are underway but it is expected that plastic microbeads will be detected in the products tested because many companies are using plastic microbeads for various purposes. It is likely that plastic will be found more commonly in everyday products that are frequently used. For example, plastic microbeads have been found in household cleaners, which can be found in almost every home and are used almost every day. This research will help prove how often plastic microbeads are used in everyday products, which will hopefully reduce their use. By raising awareness of which products and brands are using plastic fillers in their products, ideally the products will be purchased less often and people will use products that do not contain plastic fillers instead of natural ingredients.

Sacred Heart Greenwich
Teacher: Mary Musolino

Poddar, Aanchal — Project # 189

Using Surplus Agricultural Products to Increase Filtration Ability of Fiberglass

The amount of surplus agricultural products (SAP) has been increasing, causing a decrease in farmers' earnings. Research suggests that using wheat straw helps increase the filtration ability of aerogels. A common household air filter is made of fiberglass which has a low MERV (Minimum Efficiency Rating Value), removing pollen, dust, and lint. The purpose is to increase the efficiency of fiberglass filters using SAPs such as rice, wheat, or beans. Polluted air was air containing CO and CO2. To test the filtration, I made filters containing different SAPs. They were put in an airtight box separated in halves by the air filter. One half had smoke in it by putting burning paper in it and taking it out after 10 minutes. After testing the air quality, each had 15 minutes to filter. Then the other half's air quality was tested. Preliminary data suggests that wheat flour is the most efficient at filtering. The findings will help lower-income people afford a better air filter. It will also increase a farmer's earnings, since their crops will be in higher demand. There will also be less waste from farms.

Amity Regional High School
Teacher: Nicholas Shamp

Popescu, Alexandra — Project # 190

Computational Analysis of Epithelial-Endothelial Cellular Crosstalk in Complex Vascularized Tissues

According to a recent transcriptomic analysis done on mammalian lung, there is evidence to show that epithelial cells play an important role in the regulation and organization of endothelial cells (Raredon). Therefore, the focus of my research is on identifying the specific signaling allowing for this interaction, as well as determining what is organ specific and what is common tissue function.

Research is currently in progress. Computational project ' no risks

Joel Barlow High School
Teacher: Katherine Nuzzo

Porter, Sabrina — Project # 191

The Usage of CRISPR to genetically modify mutated P53 in order to prevent TNBC from metastasizing

P53 is a tumor suppressor gene that inhibits the proliferation of DNA mutated cells. Cells with mutated P53 have a higher chance of forming a tumor. The problem that will be researched is if CRISPR can genetically recode mutated P53 and if so, how that will affect the proliferation of cells in triple negative breast cancer. Cell lines of TNBC with mutated P53 will be compared to cells which have been treated with CRISPR to those which have not received treatment. The cell lines in two of the dishes will be dosed the dish with CRISPR with 2 different milligrams amounts, 30mg and 60 mg. One dish will contain no CRISPR and will act as the control. Dishes will sit in an incubator for one week. The expected results are that the cells treated with CRISPR to have more cell apoptosis as a result of the P53 being able to perform its function of eliminating mutated cells. It also can be concluded that the dishes treated with higher milligram amounts of CRISPR will have elevated levels of cell death. My research will test if CRISPR can be a usable treatment of TNBC and if it is safe to treat cell lines. It also will test if the newly recoded P53 will have properties to stop cancer from spreading. It will also prove that there is a possible treatment for the restoration of the P53 gene.

Ridgefield High School
Teacher: Patrick Hughes

Price, Allison — Project # 192

The Prediction of how fires will spread due to the effectors of climate

Forest fires have become a growing issue in most parts of the world, especially on the West Coast of America. 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 help find a way of preventing fires in the future by determining where they will move and how fast. First, I will select and compare three or more methods utilizing climatic information to predict the movement of fires in order to determine which method is the most useful. I will most likely use the MCDM method, the BEHAVE model, and the fire behavior prediction method. Then I will use data from past fires to determine which model is the most accurate in its prediction.

I believe that the MCDM method will be useful in larger regions. I believe that the BEHAVE method and the fire behavior prediction method will be the most helpful in smaller and more specific regions. 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

Prinz, Natalie   Project # 193

Investigating The Effect of BESE Substrate Stabilization on the Growth of Sand Dune Grasses

Recovery of sand dune ecosystems from natural disasters is very dependent on physical stressors such as the looseness of sand, also called substrate density. Biodegradable Elements for Starting Ecosystems, or BESE, is a stabilization array that increases substrate density. The purpose of this study is to test the effect that the application of BESE has on the growth of sand dune grasses. It is hypothesized that with a greater density of substrate the plants will have more belowground growth because there will be less substrate movement. The independent variable is the density of the substrate. The dependent variable is the height and width of the aboveground growth of each plant. Each plant was planted in the front section of a sand dune in Georgia, United States. The experimental plants were planted with the BESE substrate stabilization array. The control was plants that were planted without any substrate stabilization array. Physical stressors were constant as all plants were planted in the same front section of dune. My mentor collected data in the field by measuring the growth of the plants throughout a one year period. I analyzed the collected data and used ANOVA tests to compare the effect of substrate density on the growth of the plants. This study has implications into how BESE substrate stabilization can help the recovery of sand dune vegetation after natural disasters.

Amity Regional High School
Teacher: Catherine Piscitelli

Rai, Aditya   Project # 194

A Socionomic Perspective on Voting Results

The observation of the Ç£social mood, Ç¥ or behavior, of a particular group of individuals and how their behavior towards a certain issue precedes their actions is an essential facet of economics. Since economics is most often reliant on politics, socionomics is a valuable asset in reflecting viewpoint shifts within the public regarding politics. The study aims to analyze all incumbent elections (i.e. presidential re-elections) and establish a relationship between stock market growth during the incumbent's previous term and the popular vote the incumbent receives during the next election. Past data on a stock market index, specifically the DJIA, will be gathered to find when each incumbent candidate affected the stock market. Afterward, the percent change in the stock market during the incumbent's first term and the percentage of popular votes during the incumbent's second election will be calculated. A linear model will then be developed comparing the stock market change in an incumbent's first term and the popular vote that he receives in the following election. A high correlation coefficient is expected, since unlike other economic factors like GDP, inflation, or unemployment rate, the stock market is the most optimal way the public can exert social mood/opinions on a political issue, like an election. If this relationship is established, economists will be able to use the percent change in the stock market to predict incumbent elections and can provide insights into the upcoming election in 2020.

Darien High School
Teacher: Guy Pratt

Raissi , Siavash   Project # 195

Completed Project, Science, Health and Medical

Optimizing THP-1 Differentiation to Analyze the Role of CFTR deficiency on THP-1 Macrophage Polarization to Establish a Model System

In cystic fibrosis, M2 macrophage (anti-inflammatory) polarization is deficient, while M1 (pro-inflammatory) polarization increases. However, immortal cell lines such as THP-1 cells are used as a model substitute for macrophage research in vitro. However, an optimal procedure for differentiating THP-1s into macrophages has yet to be determined. What is the optimal procedure for THP-1 differentiation, and how do THP-1 cells polarize when CFTR expression is knocked down? The purpose of this research was to determine the optimal concentrations to efficiently analyze the role of CFTR deficiency on THP-1 macrophage polarization for future research. We hypothesized that 10 ng/mL PMA for 72 hours, with 100 ng/mL of LPS, 20 ng/mL INF-y, and 40 ng/mL IL-4 and IL-13 would maximize M1 and M2 macrophage polarization, while M2 polarization would be reduced with a CFTR knockdown. The substance concentrations were the independent variables, while the extent of polarization of the macrophages, which were measured using Western Blots, qPCR, and Flow Cytometry, was the dependent variable. We found our hypothesis was supported, and that M1 polarization was increased in CFTR knockdown cells, while M2 polarization decreased. This data informs future investigations by providing insight into the use of THP-1s a substitute model system for researching the role of macrophages in cystic fibrosis. In addition, it increases the efficiency of future experiments by providing a previously-established set of methods for optimizing THP-1 differentiation and polarization.

Amity Regional High School
Teacher: Catherine Piscitelli

Rao, Karina   Project # 196

Research Proposal, Science, Health and Medical

Effect of cryo-chamber therapy on cold-shock protein Type A levels in skeletal muscle samples

The effectiveness of cryo-chamber recovery as a treatment for exercise-induced muscle damage has been debated. If this treatment increases CspA levels in skeletal muscles, the recovery method would be effective since cold-shock proteins have pleiotropic functions that aid in muscle repair by regulating transcription and translation. My project measures CspA levels in skeletal muscle samples after exposure to similar cryo-chamber treatment conditions. Skeletal muscle samples were treated with a colloidal copper cell wash to mimic the conditions of exercise-induced muscle damage and then frozen to various temperatures using liquid nitrogen. The tissue sample was then pulverized using a cryogenic frozen tissue pulverizer and centrifuged to isolate proteins. Finally, CspA proteins were isolated using a chromatography lab and levels were recorded spectrophotometrically. Samples treated with cryo-chamber therapy are expected to exhibit increased CspA levels compared to untreated samples given that a spike in Csp levels occurred after a shift in temperature from 37°C, independent of transcriptional activity, in bacteria. Furthermore, the greater the temperature shift, the greater the CspA levels could increase since Csps are produced to counteract decreased enzyme activity in cold environments. After reaching a certain cooling temperature, a plateau will likely exist in which no more Csps are developed despite lowering temperatures. Understanding whether cryo-chamber therapy induces the synthesis of cold-shock proteins is valuable in athletic recovery. Additionally, understanding muscle tissue regeneration and cryo-chamber recovery could improve treatments for patients with muscular dystrophy or atrophy. Finally, these findings could highlight how therapeutic hypothermia would impact the body.

King School
Teacher: Victoria Schulman

Rassias, Jackson   Project # 197

Research Proposal, Engineering, Physical Science

The Fabrication of a Cost-Effective Paper Lithium-Ion Battery with Increased Voltage and Longevity

The world is in an ever-expanding digital age and revolving around the need for batteries, specifically Lithium-Ion Batteries (LIB). The motivation of this project was to create an improved, cheaper paper LIB while maintaining reasonable power output. This project will consist of fabricating a flexible paper LIB with the optimized cathode, anode, and MCNT materials. Previous results with single-walled carbon nanotubes (SCNT) have yielded between 0.5 to 0.75V, but with MCNTs and improved cathode materials, a 1.5V paper battery is feasible. The battery should degrade relatively slowly, allowing for multiple recharges, and a long life span. Also, multiple batteries can be stacked (with minimal loss) to achieve increased voltage, will be investigated. One implication for this study is that paper batteries are a cheaper alternative to the commercially available LIBs. The battery is also more flexible (due to the paper separator), which allows for a variety of uses such as wearable electronics and medical applications. Finally, the battery is rechargeable and has heating and leakage resistance.

