

Project # 0001

Amir, Aroush

Completed Project, Science, Health & Medical

Determining the Mechanisms of Cancer Stem Cell Selection

Colon cancers begin with a genetic mutation in a niche or group of colonic stem cells (SC) found in all crypts, which are tube-shaped units forming the intestine. If a mutation were to occur in a niche, the mutated SC is selected and results in the spread of cancer, however, how these mutated SCs got selected is unknown. This project aimed to understand SCs' mechanism when they have been mutated and pushed out from the niche. It was hypothesized that if a mutation is acquired in the SCs, then these cancer SCs would outcompete neighboring cells. The independent variable of this experiment was the introduction of a cancerous mutation to SCs. The dependent variable was the rate of SC multiplication. Constants included the age of mice, mice littermates, the site of mutation, and where the mutation was introduced by the mentor. Nine days post-administration of the mutation, the mouse colons were dissected and cryofixed. The mentor took pictures of the cryosections under a fluorescent microscope and the student counted SC clones, calculated the average mitotic index (AMI) of both tissue groups, and conducted a one-tailed T-test. Results thus far suggest that the AMI is higher for tissues with tumors than healthy tissues due to an overexpression of BRAF E600 (genetic mutation), showing a selective advantage of cancer SCs because of increased proliferation rates. Once completed, this research could assist in the future development of colon cancer prevention treatments by identifying the presence of a selective advantage of cancerous SCs.

Amity High School

Teacher: Catherine Piscitelli

Project # 0002

Arnold, Sadie

Completed Project, Science, Health & Medical

Determining the Best Drill Trajectories and Best Instrumentation to Conduct Core Decompressions to Treat Avascular Necrosis of the Femoral Head

Avascular necrosis (AVN) is a disease that results from temporary/permanent loss of blood supply to the bone. AVN is caused by injuries, alcohol consumption and certain medical conditions/treatments. Diagnosis in the femoral head is increasing. If left untreated, it can progress to secondary hip arthritis (osteoarthritis). There's 10,000-20,000 new cases in the U.S. annually. There are multiple surgical treatments, but no consensus on the most efficient type. Core decompressions are a type of surgery that removes the inside of bone to relieve pressure, allowing new blood vessels to form. The purpose of this project was to determine the best drill trajectory to conduct core decompressions to treat AVN of the femoral head. It was hypothesized that the volume of the femoral head and AVN will be correlated since a larger femoral head size allows for a larger AVN region. There are no variables since this is a comparison study. Scans of patients' hips with AVN were provided by the mentor. 3D models were created in ScanIP. The volumes were measured to categorize the stages of AVN. Surgeries were recreated in 3D. A statistical analysis was run to determine the most efficient drill trajectories. Results thus far support the volume of AVN region to the femoral head do not have a trend. However, the models provide an accurate view of the angle and depth needed for an efficient surgery. The findings of this project could help surgeons successfully reach the AVN region on the first try.

Amity High School

Teacher: Catherine Piscitelli

Project # 0003

Bisset, Luke

Completed Project, Science, Environmental

Researching the Effects of Microbursts On the Biodiversity In Local Ecosystems

Microbursts are storms with really strong downward wind, and are very unique disturbances. They can be equal or stronger to tornadoes. It is Hypothesized that they can cause an increase in heterogeneity and an increase in diversity wherever they hit. Hundreds of microbursts occur in the US every year. They are very destructive and can uproot trees and churn soil. Microbursts have occurred in Connecticut, and a really powerful one hit Sleeping Giant State Park a few years ago. There haven't been many studies on microburst's impacts specifically, and they might cause an increase in biodiversity. The purpose of this project is to determine the effects of microbursts on the biodiversity of local ecosystems. Two sites at Sleeping Giant State park were chosen, one that was hit by the microburst and one that wasn't. A 10 ft by 10 ft area was marked off, and everything in them was recorded. Data was collected on these two sites, including the plant species, plant type, tree thickness, and estimated age. Using the data, the above and below ground biomass was calculated using similar taxonomic taxes from background research of the site. Using the biomass, the biodiversity of each site was calculated. The species richness was also calculated by adding up the number of each species present divided by area, which was just 100 square feet. The biodiversity in the impacted cite was found to be higher, supporting the hypothesis.