Greens Farm Academy
Teacher: Mathieu Freeman

Reynolds, Matthew   Project # 198

Research Proposal, Science, Health and Medical

Organ Injuries Related to Cardiopulmonary Resuscitation in Cardiac Arrest Non-survivors

The problem of organ injuries related to cardiopulmonary resuscitation (CPR) in cardiac arrest non-survivors, comparing manual CPR with mechanical CPR, utilizing the LUCAS is the main focus of this study. If tested, patients treated with mechanical chest compressions during CPR would present an autopsy with more organ injuries than those treated with manual chest compressions, and that we would find organ damage that would be potentially lethal. My motivation for a topic like this results from spending time with Emergency Medical Services through Darien EMS Post 53. The theoretical modeling of the experiment would be produced by tracking a particular EMS association, and the local hospitals within the area. The data collection would consist of autopsies of cardiac arrest non-survivors conducted at the hospitals. Currently, there is a similar study going on titled Ç£Skeletal and soft tissue injuries after manual and mechanical chest compressions Ç¥ done by Niklas Friberg. The experiment is related to my proposed project though differentiated by the different factors being looked at as a result of the CPR's. As a result of my research, I expect to discover that mechanical CPR would result in organ damage, potentially life-threatening comparatively. Some of the possible implications of my research could be that the LUCAS device is causing more harm to patients, and not affecting the survival chance outcome, and therefore, there is no point in mechanical CPR to the LUCAS capacity. Potential research could verify this thesis and suggest sensible and prudent use of the LUCAS device for cardiac arrest.

Darien High School
Teacher: Christine Leventhal

Riebling, Riley — Project # 199

Orca and Human Behavior and Interactions

An organism will often try to interact with another if they have a relation to it in any way. This happens most often in human interactions but also occurs between animals, such as orcas. This research will look into which species will go great lengths to interact with another organism, why they interact, and what they do when they interact. The experiment will focus on comparing human interactions and orca interactions. Specifically, how humans face a conflict that involves someone or something they have a relationship with, versus when they are shown a conflict that involves complete strangers. Then, observations of orcas will be recorded from a live video feed. Data will be collected by analyzing how orcas interact with each other if they do at all. The experiment should answer the question of if an organism will definitely help another if they have a relationship with it; whether that relationship is a family, a mutual, a symbiotic, or even a predator and prey relationship. The experiment will further show if an organism will try to interact with another if they do not have a relationship with them, and which organisms will do that and why. This research is important because it will show why animals might behave the way they do in the wild and in captivity and how relationships are important to them and their survival. Then, this can lead to why certain species should not be in captivity and how humans can impact the animals' lives.

Ridgefield High School
Teacher: Patrick Hughes

Rodriguez, Evia — Project # 200

Analyzing Environmentally Friendly Biodegradable Terpene Derived Polymers as a Potential Replacement for the Polycarbonate Plastic Bisphenol A (BPA-PC)

Many people are using plastics every day, and an environmentally friendly biodegradable substitute for the common plastic BPA-PC is needed. Therefore investigating and comparing the properties of different terpene derived plastics to each other and that of BPA-PCs will determine the most suitable environmentally friendly replacement for BPA-PCs. An approach to test terpene derived polymers is to collect terpene based polymer substitutes for BPA-PC and use a DSC analysis of each polymer to observe the transition temperatures of the polymers. The DSC analysis will observe which terpene derived plastic polymer is the most robust and if the polymer is capable of replacing BPA-PC based on the temperatures at which each polymer deforms. Terpene derived plastics formed by replacing petroleum-based materials with environmentally friendly materials will likely not function as well as BPA-PC since some molecules from the BPA-PC polymer may not work cohesively with the terpene derived substitute. Synthesizing new terpene derived polymers could be a better solution because molecules curated for the terpene derived polymer can be used instead of molecules directly from the BPA-PC polymer. BPA-PC and similar plastics are large contributing factors to waste build-up in landfills and oceans due to their lack of degradability. Plastic in landfills and oceans release harmful chemicals over time, which terrestrial and marine life are exposed to. Finding an environmentally friendly and biodegradable substitute for BPA-PC is important in order to begin to resolve plastic waste buildup.

Ridgefield High School
Teacher: Patrick Hughes

Roll, Allison   Project # 201

Identification of Environmentally, Economically, and Ecologically Sustainable Polyculture Models for application in the U.S.

It is proven that intercropping is a more sustainable, environmentally beneficial, and resource-efficient agricultural practice than monoculture. Yet most farmers use monoculture for its greater economic yield. There are many published experimental intercropping studies, but a scarcity of data-driven studies synthesizing a broad assessment of optimal economical configurations and their applicable scenarios. This project seeks to identify and quantify economically viable intercropping configurations for application in the U.S. Bioinformatics research is adaptive depending on the form and location of the data being analyzed. Intercropping studies will be queried using Julia programming language and data will be extracted to generate quantitative models. These models will be compared using regression plots to predict economic output given different factors. Experimental models will be created using APSIM software, plotted, and compared to predicted models. Conclusions will synthesize and identify optimum economical configurations. I am currently in the process of retrieving data and have not yet produced results. The next step after obtaining intercropping configuration models is to test the configurations experimentally. If the theoretical configurations have the same effect in practice, then they can be applied directly to farm practices. With the rise in precision agriculture and potential for AI to replace less versatile harvesting mechanisms, it will become possible and economically advantageous for large-scale farmers to implement and grow these diverse crop configurations.

Bridgeport Regional Aquaculture Center
Teacher: Kirk Shadle

Sandhu, Arshdeep
Jureller, Isabella   Project # 202

The Effect of Extracurricular Activities on Student Stress

In an era where students overschedule themselves with activities and classes, reports of high levels of student anxiety are increasing. We wondered if there was a correlation between the two ideas, as students may be placing too much stress on themselves. The focus of our research is on how extracurricular activities impact student well-being. We obtained access to Ridgefield High School's Challenge Success Survey. The survey was analyzed for data relating to extracurriculars and their impact on student stress and academics. The National Challenge Success Survey was analyzed specifically for the effect of extracurriculars on family time and sleep cycles. Then the data from both surveys were compared and connected to synthesize ideas on the relationship between extracurriculars and student well being. Students taking higher-level classes, experience more stress and are unable to keep up with some of their afterschool activities; many end up dropping those activities. The national data supports that high-stress activities lead to unhealthy sleep cycles. Since students are overscheduled with school work and other activities, they are unable to keep up with the amount of work they have. This increases stress levels leading to mental health problems. Overscheduling is detrimental to a student's health. Taking part in extracurriculars is supposed to be for the enjoyment of students, it should not be increasing stress levels. This research sheds insight into how high-amounts of stress affects student's well-being and raises solutions that could decrease the amount of stress placed on these students through their extracurriculars and school work.

Ridgefield High School
Teacher: Ryan Gleason

Satheeshkumar, Sibi   Project # 203

Sequence specific designing of phage to Combat Antibiotic-Resistant Bacteria

A UN report predicts that drug resistance could kill 10 million people annually by 2050. The main cause of this is the misuse of antibiotics. Apart from finding new antibiotics, recent studies have also explored phage therapy. Motivation for this study stemmed from the number of recent bacteriophage publications. The proposed research will investigate available DNA and protein sequences from phagesdb.org. The phage database is a repository of phage and bacteria sequences. The study will aim to utilize modern data analytics, AI and known sequence analysis tools like Blast. Initial research will focus on surface proteins and aim to find a specificity pattern, based on sequence analysis. The study will propose a specificity formula which can be tested in a laboratory. The end result is a formula that is able to predict the specificity of bacteriophage towards a specific bacteria which can also be inversely related. The expected results are that the phages that have similar inversive properties of genomes in surface proteins will be the most effective against that bacteria. Subsequent research may help researchers and doctors to find more efficient phages to treat bacterial infections. In particular, multidrug resistant (MDR) and extremely drug resistance (XDR) bacterial targets.

Darien High School
Teacher: Guy Pratt

Satish, Anika   Project # 204

Estimating Ice Elevations Using a Bayesian Model and Satellite Image Data with Minimal Error

If completely melted, ice sheets could raise global sea levels by 60 meters. Satellite datasets provide an aerial view of these ice sheets, however, they do not measure thickness. A Bayesian model provides probabilistic inference that continuously updates the certainty of a given hypothesis. Bayesian mathematical models allow for more accurate estimations of ice sheets' thickness. NASA's GRACE mission satellite data covering multiple time periods is used as the control for this experiment. The prediction model is developed in Python through the Jupyter notebook to determine the trend in ice sheet thickness, and the corresponding sea level. The error of the model is also calculated using Python to determine the prediction's accuracy. Since ice mass elevations have a decreasing trend, there is a corresponding increasing trend in sea level. There is an increasing trend of ice mass loss, implying higher sea level with minimal error due to NASA removing certain error from the initial data. This study will lead to an understanding of efficient mathematical models to understand the risks of melting ice sheets in the near future. It will allow researchers to predict ice mass in other ice sheets and consider global effects of an increase in sea level. It will also lead to the creation of more efficient mathematical models to analyze large, unknown datasets more accurately in other areas of scientific research.

Darien High School
Teacher: Christine Leventhal

Scheggia, Fatima   Project # 205

The Effects of Vitamin B9 on the Health and Lifespan of Callosobruchus maculatus

Vitamin B9, or folate, is found in foods such as legumes and broccoli, as well as in supplements such as folic acid. This vitamin is essential for optimal brain and nerve function but has not been connected to increased lifespan. This project's purpose is to find out if vitamin B9 can improve overall health and extend lifespan in Callosobruchus maculatus, the bean beetle. It is hypothesized that the insect's lifespan will increase with consumption of vitamin B9-rich foods. Bean beetles will be divided into equally-numbered groups and placed in three containers. The first container will contain the bean beetles' normal diet, the second will contain B9 supplements and their normal diet, and the third will contain B9 foods and their normal diet. The bean beetles will be observed and changes will be recorded. The number moving and alive will be counted daily over the span of several weeks. The experiment will then be repeated. It is expected that bean beetles consuming the vitamin B9 supplements will move the least and have the shortest lifespan of the variables tested due to the concentration of the supplements. It is also expected that the Bean Beetles on the vitamin B9 food diet will move the most and have the longest lifespan compared to the control of just their normal diet. Results of the study are still underway. The experiment will likely show the importance of eating foods rich in vitamin B9 to improve health and increase lifespan. 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.

Sacred Heart Greenwich
Teacher: Mary Musolino

Schmidt, Lana   Project # 206

Propulsive Power Signatures and Increased Power Production in Athletes using Functional Isokinetic Training Compared to Weight Based Isotonic Training

Training is key to the improvement of athletic performance. It is crucial, though, to ensure that training is safe and effective. To train effectively, an athlete looks to produce power, a measurement of force times velocity, comparable to an athlete's speed and strength. Isokinetic resistance is a newer training method that allows varied force outputs and constant speed by the user throughout a motion, contrasting the constant forces and varied speed of lifting free weights. This study compares power production in barbell deadlift motions of the isokinetic resistance training to the traditional free weight method. The power the subjects produced was measured in 10-millisecond intervals throughout the motion using a force plate and a displacement tether. The results indicate that the subjects were able to generate greater power throughout the entire motion while using the isokinetic resistance technology over the free weight lifts. The users also generated more complex power signatures throughout the motions when using the isokinetic resistance.

The isokinetic training allows subjects to produce significantly more power at each moment because it allows them to apply more force in joint positions with greater mechanical advantage whereas, with free weights, the subjects are only able to lift weights doable at their weakest point and not maximize the potential of stronger positions. The power signatures were more complex in the isokinetic training because the user has greater ability and likelihood to adjust the force they put into the motion throughout the motion.

Darien High School
Teacher: Guy Pratt

Scully, Peter   Project # 207

Designing a Math Application to Increase Students' Understanding

There are a large number of students who do not learn math well from traditional methods, largely due to lack of engagement or instant feedback. Many apps have been created to help them, but they often struggle to effectively combine engagement and teaching. To better aid these students, an educational android application based on the 24 game, where players use four numbers and arithmetic operations to reach 24, was created. This solution was created using Android Studio by the student with guidance from the mentor. The initial focus was on creating the basic game, which had instructions and the ability to play 24 on different difficulties, with easy mode having only addition and subtraction, normal mode having the arithmetic operations, and hard mode having exponents too. Afterwards, supplemental features such as levels, a timed mode, and more were added. While trials with human participants were not conducted yet, predicted results include that the app improved students' understanding of arithmetic and engaged students. These students would be in upper elementary school, and these results would be indicated by improvements in scores from pretest to posttest and positive feedback on the survey. This application can help students who struggle with mathematics by engaging them and helping them to hone their math skills. With this help, these students will be able to do better in school and develop a greater appreciation for the world of mathematics. This application may also provide the opportunity for more successful students to also hone their skills.

Amity Regional High School
Teacher: Catherine Piscitelli

Scura, Lucie   Project # 208

The Effect of Nectar Distribution on Fecal Deposition in Bumble Bees: Implications for Disease Transmission

The effect of nectar distribution on fecal deposition and the implications of these results for disease transmission for bumble bees was evaluated. We predicted that spreading out nectar rewards more evenly would increase fecal deposition on that inflorescence due to the increased foraging time to acquire the nectar reward. The depositions would be concentrated on the outside of the flowers because of the flower morphology and flower size. Because the gut pathogen is transmitted via infective spores in the feces, depositing feces on flowers has the strong potential to transmit the pathogen to new hosts. Bumble bees were allowed to forage on a treated native plant with clumped nectar treatments and evenly distributed nectar treatments. There were significantly more fecal droplets on flowers with evenly distributed compared to clumped nectar resources (P=0.02777). When comparing the evenly distributed (2 ul) and clumped (10 ul) treatments within a cage, there is +.3509 more fecal deposition on the evenly distributed treatments. In a global context it becomes increasingly important to recognize how pathogens are spread and continue to thrive in an ecological setting. Pathogens are a primary concern in the decline of pollinators. We rely on pollinators for 30% of our diet and with a rising dependence on pollinators for crop pollination the need for understanding disease transmission becomes vital.

Darien High School
Teacher: Christine Leventhal

Sereday, Michael   Project # 209

Measuring the Effect of Various Printing Factors on Structural Integrity of 3-Dimensional Printed Objects

There has been testing done on how varying individual print characteristics affects tensile/compression strength of 3-D-printed objects, but very little testing on how combinations of these variations affect tensile/compression strength of 3-D-printed objects. Many iterations of the same object will be printed with several characteristics varied (including but not limited to: layer thickness, fill/internal structure, extrusion temperature, and build plate temperature), then the tensile and compression strength of said objects will be tested using a universal testing machine (UTM). The UTM will measure the tensile force and compressive force needed to break said objects and the resulting measurements will be used to deduce what combinations of variations of printing characteristics is/are most resilient to tensile and compressive forces. Each iteration of this object will be printed twice in order to see how these variations affect both tensile and compressive strength.

Newtown High School
Teacher: Timothy DeJulio

Seymour, Anna   Project # 210

Using LED Net Illumination to Reduce Sea Turtle Byc

Bycatch of unwanted species is a problem in commercial fisheries, especially in trawling fisheries because trawling nets are not species-selective. Sea turtles can become captured in trawling nets and drown. This is an issue because many species of sea turtle are endangered. Can LED lights be used to reduce sea turtle bycatch in a bottom-set shrimp trawling fishery in the Gulf of Mexico without affecting the target species catch rate? Sea turtles are sensitive to LED lights so will be used as a visual cue so they avoid the nets, shrimp are not sensitive to LED lights so it will not affect the catch rates. Green LED lights will be placed every 5 meters on the float line of the nets. There will be 50 control nets and 50 nets with the LED lights. This will take place for all of the Gulf of Mexico's shrimp catching season. The catch per unit effort (CPUE) of the sea turtles was reduced by 60% in the nets with LED's compared to the control nets. There was also no statistically significant difference in the CPUE of the target catch species between the nets with the LED's and the control nets. Commercial fishing is a huge threat to sea turtles and many other animals. Reducing the amount of sea turtles caught as bycatch is commercial fishing is important in ensuring the survival of sea turtles in the future. Finding ways to make commercial fishing more species selective and limiting the amount of unwanted species caught is crucial to making commercial fishing less damaging to our oceans.

Darien High School
Teacher: Guy Pratt

Shabet, Sarah — Project # 211

Visualization, Quantification, Localization and Colocalization of Tumor and Immune Cell Interactions in Lung Cancer

Lung cancer is the global leading cause of cancer death and kills more people than breast, prostate, and colon cancer combined. The vast majority of immunotherapies target the ligand PD-L1 but these treatments are largely ineffective in most mesotheliomas. An in-depth study of the cancer and immune cell interactions in the tumors of different lung cancer patients may reveal why current treatments are ineffective and open up alternate immunotherapy options. Different cancer and immune cells from lung cancer patient tumors will be stained, each cell with a different color, allowing their activities and interactions to be analyzed. Each cell type quantification and their locations in the tumor and to each other will be further analyzed by advanced computational biological methods, creating a deeper understanding of the microscopic interactions between cancer cells and the immune system. In other similar studies in mesothelioma, it was found that PD-L1 was largely absent and VISTA, a similar protein, was found in abundance. However, an increase in VISTA expression correlated with an increase in survival, despite VISTA's role being to inhibit immune responses. This study aims to elucidate the mechanisms behind these findings. Discovering new ligands that interact with tumors and the immune system may open up CAR T-Cell-like treatments that target these ligands. Understanding the inner workings of these interactions is an integral part of developing immunotherapies that can be used to treat patients with a variety of different cancers, saving thousands of lives for generations to come.

Darien High School
Teacher: Christine Leventhal

Sharonov, Anthony — Project # 212

Designing a Device to Remind People Seeking Independence to Take Medication

An obstacle that a person seeking independence may face is memory. This includes teenagers wanting to become adults, or the elderly wanting to live by themselves. These people might need medication that can be easily forgotten about. The purpose of this project is to create a device that will remind people to take their medication and dispense it at a set time. To accomplish this goal, an Arduino microcontroller, servo motors, and an array of infrared transmitters and receivers will be used for the primary pill disposal mechanism. To alert the patient, LEDs and buzzers will be used. Also, caregivers will have the ability to set the time without any knowledge of programming using an LCD and keypad. Pills will be placed in Ç£capsules, Ç¥ pushed by a servo into the infrareds. Data trends thus far show that the device dispenses successfully at correct times. The infrared array detected the capsule every time, and all alarms were shut off when the capsule was taken out. This device will be a great resource to those wanting to live independently, and relieve caregivers' anxiety by allowing them to be in full control/be safe with the idea that their family member is taking their correct medication. Without this device, the merge into independence may be very difficult, and it eliminates a common problem many people may have.

Amity Regional High School
Teacher: Nicholas Shamp

Sheehe, Elise   Project # 213

Completed Project, Engineering, Physical Science

Use of Generative Design to Optimize the Design and Manufacture of a Drive Shaft

Current drive shafts are either constructed from cheap yet heavy metal or lightweight but expensive composite material, and a balanced solution is needed in order to create the most efficient drive shaft possible. Generative design is a new and optimal design process for this case, as it allows the user to produce a stronger structure using less material. Using the generative design program Fusion 360, a basic drive shaft was designed to match today's design standards. The site AmesWeb was used to determine how much torque the model could transmit. The program highlighted areas of stress and unnecessary material to be adjusted after virtually applying loads and constraints. The streamlined design was 3D printed once it proved to transmit equal torque (rotating power) while utilizing less substance. The improved generative design product was compared using a data table to the original model. The table proved that the final design was lighter than the original, yet it maintained an optimal strength-to-weight ratio. This generative design project was undertaken to create an optimized and more efficient design that combines advancements in strength and weight, allowing the vehicle that the drive shaft belongs to to carry more cargo weight. Ultimately, this project utilized a new design methodology to design an improved drive shaft that could one day replace current outdated drive shafts as 3D printing becomes a cheaper and more accessible manufacturing option.

Amity Regional High School
Teacher: Nicholas Shamp

Sheridan, Olivia   Project # 214

Completed Project, Science, Health and Medical

CRISPR-induced point mutations in the donor sequence greatly decrease the percentage of donor sequence--double-strand break encounters during homology search.

Recently, ethical concerns have risen about Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) gene-editing, specifically in the context of the CRISPR-edited babies in China. Although the literature describes the rate of repair when mutations are introduced into DNA, it fails to address the specific impacts of CRISPR on error-free (high-fidelity) repair processes. To address CRISPR's impact on genomic repair processes, we introduced point mutations into the model organism Schizosaccharomyces pombe, specifically into a sequence needed for homologous recombination (HR). We inserted various numbers of point mutations into this sequence and induced a double-strand break (DSB). We visualized repair via HR using GFP and Rad52-mCherry tagged proteins, noting interactions between the DSB and the DNA template used for repair. Our findings showed that strains with CRISPR-edits may not repair via HR as expected, but rather through an error-prone pathway known as non-homologous end joining (NHEJ), as the percentage of DSB'donor sequence interactions were greatly reduced compared to wild-type cells. These results suggest that CRISPR-edited genomes are harder to repair accurately. This could lead to increased risks for early onset cancers and diseases that result from faulty cell cycle checkpoints. We expect these findings to help guide long-term studies on the CRISPR babies in China to determine whether CRISPR is safe for humans. Additionally, we expect this work to inform health care physicians as they monitor these children over time, considering that, without proper DNA repair, they may have increased risks for developing early-onset disease due to CRISPR-induced edits.