Amity High School

Teacher: Catherine Piscitelli

Project # 0004

Brissette, Kaylin

Completed Project, Science, Health & Medical

Hepatic Stellate Cells in Liver Regeneration

Hepatic stellate cells, once described as Kupffer cells, are generally quiescent or inactive within the healthy liver. Once activated through injury stimuli, stellate cells transform from fibroblasts into myofibroblasts. Stellate cells' main role is in remodeling the cellular matrix and producing scar tissue through the synthesis of collagen and lamin. Thus allowing stellate cells to contribute to the maintenance of homeostasis within the liver but also makes them a large proponent in fibrosis. The fibrotic liver then becomes carcinogenic and is progressively linked to various cancers and tumors, such as hepatocellular carcinoma. Additionally, stellate cells have the ability to stimulate migration and transformation of nearby hepatocytes through the chemical secretion of chemokines. Gene expression analysis through UMAP(Uniform Manifold Approximation and Projection), a program similar to t-sne processing, could prove useful in identifying patterns of proliferation and production of proteins. UMAP is especially useful in reducing the dimensionality of data while having more simple parameters and operations. Data from pre-existing databases would be used for the software program. Patterns of proliferation capabilities would prove insightful in the aim of better understanding the delicate nature of stellate cells.

Newtown High School

Teacher: Timothy DeJulio

Project # 0005

Burbank, Aiden

Completed Project, Engineering, Physical Science

Autonomous Ping Pong Robot Object Detection and Prediction

Can robotics be used as a replacement for human players in Ping Pong? I will find this out through creating a Ping Pong robot that will successfully return a Ping Pong ball hit by a human player. This is done through having multiple arm-like segments, each controlled by its own motor. The robot sees the ball with a multiple camera system that will track the ball and predict its location in real time. I first designed the Ping Pong robot in Solidworks, then 3D printed my design on a smaller scale. With the model, adjustments were made until the design had minimal and inconsequential flaws. With this complete design I will go to a metal manufacturer and have a full sized model made out of aluminum. A mix of ROS(Robot Operating System) and python coding will be used to control the robot. Basic functions like moving will be coded into the robot first, then more complicated things like tracking the Ping Pong ball movement will be completed. Object detection is done using faster RCNN. After all of the functions are incorporated improvements will be made to increase speed and efficiency for a better outcome. I expect that the robot will be incapable of the goal at first but I will keep making improvements until it does work. When the robot is successful I think that it will be capable of replacing a human player on a low level being able to return a ball back across the table.

Newtown High School

Teacher: Timothy DeJulio

Project # 0006

Cannon, Emma

Completed Project, Science, Environmental

Determining the Ability of Mosses and Plants to Remove Algae-Causing Phosphates and Nitrates From
Water

When phosphates and nitrates enter bodies of water, algae blooms form, covering the surface and diminishing water quality by hindering sunlight for underwater plants. In addition, when the algae die, the oxygen in the water is consumed, making it extremely difficult for aquatic life to survive. This study assessed mosses and plants' ability to mitigate these pollutants due to their leaf and root structures. A fertilizer solution containing phosphates and nitrates was added to water and the initial levels of these nutrients were recorded, then a sample was set aside to be used as a control. Five mosses in triplicate were then exposed to the polluted water and the water was tested for the pollutants over periods of time. It was expected that the *Polytrichum commune* would remove a significant amount of the pollutants from the water. After testing, it was found to be successful, but the moss that performed best was the Fruiting Moss. Plants were also introduced in a separate trial. Five different species were tested the same as the moss. It was hypothesized that the plants would be able to use their roots to absorb the pollutants, similar to the moss's ability to absorb through their leaves. King's Choice Ivy was the most effective. This experiment implies that mosses, and possibly plants, can be used along the shoreline to remove the algae-causing pollutants before they enter the water. Water will become safer to swim in, and will become environmentally stable for the habitats of marine life.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 0007