King School
Teacher: Victoria Schulman

Silbert, Jacob   Project # 215

Analyzing the effect of various deicing compounds on the germination and development of Phaseolus vulgaris

Sodium chloride is the most commonly used deicing salt, but it has been shown to be detrimental to plant growth and persist in the environment long after its application. It can cause nutrient imbalances within plants, which can increase osmotic stress or. Deicing salt use is on the rise, so its effects should be well understood. Alternative deicers exist but are seldom used due to their relative expensiveness. The study started with a dose range finding experiment to determine what molarity to use in the actual experiment. After, all salt solutions were made using that molarity. At the beginning of each week, the beans were watered with the appropriate solution and had their height measured. At the end of experimentation, plant coloration, soil pH, and final plant mass were measured. It was hypothesized that the calcium magnesium acetate solution would harm the plants' germination and growth the least. This was tested by measuring time to germination, plant height, coloration, soil pH, and plant mass. The results indicated which deicer is the most environmentally friendly. The statistical significance of the results was assessed with T-tests. There is a lack of research on the comparison between sodium chloride and alternative deicers. There is also a misconception that alternative deicers are more expensive. This study provided a comprehensive comparison of each deicer's environmental impacts, which will help consumers make more educated decisions. This, consequently, could save communities money on aesthetic repair costs, answering the financial concerns around alternative deicers.

Amity Regional High School
Teacher: Catherine Piscitelli

Simari, Charlotte   Project # 216

Use of C. spinosa in mitigating climate induced wildfire risk

Wildfires have been, and will be, problematic due to many factors, one being climate change. These fires can often wipe out species as a whole and can lead to adverse effects on people and other animals living there. The C. spinosa is a drought and fire resistant plant natively grown in Turkey. The problem of this experiment is to see what is the effect of the C. spinosa on wildfire. There will be a controlled study done, by fencing off a plot of land, by replicating the ecosystem of North Dakota and planting the C. spinosa. After six months of monitoring the C. spinosa and its effects on native plants, the plot will be burned. The fire will be compared to a control fire which is just burning a plot of native plants. The effect will be determined by monitoring the duration, size, and sustainability of the fire. The C. spinosa will most likely contain the fire and have minimal effect on native plants, because of its proven fire resistance and already existing little impact on native plants. If the experiment shows that the C. spinosa has a minimal effect on native species and helps to keep a wildfire to a minimum, then it should be planted in spots that are very prone to wildfires and get little rain, such as California.

Darien High School
Teacher: Guy Pratt

Simons, Noah   Project # 217

Various Adhesives Ability to Prevent Corrosion and Malfunction of Printed Control Boards When Exposed to Extreme Moisture

The problem I am looking into is the research behind adhesives and their ability to prevent moisture from corroding Printed Controls Boards. I want to look at two different adhesives which are silicone and epoxy resin and expose them both to extreme amounts of water to see how they fare. Obtain 18 IPC-B-25A boards and cut them vertically. Once the F boards are isolated randomly assign 6 to each of the three different methods, control, silicone sealant, epoxy resin sealant. Coat all boards with their assigned sealant. Immerse the boards into 1 meter of water for all boards, for each type of board applies 3 voltages of energy using BK Precision DC power supply model 1670A to the boards. Leave for 60 minutes and test whether they function or not. Next repeat for the next three different boards with applying 6 volts for 60 minutes. Lastly, repeat the step with 12 volts for 60 minutes. Once all these trials are completed repeat the whole process with a 5% saltwater solution. To analyze the data I will look at their ability to withstand the water and compare them by looking at their ability to function after a long time being exposed to the water. This test will give insight on which adhesives are better suited for large amounts of water in protecting Printed Control Boards.

Joel Barlow High School
Teacher: Katherine Nuzzo

Slanski, Abigail   Project # 218

Using an Automated Coating System to Optimize Nitric Oxide Release Patterns of Antibacterial Catheters

Intravascular (IV) catheters are essential medical devices used for monitoring, the deliverance of medications, and more. IV catheters are also one of the leading causes of hospital infection, due largely to biofilm formation. These infections lead to longer hospital stays and increased costs. While infections can be treated with antibiotics, increased resistance and the ineffectiveness of antibiotic locking at clearing biofilms. An antiseptic catheter, however, could circumvent these issues entirely. This project will create an antibiotic catheter by functionalizing polydimethylsiloxane (PDMS) catheters with nitric oxide (NO). Catheters were spin cast and NO releasing coatings were added using a dip coating system. One coating is composed of diazeniumdiolated dimethyl-1,6-hexadiamine (DMHD-N2O2) and polylacticglycolic acid, and the other is composed of DMHD-N2O2 and the polymer poly-3-hydroxybutyrate. The amount of coating and order of layers will be changed to achieve optimal release. NO release will be measured using a sievers Nitric Oxide Analyser. The NO release data will reveal quantity was released over time and will be compared to previous data of bactericidal NO release. The final prototype will ideally have a release pattern with rising levels for 72 hours and maintain a high level for another 24. Release should then drop off to a lesser level, releasing for 24 more hours. If successful, this catheter will use a natural compound created within the body's immune system to prevent catheter infections. The release pattern of this catheter is optimized to prevent biofilm formation, the primary cause of catheter infections and chronic infections.

Amity Regional High School
Teacher: Catherine Piscitelli

Spallone, Christian Project # 219

Testing the Effectiveness of the Raspberry Pi Sense HAT in Comparison to a Traditional Weather Station

Emerging countries lack accurate information regarding weather and climate. These gaps in knowledge prevent proper preparation for meteorological events and limit weather awareness in specific regions. Without proper recognition of future weather patterns, threatening conditions become more common occurrences, especially in the face of climate change. An inexpensive weather station was developed using the Raspberry Pi computer and its popular add-on, the Sense HAT. The effectiveness of the device was tested in comparison to a heavily researched and reputable station produced by Ambient. If meteorological data collected during the same time period aligned similarly between the two systems, the Raspberry Pi station could be deemed effective. The results of the data collected by the Raspberry Pi and Sense HAT displayed several similarities to that of the Ambient weather station. The temperature data was consistently within 1-2 degrees Celsius, the pressure data within 2-3 inHg, and the humidity data within 10% of the Ambient readings. The completed research introduces and details an additional use for the Raspberry Pi computer and the Sense HAT. The station is able to gather weather data efficiently, which enables scientists to implement small stations in areas which lack sufficient observational data. With this information, citizens of these regions can adequately prepare in advance of a dangerous weather event, therefore saving lives. The data will also add to the global bank of climate information, allowing for a more accurate modeled representation of our future world.

Ridgefield High School
Teacher: Patrick Hughes

Spataro, Gracie Project # 220

Microplastic Consumption in Alcyonium digitatum

Plastics used in everyday lives are broken down into smaller microplastics, where they are then consumed throughout the food chain. Microplastics have a significant effect on the marine environment as marine animals mistake these tiny particles for food. Microplastic consumption may inhibit the growth of coral, and possibly other marine life. Alcyonium digitatum, more commonly known as Dead Man's Fingers Coral, lives in Long Island Sound. In previous studies, Astrangia poculata, another coral living in Long Island Sound, was found to prefer microplastic beads to their nutritive prey, brine shrimp eggs. The objective of this experiment is to discover whether or not Dead Man's Fingers Coral ingest microplastics, and if they do, determine if the microplastics inhibit their ability to consume nutritive prey. Samples of coral will be provided equal amounts of microplastic and plankton, and then analyzed to see the amount present of each substance consumed. The results are expected to show that the coral will prefer microbeads to plankton because of their similar shape and size. Microplastic ingestion would stimulate a sense of "fullness" in the coral, preventing them from eating their prey, further depriving them of nutritional value. This study may lead to greater awareness of the effects of plastic pollution on the environment.

Darien High School
Teacher: David Lewis

Sperry, Isabella   Project # 221

Research Proposal, Science, Environmental

Mycoremediation Potential of Pleurotus Ostreatus to Eradicate Dyes, Copper(II) Chloride Dihydrate, and Engine Oil per Evaluation of an Ecotoxicity Analysis of Raphanus sativus

Inspired by the research of environmental activist Gabe Toth, I decided to continue his research on mycoremediation. I have always had a passion for the environment, and have a garden of my own that I enjoy maintaining every summer. My project will explore the ability of Pleurotus Ostreatus to remediate four common types of pollutants found in soil (dye, copper, and engine oil) using an ecotoxicity test of Raphanus sativus. I began by distributing Pleurotus Ostreatus mycelium into sterilized jars filled with coffee grounds. I will eventually embed them in four soil-filled drainage trays. I will contaminate one liter of water with dye, another with Copper(II) Chloride, and the soil of one tray with engine oil. I will then plant radish seeds in each tray, one of which is the control, and water two with the contaminated liquids daily. If compared to the control, radish seeds in trays containing mycelium have a higher germination rate, healthier (white and firm) roots, heavier stem mass, and an optimal appearance (bright green with abundant leaves), it can be concluded that Raphanus sativus has remediated pollutants. In a cost comparison of remediation methods compiled by Paul Stamets in Mycelium Running, it is clear that mycoremediation holds a promising grip on the future of affordable cleanup methods. Remediation with mushrooms eliminates the expenses involved in removing thousands of tons of contaminated soil to a toxic waste site. Oyster mushrooms act as a catalyst in habitat restoration by transforming contaminated ecosystems into healthy, hospitable habitats.

Weston High School
Teacher: Stacey Greenberg

St Jean, Abby   Project # 222

Research Proposal, Science, Behavioral

A Retroactive Analysis Comparing Three Alternative Treatments for Depression as Opposed to the Traditional Antidepressant Treatment

Depression is a common mood disorder affecting the way one thinks, acts and works, and is an issue becoming increasingly prevalent in society. Depression is most commonly treated with antidepressants, however, antidepressants have many negative side effects which often outweigh the positive effects. These side effects include nausea, fatigue, insomnia, blurred vision, loss of appetite, and increased anxiety. There are also many alternative ways to treat depression that do not involve the side effects that traditional antidepressants do. Art Therapy, Cranial Electrotherapy Stimulation (CES) and Ketamine treatments are all proven effective to treat depression. The purpose of this study is to determine the efficacy of 3 alternative treatments to depression, and to find the most effective non-medicinal treatment. There will be three treatment groups and one healthy control group. Data will be collected from 3 separate studies comparing Art Therapy, CES, and Ketamine to healthy controls. Since different inventories are used to determine the severity of Depression, an index will be created to compare the depression severity with the healthy controls. It is hypothesized that the symptoms of depression will decrease with all 3 treatments. However, Ketamine will be more effective for short term relief, CES will be more effective for long term relief, and Art Therapy will take more time for relief to occur. Alternative treatments represent more beneficial methods for treating depression that allow patients to ultimately reduce the symptoms of depression without using commonly administered medications and their associated side effects.

Darien High School
Teacher: Guy Pratt

Stiel, Julian   Project # 223

Engineering the production of a bacteriochlorophyll precursor in the model cyanobacterium Synechococcus elongatus

Photosynthesis underlies many industries, including agriculture, and it is the only process currently known to sequester carbon dioxide on a planetary scale. However, oxygenic photosynthesis is constrained to using visible light, which drastically reduces efficiency. This project aims to produce a precursor to bacteriochlorophyll a, an infrared-absorbing pigment analogous to chlorophyll, in the UTEX 2973 strain of the model cyanobacterium Synechococcus elongatus. This will be done by introducing the BchXYZ genes, which encode chlorophyllide a oxidoreductase, into the genome of S. elongatus UTEX 2973. Well-established genetic engineering techniques, including tri-parental mating, will be used to this end. After the strain is engineered, pigments will be extracted by following previously described protocols and analyzed via spectrometry. If the production of 3-vinylbacteriochlorophyllide a is successful, a change in the absorption spectra of extracted pigments is expected. This would represent the first step towards redesigned, efficient photosynthesis, which could ultimately lead to drastic advances in food and biofuel production while simultaneously providing a new tool to combat the climate crisis. Future endeavors to produce bacteriochlorophyll a and the antenna complexes needed to utilize it in a cyanobacterium will be necessary to fully realize these benefits.

Weston High School
Teacher: Stacey Greenberg

Su, Allison   Project # 224

Creating and Implementing a Model that Predicts Concentrations of the Air Pollutant $NO_{éé}$ in Springfield, Massachusetts

The aim is modeling and predicting the concentration of $NO_{éé}$ in Springfield, Massachusetts, a city with a high pediatric asthma rate, using ArcMap, a Geographic Information System (GIS)-based desktop application, and a linear regression equation. $NO_{éé}$ is an air pollutant that is linked to cardiovascular and respiratory health risks. A main source of $NO_{éé}$ is transportation emissions, and in some areas, industrial combustion is a major source. Using data collected in Springfield in summer 2018 and from databases online, ArcMap 10.4.1 was used to create a map that shows $NO_{éé}$ concentrations based on predictors determined in R. After all the data was compiled, a linear regression model was used to predict $NO_{éé}$ concentrations based on these predictors. A similar process was used with data from winter 2018 but with different predictors. The equation for the linear regression model of estimated $NO_{éé}$ concentrations was determined in R. This equation was applied to compute estimates of ambient $NO_{éé}$ at high resolution across the study area, visualized in a colored map. There are higher concentrations near industrial areas and areas of transportation and lower concentrations near open land areas. The models can inform community decisions to reduce ambient exposure to $NO_{éé}$ and inform officials on where there are higher concentrations of $NO_{éé}$. For example, emissions could be cut if shown to be correlated with a high $NO_{éé}$ concentration. Regulations on air pollution could potentially be enforced.

Amity Regional High School
Teacher: Catherine Piscitelli

Sundararajan, Pranav — Project #225

Investigating The Effect of Online Versus In Person SMART Goal Clarification on Academic Procrastination

Procrastination is a widespread phenomenon in students, with an estimated 80% of college students in North America displaying academic procrastination. Procrastination can have negative consequences such as poor academic performance and stress. The problem statement was which delivery method of goal clarification intervention, either online or in person, yields the most reduction in levels of academic procrastination?

Participants were gathered and organized into three groups; two treatment groups and a control given no treatment. The first group was treated online with the SMART goal clarification system for two weeks. The second group was treated in person with the goal clarification system for two weeks. The PASS (Procrastination Assessment Scale for Students) was given before the study, 1 week in, and after the study to measure procrastination.

Data trends thus far show that the intervention delivered online was more effective than the face-to-face intervention. Data analysis was done with non-parametric tests, specifically the Wilcoxon Rank Sum Test due to the distribution of data. This study provides more data about methods to reduce procrastination by exploring another type of intervention as well as delivery methods for these treatments. The main implication is finding a more efficient way to reduce procrastination which could improve the quality of life and academic achievement for some students.

Amity Regional High School
Teacher: Catherine Piscitelli

Sweeney, Edwin — Project #226

Using Glycerin and Potato Starch to make a Biodegradable and Renewable Plastic Bottle

Billions of (PET) polyethylene terephthalate water bottles are thrown into landfills, the environment each year. Polylactic Acid (PLA) is a plant-based plastic that's made from starch. Since starch is plant-based, it's more environmentally friendly, breaking down faster than PET plastics. During food production, millions of potatoes are thrown into landfills. By using potato starch, I created a PLA water bottle using lactic acid to substitute PET-based water bottles. Some factors that were taken into account were the types of materials that were used. In order to make the plastic: vegetable glycerin, organic potato starch, vinegar, and water were heated and stirred in a pot until gel is formed. Then, the gel was poured into a silicone mold of a rod. The tube was then blow-molded into a plastic bottle. The bottle was tested for leaks by filling the water bottle with water. The bottle's strength was tested by hanging weights off the side of the bottle. Different temperatures of water were poured into the bottle to see how temperature would affect the pH levels. The pH levels were tested with a pH meter. Some greater implications of this would be investigating alternative food products that can be made into plastics. This could reduce the number of harmful chemicals that enter the environment creating a cleaner world. Equally as important, it would provide another renewable material source for making plastic products.

Amity Regional High School
Teacher: Nichoals Shamp

Tang, Luhai   Project # 227

The Effect of Listening to Music on Reading Comprehension

High school students sometimes listen to music while they are studying, or trying to get an assignment done, and this may or may not affect their concentration. While listening to music, they may pay more attention to the music they are listening to, and may not be as productive. The purpose of this experiment was to find out whether or not music affects the productivity and outcome of reading comprehension. The hypothesis was that if a high school student listens to music while trying to do a certain assignment, then their productivity or score would be worse than if they were not listening to music. The independent variable in this experiment was whether the students listen to music or not, and the dependent variable in this experiment was the reading comprehension score of the questions that follow. A reading comprehension assignment was assigned to each student, and they were told whether or not they were going to listen to music or not. If they are going to listen to music, they had the choice of what music to listen to. They then proceeded to complete the reading assignment while listening or not listening to music, and the score of the information given through the reading assignment were be taken into account. The data from the experiment was taken in the form of scoring or grade. The score of the comprehension questions answered after the reading, without going back to the text, was accessed to see the studying results of while listening to music compared to when not. The scores were used to compare whether listening to music affects your concentration or learning against not listening to music. The data trend so far supports the hypothesis. The implications can show whether or not students should be allowed to listen to music or not, whether or not teachers should be allowed to play music during class, but can also extend to whether or not music can actually help concentration with work.

Amity Regional High School
Teacher: Catherine Piscitelli

Tischer, Aiden   Project # 228

Incorporating a Bacteriophage Cocktail and Vancomycin into Emulsified Propol to prevent Staphylococcus aureus Surgical Site Infections in Vitro

Antibiotic resistant surgical site infections cost the U.S. medical system millions of dollars, increase hospital stays and risk of mortality. Bacteriophages are shown to be a viable treatment for antibiotic resistant bacteria with its ability to break down biofilms, induce bacterial lysis and stay in circulatory systems for several days. This project will incorporate a bacteriophage cocktail and Vancomycin into Emulsified Propol to target Staphylococcus aureus surgical site infections. Culture Methicillin-resistant Staphylococcus aureus (MRSA), combine with bacteriophages to amplify and filter to purify phages. Again culture MRSA on dacron sections to grow biofilms. Apply phage, Vancomycin and 10% Intralipid (replacement for Emulsified Propofol) mixture, Intralipid and Vancomycin (control) and Intralipid (control). Place solution on sterile TSA to determine bacteria cell density. Collect data and analyze with Statcrunch. Findings thus far support the hypothesis. This treatment has the potential to save many and reduce the threat posed by antibiotic resistant surgical sites infections. In addition to this, it would substantially reduce the stress antibiotic resistant infections put on the United States medical system, reduce the cost of treating antibiotic resistant surgical site infections and the length of hospital stays.

Amity Regional High School
Teacher: Catherine Piscitelli

Viswanathan, Shyam   Project #229

Designing and Testing an In vitro 3D Tumor Model System for Preclinical Applications

For decades 2D in-vitro modeling (glass slides) in science has been the default when it comes to viewing cells and tumors. 2D models which are used in drug discovery which show positive results often fail when tested further. The purpose of this project is to create an effective 3D in-vitro modeling system (a gel to grow cells in) that will be comparable to in-vivo animal responses . Part one of this project is growing varying numbers of cells in various concentrations of agarose with a constant about of PBS(media), to determine which concentration of agarose has the best growth of cells. In part one of this project, wells composed of various mixtures of agarose (a refined form of agar) and different concentrations of PBS (Phosphate-buffered saline) will be put into 4x6 trays. There will be 4 compositions, each composition will have 6 wells. The 1st well of the 6 for each composition will contain 25,000 cells, the 2nd, 50,000, the 3rd, 100,000, the 4th, 200,000, the 5th, 400,000, and the 6th, 800,000. All the cells will be perfused in Opti-Mem (a type of media). Tumors grew and developed in the wells. This results were verified by a pathologist. Drug testing is still in trials. Overall the goals of the project were successful. This work has the potential to reduce animal testing, cost, time, and resources that are required for drug discovery.

Amity Regional High School
Teacher: Catherine Piscitelli

Viswanathan, Arjun   Project #230

Using Kinetic Monte Carlo Methods Learned from Molecular Dynamics Simulation of Hydrocarbon Chemistry to Predict Outcomes of Similar but Different Systems

Molecular Dynamics (MD) simulation data on a reactive system is used to statistically learn a Kinetic Monte Carlo model, which is significantly faster in mapping system evolution over time. Combine multiple KMC models from multiple MD simulations and extrapolate molecular evolution over time for many different chemical reactive systems, for example, MD simulations of methane, ethane and isobutane combined together in a system and learning a KMC model. Use a computer algorithm that uses a learnt reaction network from the MD data, in the form of a matrix containing stoichiometric coefficients, and reaction rate constants statistically learned from MD. Then use KMC, specifically Gillespie stochastic simulation algorithm, to simulate the reaction network. For example, if methane and a CH_2 group molecules reacted to form Ethane, and the matrix line will be [-1, -1, 1] with negative being a reactant and positive being a product. The algorithm is based on probability, i.e it updates molecule counts by the reaction that is most probable to occur. So if a specific reaction A's reactants are more abundant than reaction B's reactants, then the algorithm picks reaction A. This method is used to update the molecule counts of the reactive system being mapped. Run the algorithm for a given time scale, logging all molecule counts and plot the counts against time. The graph will show the evolution of the system, which we will show whether it is correct when applied to a different chemical systems consisting of the same reactions but different initial molecule concentrations. Project still in progress Through the success of the combined KMC model, scientists can now rely on more efficiently predict the outputs of a variety of chemical reactive systems.

Glastonbury High School
Teacher: Diane Pintavalle

Voellmicke, Isabel   Project # 231

The Impact of Immunological Factors on the Etiology of ASD

Autism Spectrum Disorder(ASD) is a common, complex condition that causes repetitive behavior and impairments in communication and sociability. Given autism's complex etiology, causes are mostly unknown. Through research, the immune system has shown influence on the autistic phenotype through cytokines during the prenatal period, known as maternal immune activation(MIA). If immune factors involved with ASD can be targeted, then the ASD symptoms can be reduced or eliminated. For this study, a meta-analysis will be performed. Anonymous data about timing, length and type of infection during pregnancy will be collected from databases as well as condition of the child postpartum. This data will show the effect that infections have on the fetus and whether timing, type, or length of infection impacts the autistic phenotype displayed. This data will show the significant impact that infection has on the severity of ASD. An earlier or more severe infection will likely increase the severity of ASD, due to increased cytokine passage across the placental barrier. The timing of the infection during the fetus' developmental period will indicate which organs are being most affected, linking characteristics of ASD to certain infections during pregnancy. This research will aid in determining a more definite cause of ASD and aid in the prevention and treatment of the disorder. Therapy based on findings from this immune research will provide a more personalized treatment for patients with ASD. These therapy options could reduce symptoms and raise autistic patients' quality of life, potentially helping to treat millions of autistic individuals worldwide.