Cardamone, Beatrice

Completed Project, Science, Health & Medical

Inhibition of Prion Protein Propagation

Transmissible Spongiform Encephalopathies (TSEs), or Prion Diseases, are a class of rare neurodegenerative diseases with no known cure or treatments. Though the understanding of their processes is lacking within the science community, some important pieces of information have been gathered. As shown by Prusiner et alia, no genetic information is responsible for their pathogenesis. Instead, the 'prion only hypothesis' states that the prion protein, a protein conserved in most mammals, and of which the exact purpose is unclear, is responsible for these diseases. In TSEs, the healthy prion protein, denoted PrP^c, converts to a diseased isoform, denoted PrP^{sc}. It is also known that the diseased prion isoform is capable of conferring its malformity to the healthy variant. PrP^{sc} forms oligomers, fibrils, and amyloid plaques within the brain, the concentration of which is associated with a further course of disease. As shown by Collinge et alia, the removal of the prion protein from the brain via a monoclonal antibody has a stabilizing effect on the degeneration caused by Creutzfeldt-Jakob Disease -- a TSE -- in humans, as well as mice. This paper proposes a novel technique for the treatment of TSEs wherein an interfering peptide (IP) is designed in silico similar in structure to PrP^c which is capable of binding to the diseased isoform, and inhibiting its ability to convert more proteins, via the interference in protein-protein interactions (PPI) therefore slowing or halting disease progression. The IP will be designed based on a 3D model of the prion protein, its structure tailored to bind to so-called hotspots, residues within the protein with higher binding energies than the remainder; these areas, therefore, are those with a higher likelihood to interact with other proteins, exactly what is intended to be inhibited, as this interaction is responsible for at least some portion of the disease. In doing this, the intention is to provide succor to both those suffering, and those whose families' have suffered, from TSEs, in the form of relief from the disease, as well as further progress and hope that one day such ravages will be cured in their entirety.

Newtown High School

Teacher: Timothy DeJulio

Project # 0008

Chen, Rebecca

Completed Project, Science, Health & Medical

Determining the Similarities and Differences Among the Characteristics of Mitochondrial Proteins Found in Brains Affected by Alzheimer's Disease

Alzheimer's Disease (AD) is one of the most common types of dementia primarily found within people over the age of 65. The disease causes people to progressively lose their memory, cognitive skills, and the ability to accomplish simple everyday tasks. AD currently has no cure and the causes such as the build-up of proteins in and around brain cells are continuously being researched. Proteins have many unique characteristics and are thought to impact AD due to abnormal levels of proteins found in AD brains compared to healthy aging brains. The purpose of this experiment was to determine the similarities and differences among the characteristics of mitochondrial proteins found in brains affected by Alzheimer's Disease. It was hypothesized that there will be a correlation between the characteristics of proteins that have similar effects on AD brains. The independent variable was the ten proteins and the dependent variable was the protein characteristics. The mentor provided the protein names along with their ratio of expression and subcellular location. The other characteristic data were found through UniProt, a large database of protein information. Two characteristics were compared at a time with the use of excel. Results thus far support minor and major similarities among nearly all the characteristics with the exception of function, which seems to differ the most among the proteins. This research will provide more information on how protein characteristics are related and how they might be responsible for certain AD symptoms.

Amity High School

Teacher: Catherine Piscitelli

Project # 0009

Cox, Lydia

Completed Project, Science, Environmental

Using Sunscreen as a way to distribute Beneficial Microorganisms for Corals (BMCs)

Using Sunscreen as a way to distribute Beneficial Microorganisms for Corals (BMCs). This project is trying to create a BMCs enriched sunscreen that will be used to distribute the BMCs to a natural reef environment. To do this a 2-section sunscreen compartment will be created. In half of the container freeze-dried BMCs will be stored, the other half there will be non-nano zinc oxide (the sunblock). The first question that will be tested is will the BMCs rehydrate in the zinc or in water. To see how effective the BMCs are at mitigating the effects of bleaching a heat stress simulation will be performed. There will be 12 fish tanks used in the whole experiment but only 6 tanks will go through the heat stress simulation. The water temperature in the 6 tanks will start at 26°C and be raised to 30° C over a period of 10 days. Then the water temperature will remain at 30 degrees Celsius for 10 days, before being lowered back to 26°C over 10 days. There will then be a 20-day recovery period. To avoid working with humans participants neoprene diving gloves will be used to inoculate the corals with zinc-oxide compound or just zinc. Farther down the road the sunscreen will be tested on humans. The other 6 tanks will remain at 26°C as a control. This sunscreen could be a way to distribute BMCs to natural environments.