Ridgefield High School
Teacher: Patrick Hughes

Vollmer, Ursula   Project # 232

The Effect of Anti-Inflammatory and Aromatic Spices on Repelling Beetles from Plants

A farmer's main goal is to ensure they are producing the highest quantity of crops to support their community. Many farmers choose to utilize conventional pesticides to ensure the growth and quality of their crops. Pesticides have been shown to lead to many dangerous health effects, however, including depression, cancer and ALS. This study looks at applying spices in lieu of conventional pesticides as a more eco-friendly version. It was hypothesized that the spices tested would be effective in repelling beetles due to their aromatic properties. This study used cinnamon, turmeric, cilantro, and cayenne pepper, along with a traditionally used pesticide and no pesticide as controls. Each spice solution was sprayed over plants in a container with beetles, and monitored for several weeks to determine how well each spice repelled the beetles and how it affected the plant. This study is still underway, but initial results seem promising. The spices used in this study have not yet been tested or reported in the literature, therefore the study will produce new results. Furthermore, it is important research that will indicate the general success of utilizing alternative methods over conventional pesticides. Spices have been shown to work as an effective replacement as they have not only repelled beetles, but have proven to not kill or degrade the quality of the plant itself. For future research, tests could potentially be conducted with other spices and plants, and potentially with other insects.

Sacred Heart Greenwich
Teacher: Mary Musolino

Wang, Sophia   Project # 233

Optimization of a Real-Time Sinkhole Detection System Using Localization Methodology, Machine Learning Algorithms, and Limestone Dissolution Modeling

In the United States, 20% of land is susceptible to sinkholes. Designs derived from civil engineering (structural health monitoring system (SHMS), wireless sensor network (WSN), and localization methodologies) and computer science (the Internet of Things (IoT), Artificial Intelligence/Machine Learning (ML), and the Discrete Element Method (DEM)) were used to more accurately and efficiently detect sinkholes compared to current methods, which are single frame detections and inapplicable to the most dangerous sinkhole type (cover collapse). SHMS and WSN were used to create a sensor network and sensing device that could diagnosis underground structural state in real time by modeling the limestone dissolution process. IoT was applied to create a user friendly interface, and ML algorithms were developed to automate real-time data analyzation. A numerical limestone dissolution model based on the Discrete Element Method (DEM) was programmed to determine ML algorithm classification features. The real-time inertial measurement units (IMU) from sensor data was used to derive location predictions for sinkhole formation. To test the system, a cover collapse sinkhole was physically modeled using karst geology. The sensing devices were placed in set locations prior to simulation. The sensor data was recorded during simulation and ML analyzed in real-time to provide for a significant detection, prediction, and localization period prior to sinkhole collapse. The detection system accurately and efficiently detected future sinkhole occurrences in real time, and when advanced, these designs have the potential to not only reduce property damage, but more importantly, eliminate the massive public health threat that sinkholes pose.

Amity Regional High School
Teacher: Catherine Piscitelli

Wang, Sienna   Project # 234

Modeling the Complexities of E. coli Transmission in Bangladeshi Children in order to Calculate Risk of Early Childhood Diarrhea (ECD)

Growth stunting, a major problem that affects one in three children aged 0-5 years old in Bangladesh, causes a five-fold increase in risk of mortality. A primary cause of growth stunting is early childhood diarrhea (ECD). The knowledge of E. coli ingestion pathways through agent-based modeling can inform more successful interventions than current ones. The objective of this project was to create a model of the complex fecal-oral pathways of pathogenic transmission and study the role these play in ECD. Data from a WASH Benefits Trial in Bangladesh was inputted into the model, run in the software NetLogo. The data consisted of diarrhea occurrences in children, E. coli amounts found in household vectors (food, hands, soil, stored water, flies), season, rainfall, and geospatial location. Hazard variables of animal presence, within-household interaction, and sanitation infrastructure, among others, were incorporated into the framework of the model. Exposure to E. coli was calculated across four different pathways: mouthing hands, drinking water, eating food, and eating soil. The combination of the hazard and exposure variables was used to calculate a risk of ECD. BehaviorSpace, a function of NetLogo, was used to validate the model; experiments provided for the total number of ECD cases and amount of E. coli ingested per child per year of each exposure pathway, allowing for error analysis and ANOVA tests. Timeline is on track to successfully complete the model. Trends thus far show food and soil as major contributors to E. coli consumption and risk of ECD.

Amity Regional High School
Teacher: Catherine Piscitelli

Wang, Zachary   Project # 235

Completed Project, Engineering, Environmental

Simple Creation of Portable Renewable Energy using a Recycled/Repurposed Water Bottle ' C. reinhardtii Biophotovoltaic System

Climate change remains at the fore of current research initiatives, as the depletion of our natural resources continues. Biophotovoltaics (BPVs) has come into focus as a promising renewable energy resource. Unlike solars, which require expensive materials for their fabrication, BPVs are constructed with recycled materials, and are particularly useful in remote, underdeveloped areas. The output of BPVs, however, remains poor; improvement is needed to increase its viability. This study reversibly immortalizes primary primate hepatocytes (PPH) by transfecting with viral oncogenes SV40LT and hTERT using calcium phosphate method. Isolated immortalized primate hepatocytes (IPH) produce measurable albumin and urea. Tumorigenicity of IPH will be tested by intrasplenically implanting12-week-old nude mice with IPH and implanting additional mice with human hepatocytes. Groups of five cynomolgus monkeys will each be intrasplenically implanted with IPH, injected with DMEM, or implanted with PPH. With 2.3x10-3 nmol-Chl/ml equivalent C. reinhardtii, and a 2.5x10cm 0.5mg/cm2 20%Pt-load-on-carbon, a BPV output of 235mW/m2 was realized. To increase BPV viability for remote regions, a floatable, 3D bottle holder was designed with side-clips, so that holders are joined in an open pond, creating a multichannel BPV grid, with open-cell bottoms. In a 6-channel, optimized-BPV tandem, grid output reached 171mW/m2 using typical pond water. To facilitate adoption of the BPV-grid, the 3D holder-design will be crowdsourced, to allow for simple construction, at ~$2/cell.

Greenwich High School
Teacher: Andrew Bramante

Washington, Jennafer   Project # 236

Completed Project, Science, Health and Medical

Using DNA Barcoding and Invertebrate Primers to detect Shellfish Contamination

The study of finding traces of shellfish in foods or supplements that should not contain it is significant, especially for those who have shellfish allergies. When producers of the product do not raise awareness about the possible allergens, the product can become dangerous. It is hypothesized that there may be more shellfish findings in these products than what is being presented to the public. This study uses DNA barcoding and invertebrate primers to test for trace amounts of shellfish in products that should not contain them. DNA will be extracted, amplified, and sequenced from glucosamine supplements and fish stock. Glucosamine is being tested because the supplement is extracted shellfish. For the fish stock that does not have shellfish on the label, invertebrate primers will be used to detect shellfish contamination. Results are pending, but it is predicted that there will be more shellfish in the glucosamine than in the fish stock. It is possible that there will be no difference between bottles that say Ç£may contain shellfish Ç¥ and bottles without the warning. As for fish stock, it will be less likely to have shellfish contamination due to its added expense. It is intended that this study will create a safer environment for consumers with shellfish allergies. Further research will be done to gain knowledge on a variety of other shellfish-contaminated food. Overall, shellfish contamination is a problem that needs to be studied further in order to ensure the safety of consumers with allergies.

Sacred Heart Greenwich
Teacher: Mary Musolino

Wei, William   Project # 237

Algorithm for Object Detection and Avoidance For Drone Swarms

In recent years, the development of UAV (Unmanned Aerial Vehicle) or drones are becoming more popular with more applications including in military, industry, and entertainment. Drones can also be used in Drone swarming which is a system where a swarm of drones communicate with each other in flight and make decisions autonomously as a single unit; however, one large difficulty for drone swarms is object detection and avoiding the object in an organized manner. The purpose of this project was to create 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 was for the drones to be able to identify objects and coordinate paths around the object in simulations. The limitations to this project were the amount of drones so the scalability can not be tested. One possible solution was to have multiple drones communicate what they see and for them to piece together an image, then use machine learning to determine what type of object it is, then for the drones to calculate the best path for the swarm to take without collision. In order to complete this project, a drone simulation program was needed. The drones and the research platform is at Sacred Heart University's MakerSpace and they were used under the supervision and guidance of Professor Tolga. Currently, the project has seen promise to progressing toward the goals. With 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

Welsh, Julia, O'Connor, Erin
Trevino, Renata   Project # 238

Using Nile Red Dye to Test for the Presence of Microplastics in Bottled Water

The problem of microplastics in the environment during a plastic-dependent age is important because they are potentially harmful to organisms and take hundreds of years to degrade. This study tested bottled water to identify the presence of microplastics in different brands. It was hypothesized that nile red dye can be used to find microplastics in water bottles, and that they will be found in almost every brand of water tested. Nile red dye was used to test for the presence of microplastics. The dye clings to nonpolar particles such as plastic, and fluoresces under a blue light. Nile red solution was placed in each bottled water for 30 minutes. The water was filtered through a glass filter, and plastic particles on the filter were massed after drying, photographed, and viewed under a microscope and blue light using an orange filter. The negative control, distilled water, with nile red showed no glow. The positive control in which we added microplastics, glowed. Aquafina, Essentia, and Poland Spring showed major areas of fluorescence. No fluorescence was observed in Dasani or Life Water. Nestle Pure Life showed a significant number of microplastic particles. Nestle Pure Life, filtered using a Brita filter, showed a reduction of microplastics, and those that remained were smaller in size. Microplastic debris can lead to health issues and can disrupt the environment. Since microplastics were found in many of the bottled water brands tested, this demonstrates that they may pose a threat to human health, such as an enhanced inflammatory response. This study is significant because there is limited research available on this topic. Fifty billion bottles of water are purchased each year, demonstrating the scope of this potential issue.

Sacred Heart Greenwich
Teacher: Mary Musolino

Weng, Kelly   Project # 239

Designing and Programming a Robot that Collects Plastic from Various Bodies of Water

With the growing plastic epidemic, about 22 million pounds of plastic are entering the Great Lakes alone every year, only 32 thousand pounds of that plastic is being collected every year. This is due to the fact that the only methods of collection right now are people collecting plastic from around the shores and scuba divers. If we were to take a look at oceans, about 12.7 million tons of plastic is entering every year. Again, the same methods of collection as that of the Great Lakes is utilized, with the addition of passive methods of collection. An example of this passive method of collection would be the Ocean Cleanup project, which is a passive 600m long net to collect surface level plastic. This hasn't been proven very successful, so I hope to make an automated method of collection to maximize the amount of plastic collected.