Newtown High School

Teacher: Timothy DeJulio

Project # 0010

Dillon, Avery

Completed Project, Science, Health & Medical

Determining Whether or Not Using Certain Exercises in Physical Therapy will be More Effective

Physical therapy is the practice of treating diseases, muscle tightness, torn ligaments or tendons, inflammation, deformity, or other injury through exercises, massaging, and heat therapy instead of using pharmaceutical drugs or surgery. Focusing on treatment plans in physical therapy, physical therapists frequently provide different plans for individual patients, even if they have the same injury. This project's purpose was to determine whether using different treatments in physical therapy for the same injury would make recovery time faster. Building on the challenges faced in the previous year, where data collection was limited, this continuation project sought to expand and refine its findings. The researcher recorded therapies and exercises employed, addressing the gaps identified in the initial study. The hypothesis of this project is that specific treatment plans prescribed by physical therapists contribute to faster recovery times compared to alternative plans. Key variables in this study include the independent variable of treatment plans, the dependent quantitative variable of recovery time, and the dependent qualitative variable of pain levels. Constants involve lower extremity injuries and an age range of 35-65 years. Weekly visits to Amity Physical Therapy facilitated data collection through patient charts provided by the mentor. The recorded information includes patient demographics, injury details, surgical history, time since surgery, prescribed exercises, and massage techniques. Although meaningful trends have yet to emerge, there are many potential implications. The project aims to enhance the ability to tailor treatment plans, ultimately leading to accelerated recovery times for patients with specific injuries.

Amity High School

Teacher: Catherine Piscitelli

Project # 0011

Fan, Janet

Completed Project, Science, Behavioral

Comparing the Tendency to Perceive Online and Offline Offending as “Violence” in Youth Victims of Online Offenses

The purpose of this study is to determine if a correlation exists between the extent to which a youth has been a victim of online offenses and the extent to which they consider various offenses “violent.” The hypothesis is that if a youth has been a victim of online offenses to a great extent, then they will consider various online and offline offenses as “violent” to a much lesser extent than youths who have not been victimized because youths who view offenses as less violent may be more likely to commit them in the future, supporting the correlation suggested by past studies. The independent variable is the extent to which a youth has experienced online victimization, as measured by the number of times an individual has reported being threatened or verbally assaulted online in the past 12 months. The dependent variable is the extent to which a youth considers offenses “violent” as measured on a likert scale from 1-4. The control in this experiment was the average responses of individuals who have never been victim of a violent offense. Participants were asked if they had ever been a victim of a violent offense, and if so, how many times in the past year. Then, students ranked actions such as “threatening someone on social media” and “touching someone else on the shoulder, with or without his/her permission” as more or less violent using a Likert scale. Data was analyzed and a regression analysis was run. This study will help build a greater understanding of the link between online victimization and perpetration, and specifically how individuals move from the role of victim to perpetrator.

Amity High School

Teacher: Catherine Piscitelli

Project # 0012

Gleason, Calista Speicher Emma

Completed Project, Science, Teams (Completed Project)

The Effects of Golf Course Runoff on Rooster River

Algae blooms have harmful effects on aquatic ecosystems. We wanted to see if water with fertilizer, in comparison to water without fertilizer, had any effect on the growth of the algae. We started by collecting river water samples from before a golf course and after the golf course, along with plain distilled water. We used these three water samples to grow our algae, each in a different bottle. We grew the algae under a growth lamp and took observations with a light meter every other day for two weeks. By seeing the difference in the algae growth we're able to see how the amount of fertilizer affects the amount of algae in the water. The results ended with the water after the golf course having the most lux. The river water before the golf course came in second and the distilled water came in last with the least amount of lux. This demonstrated that the more fertilizer in the water resulted in more algae, causing more harm to the aquatic ecosystems.