1. Design the robot (rough pencil sketches, modify design).
  - Figure out flotation devices.

2. Plan out electrical schematics and modify mechanical design to better house the electrical components.
 - Plan out camera and sensor placement and housing.
- Figure out a waterproof system for the electrical board(s).
 - Have code ready (test out autonomous).
 - Test motors, batteries, and propellers and modify if needed.

3. CAD the robot (using Fusion 360).
- Potentially have electrical components CADed as well.

4. 3D print the robot.
- Build the net part.

5. Attach electrical components.

6. Debug, troubleshoot, initial testing.

7. Test and modify design and code.

8. Test robot in pond (and make adjustments). N/A - How many pieces of plastic gets caught (how well the sensors work, efficiency of robot design).
 - If the robot steers clear of obstructions (how well the sensors work).
 - How much human interaction is needed (how well the sensors work).

Joel Barlow High School
Teacher: Katherine Nuzzo

Wijesekera, Adithi   Project # 240

Analyzing the Prevalence of Musculoskeletal Health Advertisements in a Variety of Magazines Targeting Different Demographic Groups

Citizens across the United States have been struggling with maintaining adequate musculoskeletal health for some times now. Unfortunately, about 126.6 million Americans suffer from a musculoskeletal condition. The purpose was to determine which demographic groups are not receiving this information about musculoskeletal health through an examination of various magazines. The project studied the prevalence of these advertisements in magazines targeted towards different groups. It was hypothesized that there would be a great amount of advertisements in women's health magazines because of the high freqency of musculoskeletal conditions in the female sex. The independent variable was the type of magazine demographic and dependent variable was how often a musculoskeletal health advertisement appears. Magazine issues, over the course of twelve months, were included in this study about women's health, men's health, the health of the elderly, and sports' health, food and diet, and general lifestyle. The five most popular magazines for each demographic group were selected.

A data analysis program was used to determine the results of the study; furthermore, statistical analysis was conducted at the end of the project to determine if the data itself was significant. By obtaining notable results, these magazine companies can accordingly alter the amount of advertisements relating to musculoskeletal health in their media. Musculoskeletal physicians could diagnose a disease earlier and would be able to prevent the onset of a condition if they are more knowledgeable on the subject.

Amity Regional High School
Teacher: Catherine Piscitelli

Wijesekera, Aadya   Project # 241

Creating a Talking Inhaler to Teach Users To Improve Inhaler Technique

When people are treated for asthma, many users do not get the full dose of medicine because of errors made during the entire process of taking your inhaler. A Romanian study showed decreases in the amount of errors and improved inhaler technique when a video instructor was used over a period of time. However, it is cumbersome for some people to watch videos whilst taking their inhalers. The purpose of this experiment is to create a talking inhaler would allow the same benefits as video instruction, but reaching a larger group of people. In this expirement, I changed the delivery of instruction which affected delivery preference. The prototype developed is an automated instructional device that synthesizes the instructions for taking an inhaler using an Arduino motherboard. An audio was created beforehand and then played using the Arduino. Phase 1 of testing was proof of concept, which showed that the device ran correctly. In Phase 2 of testing, a survey was given to see which method of instruction was preferred, an audio or a pamphlet. The users did not administer the inhaler to themselves. The audio was played aloud and the users chose their preference. Results showed that the audio was preferred over the pamphlet overall. In the future, these devices could be used everywhere or even come standard to an inhaler. It could also be further improved by adding a flow meter to provide feedback on the person's treatment.

Amity Regional High School
Teacher: Nicholas Shamp

Wilkenloh, Kelsi   Project # 242

Analyzing the Effect of Soil Contaminants on Human Health Using a Scio Spectrometer

Will ordinary families/gardeners be able to use the Scio Spectrometer to detect dangerous amounts of lead in their soil, and keep themselves away from the detrimental effects of lead on human health? I will create 4 different samples of soil using a Ç£clean soil Ç¥ with no lead or other heavy metals in it. I will mix different amounts of lead into the 4 samples. The first will be a constant so it will not contain any added lead. The next sample will me a low level of lead, the next will be a normal amount of lead, and the last will be a high amount of lead (or a dangerous amount to human health). I will calibrate the Scio Spectrometer with these 4 samples and create a fingerprint. Then, I will go around and take samples from various locations that I suspect have a high level of lead and I will scan them with the Scio as unknowns and find which level they fall into. I will expect to find that the Scio Spectrometer is an accurate and efficient way to test lead in soil. I will be able to determine which levels of lead contamination each of my unknown samples fall into. This could improve cost and efficiency for soil lead sampling in my area and areas around the world. If humans or young children particularly are exposed to dangerous amounts of lead, their health will be severely affected. It is important for communities to know if it is safe to interact with the soil around them. This also shows the future possibilities for the Scio Spectrometer because it is a new technology.

Ridgefield High School
Teacher: Patrick Hughes

Wilkes, Trevor   Project # 243

The Viability of Cefazolin and Vancomycin on Staphylococcus on the Basis of Their Use in Canines

I have a personal connection to this topic. My father had an accident and required antibiotics to treat osteomyelitis in his foot. Osteomyelitis is a fairly prevalent infection with around 50,000 cases in the U.S. alone per year. Most cases of osteomyelitis stem as a complication from diabetes, which is extremely prevalent, especially in the U.S. The antibiotics used to treat this disease caused by Staphylococci will have different effects based on the health condition of the patient. In some of the studies referenced, the infection took place within canines, all with different health conditions. Other background literature that I reviewed discussed the plasma protein binding of cephalosporin class antibiotics in dogs in comparison to the plasma protein binding in humans. Based off of the data collected from the trials with canines, the plasma protein binding of cefazolin and vancomycin can be used to predict the plasma protein binding of the antibiotics in humans. Health conditions could also be taken into account, comparing health conditions of the canines in these studies to those of humans. Research Question:

Based off of the protein binding of cefazolin and vancomycin in dogs, will the degree at which these antibiotics bind be enough in order to combat infection? How will this vary with different health conditions? No findings as of now. I would use the ratio of plasma protein binding of the antibiotics in canines versus humans in order to get an accurate prediction on how much of the antibiotic is attached to proteins in the blood, and how much would be available to combat the infection. If the plasma protein binding of cefazolin and vancomycin in dogs is calculated, then a prediction of plasma protein binding of the antibiotics in humans can be made which could be analyzed in conjunction with health conditions of the patient.

Joel Barlow High School
Teacher: Katherine Nuzzo

Williams, Emma   Project # 244

Effectiveness of Asthma Education on Participants' Asthma Knowledge

Asthma is a chronic pulmonary condition characterized by inflammation of the airways. Despite the fact that 25 million people in the US suffer from asthma, and yet limited asthma education continues to inhibit the lives of asthmatics. The expansion of the community asthma prevention program (CAPP) in Philadelphia has highlighted the importance of providing adequate education classes. Thus, this research project aims to investigate the effectiveness of a free community class on the attendee's asthma knowledge. This study will include parents/caretakers of children ages 2-18. The attendees of the class will be given the Patient Asthma Knowledge Questionnaire (PAKQ) at the beginning of the class, and will learn about asthma triggers, prevention, medication, and delivery devices. The class will consist of both oral instruction and demonstration. At the conclusion of the class, participants will complete the survey again. It is expected that the majority of the participants will be of a lower socioeconomic class, and that the results will show a 90% improvement in asthma knowledge. The increase in asthma knowledge will, in turn, improve the patient care of the children. Asthma is only becoming more common. The research of asthma and asthma education is necessary to help the 300 million people worldwide who suffer from this disease.

Darien High School
Teacher: Christine Leventhal

Wolters, Katherine   Project #245

Effectiveness of a Mutated CXCR4 Hematopoietic Stem-Cell Transplant on HIV-1 Patients

HIV is an autoimmune disease for which there is no known cure. There are currently 37.9 million people around the world living with this disease. So far, there have been two recorded hematopoietic stem-cell transplants (HSCT) in two different patients that resulted in long-term HIV remission. Both patients received HSCT procedures using cells from a donor with a mutation in the HIV coreceptor CCR5 (CCR5Δ32/Δ32). HIV remission was found to have been maintained over at least 18 months in both cases. HIV enters and attacks CD4 T cells, which fight infection, and eventually kills them. The HIV virus can enter the cell through the coreceptor CCR5 or the coreceptor CXCR4. In this experiment, 5 patients with HIV-1 will receive HSCT from donors with a mutation in the HIV coreceptor CXCR4. These patients will then be observed over the next two years, testing the levels of HIV in their blood. It is expected that there will be a decrease in the HIV levels in the blood. Due to the stem cells containing a mutated CXCR4 protein, the virus will only be able to enter the cell through the CCR5 protein. This will result in a decrease in the levels of the HIV virus.

Darien High School
Teacher: David Lewis

Worthington, Mitchell   Project #246

Use of Carbonic Anhydrase and Different Concentrations of Water for Carbon Dioxide Sequestration in Soil

Carbon dioxide is a harmful greenhouse gas that causes climate change. Carbon sequestration is a process that captures and stores carbon dioxide to mitigate climate change. I will examine carbon sequestration through soil using carbonic anhydrase, an enzyme that catalyzes the reaction between carbon dioxide and water to produce bicarbonate and hydrogen ions. The question I am asking is: when carbonic anhydrase is added to soil, what amount of water will reduce carbon dioxide content the most? First, collect 50 g of soil using a soil probe. Then, sieve the soil to fine particles. Dry the soil in an oven to remove excess water. Then, mix 1 mg powdered carbonic anhydrase with different amounts of water and add the mixture to soil. Then, insert a carbon dioxide sensor into the container of soil. This will read carbon dioxide in parts per million, twice per minute for 24 hours. Compare data when complete. I have yet to complete my project. However, when I am finished, the soil sample with the lowest carbon dioxide content will be the best amount of water to use. This data can potentially be used in a large scale irrigation project on pasture soil. Scientists would sprinkle carbonic anhydrase into a large field of undeveloped soil. Using industrialized sprinklers, they would add a certain amount of water to decrease carbon dioxide content in the soil. The rate of water sprinklings depends on outside factors like the weather and will be regulated consistently.

Joel Barlow High School
Teacher: Dr. Katherine Nuzzo

Xu, Ryan Project # 247

Crowd Risk Assessment Based on Crowd Density Estimation Using CNN and Crowd Dynamic Behavior Modeling

With the rapid development of social infrastructure, visitor rates continue to rise in public areas, hence making crowd evaluation increasingly important. This project aims to develop a system that can comprehensively evaluate the risk of accidents in crowded scenes based on indicators from both static and dynamic scenarios. First, an accurate crowd count of static images is made using a specialized Convolutional Neural Network based on the multicolumn architecture. The model consists of a front-end network with three columns and a back-end network that uses multiple receptive fields to produce features and can learn the importance of each feature at different image locations. Second, a novel risk assessment index is proposed incorporating indicators in dynamic scenarios. The indicators include the probability of an accident, congestion level, and crowd interactive force. The final risk model joins the dynamic indicators and static indicators (crowd density) together. The congestion level uses a pyramidal optical flow approach to extract the motion vector of a crowd in a certain region to form trajectories that are then used to estimate relative inertia (discontinuity of crowd motion) and velocity entropy. The proposed CNN algorithm yields compelling results in challenging datasets of crowd count and density evaluation, and together with dynamic behavior modeling, the complete risk assessment system provides a more inclusive, reliable evaluation of risk level of crowded scenarios in reality in order to effectively prevent malignant crowding accidents.

Choate Rosemary Hall
Teacher: Avery Feingold

Yang, Haoyue Project # 248

Developing a More Affordable and Efficient Item Detection System

In 2018, Amazon proposed the idea of Amazon Go, a cashierless store where sensors and cameras within the store detect if an item is taken and/or put back onto the self. Thus, the purpose of this design was to create a more affordable but effective item detection system to allow smaller companies to introduce cashierless technology to their locations. Amazon did not release their design of the sensors and with the Raspberry Pi's, there were software and hardware limitations, such as limited processing power. By using a machine learning and computer vision library named TensorFlow and OpenCV, object detection was created on a Raspberry Pi. Furthermore, a python script was coded to detect for a change in the item's location and if it was moved into a shopping basket. Data thus far showed that the object detection function was functional without errors or bugs and detected objects at an average of 1 frame per second. However, the results of the additional python programs were unknown at that time. To test the design, a shelf with items were used. In a test for accuracy, multiple items with similar looks were placed on the shelf and shuffled around. For a more real-world scenario, an item was taken, put back in a different location, and tested again for accuracy of identification. Using this design, smaller businesses with not as many resources as a large company like Amazon will have the opportunity to use next-generation technology without draining their budgets.

Amity Regional High School
Teacher: Catherine Piscitelli

Zafar, Baasim   Project # 249

Determining Difference in Growth and Developmental Rates of Amphibian Metapopulation Depending on Average Spring Temperature of the Larva's Home Pond

There is fine-scale genetic variation among wood frogs in ponds that are very close geographically. There are heritable differences in these ponds. The purpose of this experiment was to determine if there is a difference in growth and developmental rates of amphibian metapopulation depending on average spring temperature of the larva's home pond. The hypothesis was if local adaptation is present, then wood frog larvae from different ponds will exhibit distinct differences in growth and developmental rates when reared in a common environment. It was expected that intrinsic growth and developmental rates would correlate with average temperature of the larva's home pond. The independent variable was the larva's home pond measured by average spring temperature of the larva's home pond. The two dependent variables are growth rate and development rate. The mentor collected wood frog eggs from 10 ponds in the Yale Myers Forest within 24 hours after they were deposited. He reared the eggs through the larval period in temperature and light controlled incubators. Photos of the larvae were captured every 1-2 weeks. The student used ImageJ to measure total length and snout-to-vent length and determine the developmental stage of the larva in each image. Analysis of variance was performed to test for differences in growth and developmental rates between ponds. Linear regression was also performed to test for correlations between pond temperatures and growth and developmental rates. The results of this project can help us understand how small scale evolution happens and the potential impacts it could have.

Amity Regional High School
Teacher: Catherine Piscitelli

Zhan, Annie   Project # 250

Creating a Hydrocolloid Bandage that can Absorb Wound Drainage

Hydrocolloids, crosslinked long-chain polymers, are used for many purposes. This project focuses specifically on hydrocolloid bandages, which are bandages made from hydrocolloids. Hydrocolloid bandages are different than the average bandage because they are able to heal and protect a wound from infection and bacteria. They can also last for long periods of time and are impermeable to water, allowing the wound to heal effectively. Despite these benefits, hydrocolloid bandages can only be used on wounds with little to no drainage. The goal of this project was to design a hydrocolloid bandage that could absorb wound drainage yet could still provide the same benefits as a normal hydrocolloid bandage. To do this, a normal hydrocolloid bandage was used as the basic structure for the new bandage. New layers were added to incorporate the absorption factor in the bandage. Chemicals such as sodium polyacrylate, collagen, cellulose, carboxymethyl cellulose, polyisobutene, pectin, and alginate are commonly found in most hydrocolloid bandages, and some of these chemicals were utilized to create the layers of the new hydrocolloid bandage. To test the effectiveness of the bandage, both a normal hydrocolloid and the altered hydrocolloid bandage were tested to absorb the same amount of blood. Due to variability and hazardous reasons, synthetic blood was used in replacement of real blood. Each bandage was put into the same environment and was tested with the same amount of blood. Progression of this project is on track to complete goals as set forth.

Amity Regional High School
Teacher: Catherine Piscitelli

Zhang, Mason   Project # 251

Using Deep Neural Networks to Characterize the Impact of Salt Contamination from Roads on the Reproductive Performance of Wood Frogs

Wood frogs have short lifespans accompanied with high fecundity which helps optimize population survival. But, in the face of salt contamination by pervasive road networks, there are adverse impacts on these populations. This contrast between woodland and roadside demes is detrimental, and to further gauge the effects, this study aimed to understand how salt contaminants affect wood frog reproduction, fertilization rate, and motility of male gametes. It was hypothesized that increased reproductive performance would be observed in ponds closer to roads because an evolutionary response might occur where fecundity increases to compensate for the harsh conditions. The independent variable was the salinity of the ponds measured by specific conductance. The dependent variable was reproductive performance, specifically fertilization rates and the motility of male gametes. The control of the experiment was the woodland populations, and the ponds were uncontrolled, but monitored, in order to simulate actual conditions. Microsoft Azure, R, and DeepLabCut were used to analyze videos of male gametes and fertilization data. DeepLabCut, a deep learning software, is more versatile and efficient in modeling, and was chosen because there is currently no specialized software measuring medial-lateral behavior observed in wood frog sperm. This could also be utilized for many applications such as tadpole burst response. Preliminary data analysis supports the hypothesis. By understanding wood frog reproduction at the fundamental, microscopic level and how salt impacts it, the effect of roads can be better understood in the context of population health, and thus, solutions can be designed to remedy this harm.

Amity Regional High School
Teacher: Catherine Piscitelli

Zhang, Wendy   Project # 252

Analyzing the role of Sonic Hedgehog Signaling in Germinal Center B-Cell Differentiation

The germinal center is crucial to the creation and proliferation of distinct white blood cells, namely B-cells, that defend the body against unique and reoccurring pathogens. However, the factors that regulate B-cell differentiation is currently unclear. Thus, this project aimed to analyze the Sonic Hedgehog (SHH) signaling pathway, and the possible role it has on determining the fate of germinal center B-cells. SHH is currently known to regulate the differentiation of T-cells, a type of white blood cell, in the immune system. It was hypothesized that SHH encourages B-cells to differentiate into plasma cells, which are B-cells activated as a short term response to a pathogen. In the project, the independent variable was the successful receival of SHH signaling, which was measured by the presence or lack of Gli-1, the end product of SHH signaling. The dependent variable was the specific subset of B-cell and its location. To measure this, three lymph node tissue samples from twelve healthy mice were stained using immunofluorescent staining procedure with reagents that marked for several B-cell subsets, Gli-1, and T-cell subsets. Then, the characteristics of the cells with high expression of Gli-1 were analyzed. Results thus far demonstrate that there is a possibility that cells that receive SHH signaling are more likely to become memory B-cells, which are B-cells that respond to reoccurring pathogens.

If this project is successful, it can further the knowledge of b-cell fate and differentiation, which is vital to improving the precision of treatment and drugs.

Amity Regional High School
Teacher: Catherine Piscitelli

Zhang, Ethan — Project # 253

Minimally-Invasive Pancreatoduodenectomy versus Open Pancreatoduodenectomy in the current era: A Systematic review and Meta-analysis of the Available literature

Traditionally, open pancreaticoduodenectomy(OPD) remains one of the most challenging gastrointestinal surgeries to perform due to the biological behavior of the neoplasm. With the introduction of new technology, however, the ability to resect complex cancers has been refined to allow introduction of robot-assisted pancreaticoduodenectomy(RPD), which has prompted a multitude of reports to assess the efficacy of this novel technique. However, they are largely single-institutional or obsolete: the differences between the two approaches have not been fully compared in the modern era. This meta-analysis was conducted to compare the clinical safety and efficacy of RPD with OPD. Multiple medical databases (PubMed, Medline, and Google Scholar) were queried to identify studies comparing the outcomes of RAPD and OPD (up to July 31, 2019). Forest plots were created in Revman 5.3. Twenty non-randomized controlled trials passed the selection criteria. RAPD had longer operative time (p<0.00001), but less blood loss (p<0.00001), shorter hospitalization (p< 0.00001) and lower rates of wound infection (p=0.0002) and blood transfusion (p=0.0004). There was no significant difference in the lymph node yield, the rate of pancreatic fistula, delayed gastric emptying, reoperation, or mortality.

RAPD is a safe and feasible alternative to OPD with regard to perioperative and postoperative outcomes. This meta-analysis was able to confirm the equivalency or improvements in morbidity and oncologic outcomes of RPD when compared with OPD. Conclusions drawn will provide evidence for clinical practice and is expected to improve outcomes in the future.

Darien High School
Teacher: Christine Leventhal

Zhou, David — Project # 254

Novel Anticancer Activity of Phloroglucinol, Kaempferol, 3,5 Dimethoxyphenol and 1,3,5 Trimethoxybenzene Against Non-Hodgkin Lymphoma Cells

Non-Hodgkin's lymphoma (NHL) is a common cancer, killing about twenty thousand people worldwide each year. Existing chemotherapeutic drugs have severe side effects and high cost, limiting their use on lymphoma patients. Many chemicals from plants have anticancer effect but never been studied for the treatment of lymphoma. My project aims to test if these chemicals can work to kill lymphoma cells individually or synergistically. It is projected that IPH will have similar albumin (~20 ng/mL per day) and urea productions (~35 ug/mL per day) as PPH. There are expectations that nude mice implanted with IPH and those implanted with human hepatocytes will have similar tumorigenicity as noted by their morphology under SEM and TEM. The survival rate of monkeys implanted with IPH is projected to be higher than that of monkeys implanted with PPH. My test results indicate that all four chemicals have anticancer effects on U937 lymphoma cells; furthermore, combinations of the chemicals are more effective than individual ones. The combination of DMP + TMB at 0.2uM concentration was the most effective, blocking 70% of the cells versus 30% by individual chemicals. My study was the first to experiment with different combinations and concentrations of the four chemicals. My novel experiment reveals anticancer effects of combinations of these chemicals on NHL. My next step is to investigate effects of these chemicals with current chemotherapeutic drugs. These findings could lead to further investigation of anticancer effects of chemicals from plants and potential development of alternative treatments for NHL.

Hopkins School, New Haven, CT
Teacher: Wei Zhu