Fairfield Warde High School

Teacher: Ryan Gleason

Project # 0013

Gopal, Alesandro Liu Adam

Completed Project, Science, Teams (Completed Project)

Designing a More Human-Like Non-Player-Character to Enhance Player Experience in Video Games

Artificial Intelligence (AI) has been rapidly integrated into various aspects of human life, highlighting a challenge: AI lacks human-like qualities. This is why, in the realm of video-games, playing with Non-Player Characters (NPCs), or AI robots, often results in less enjoyable experiences. To address this, researchers and game developers explored using machine learning to artificially mimic human learning. Long Short-Term Memory (LSTM) models are machine learning algorithms known for processing sequential data. The purpose of this project was to design a human-like LSTM-based NPC to enhance gaming experiences. The project was deemed successful if the NPC could exhibit human-like reactions and seamlessly blend with real players in 80% of testing scenarios. Training was split up into different skills required for the game: aiming, moving, and action-timing. Human participants, mainly 14-22 year olds recruited through convenience sampling, played small games in Minecraft to generate skill-specific data for training the LSTM model. The NPC was programmed using Mineflayer, a JavaScript library for Minecraft NPCs, and trained on Google Cloud servers. Following the Turing test approach, an online survey asked participants to distinguish between NPC and human players based on gameplay videos. Findings thus far show that the implemented machine learning based NPC does show resemblances to a human player but fails to be indistinguishable from them. The project aimed to enhance the Minecraft player experience and potentially extend these techniques to other fields like healthcare and education, fostering more engaging interactions between humans and AIs.

Amity High School

Teacher: Catherine Piscitelli

Project # 0014

Greco, Bella

Completed Project, Science, Health & Medical

The Effect of Morning vs. Night Exercise on Sleep Length and Quality

When it comes to muscle growth and making your body more healthy, sleep is one of the most important aspects. Sleep is when your muscles are able to grow and your body can recover. So, to optimize sleep is to optimize athletic performance as well. In order to investigate this I tested the effect of morning versus night exercise on sleep length and quality. I did this through self experimentation using a fitness band called WHOOP. This band tracks sleep length and recovery. For 3 weeks, I exercised every day in the morning and slept at a constant time. Then the next three weeks I exercised every day at night and slept at the same constant time. I then studied and analyzed my results on the whoop band app.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0015

Hayashi, Parker

Completed Project, Engineering, Physical Science

Clonal Evolution of Non-Small Cell Lung Cancer Reveals TP53/EGFR Maintenance and SETD2 Selection in Metastases

According to the World Health Organization, almost 10 million people die of cancer annually, equating to about one-sixth of all deaths. Approximately 90% of these deaths are a result of metastatic cancer, highlighting the importance of metastasis focused research. As cancer cells evolve over time, certain cells gain the ability to disseminate from their primary tumor and metastasize to a distant organ. Understanding which cancer cells metastasize and the routes they took to get there would aid in our understanding of metastasis and the development of novel therapeutics. We investigated the genetics of metastatic cells by identifying the genes that are selected for in metastasis. To do so, we inferred the clonal evolution and migration histories of non-small cell lung cancer (NSCLC) patients, the most common cancer type seen at Memorial Sloan Kettering Cancer Center (MSKCC). By preprocessing large datasets and utilizing recently developed machine learning techniques, we generated highly accurate clonal evolution trees that facilitate the search for mutations correlated with metastasis. By compiling the genes found in our results, lists of mutations were categorized by various data points, such as the anatomical site and mutation type (primary or metastasis). We identify one gene, SETD2, as significantly associated with metastasis, as well as possible explanations for this link. We've identified a previously unknown gene that could aid future researchers as a potential therapeutic target for metastatic NSCLC.

King School

Teacher: Victoria Schulman

Project # 0016

Hicks, Cate

Completed Project, Science, Health & Medical

Caffeinated Energy Drinks Effects on Energy and Performance

With a large amount of young adult athletes consuming highly caffeinated beverages, further research into their ingredients is extremely necessary. Creating awareness and helping to educate the public and athletes of all levels about the possible effects consuming caffeinated energy drinks may have. As well as increasing our knowledge of how these energy drinks and the herbs they contain may boost athletic performance. Main ingredients such as guarana, ginseng, and taurine are highly concentrated in these popular drinks. In this experiment, I focus on the possible stimulant effects of guarana on fruit fly behaviors as similar indicators to human athletic performance. I hypothesized that if given an herbal stimulant of paullinia cupana then drosophila melanogaster will experience little to no increased movement behaviors over a period of time. By performing a serial dilution and administering different concentrations of a water and guarana solution, I was able to see if there were different effects based on dosages. I then recorded the flies that were administered the different concentrations, as well as a control group who was given only water. When reviewing my data, I focus on the behavioral and physical indicators shown by the flies such as flight and response times. Initially, my data shows little to no differences between concentrations and between control and guarana-dosed flies.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0017

Huitron, Martha Krishnan Ashwika

Completed Project, Science, Teams (Completed Project)

Quantify Microplastics in Shrimp Using Potassium Hydroxide and Nile Red Dye

Microplastics are extremely small pieces of plastic debris left in the environment. Plastics are not able to dissolve, instead, they break down into smaller and smaller pieces. Microplastics are miniscule but dangerous to terrestrial and oceanic ecosystems around the world. When microplastics break down from larger plastics, they become a different kind of threat to wildlife because of their small size, and the amount of microplastics is only projected to increase in the upcoming years. This research will serve to advance the study of how microplastics affect marine ecosystems and seafood consumption by humans. Plastic pollution is expected to double by 2030, so research towards the conservation of the environment is more vital now than ever. Additionally, this experiment will highlight the possible harm of consuming microplastics in seafood. The research question is: If microplastics are so prominent in oceanic environments, will they be found in marine organisms like shrimp? The hypothesis is: If microplastics are so prominent in oceanic environments, there will be microplastics found in marine organisms like shrimp because they would have consumed them in their natural habitat. The methodology is as follows: Acquire Nile Red Dye, Potassium Hydroxide, and marine organisms. We will get 4 large tiger shrimp Carefully remove all of the shrimp's digestive system and GI tract Separate the shrimp's intestine and stomach contents into 8 different test tubes. Weigh the materials and record data. Label each test tube. Pour 3-4 mols of potassium hydroxide diluted in distilled water into each test tube. Place test tubes in the oven and bake at 60 °C for 24 hours. This will allow for the biological components of the sample to be digested away by the chemicals. Take each sample, and put filter paper on a funnel on 8 new test tubes. Leave the solutions to strain. Introduce the Nile Red Dye Put leftover particles on a slide and examine them under a microscope (UV light). Examine and collect data

Ridgefield High School

Teacher: Patrick Hughes

Project # 0018

Jerfy, Aadit

Completed Project, Engineering, Physical Science

AI Based Skin Cancer Detection System

Melanoma, the most severe form of skin cancer, is almost always deadly if left untreated. While it comprises a small minority of skin cancer diagnoses, it has the highest fatality rate. Current detection requires a visit to a clinic to receive a physical examination or biopsy, which some people don't have access to. I have created a detection method that will effectively be accessible to anyone with a phone, computer, or similar device. A user interface was made using PyCharm, and code written by Sasank Chilamkurthy, in which Python is utilized to identify whether or not an image submission is melanoma. The AI is trained on 6,000 images from the HAM10000 dataset from harvard.edu, which consists of 10,000 images of melanoma, to train the neural network for detection. The code considers variance in skin tone and crops the image so as to limit computing power needed. Transfer learning is utilized so that the data can be made into a more comprehensive imageset for the network. The AI iterates through the database, comparing it to the submitted image and picking up on similarities. If there are enough characteristics of melanoma in the submitted image, it is identified. The code will be incorporated into an application eventually, in which people can take a picture of a lesion for accurate and simple detection of melanoma. The AI is currently able to detect melanoma with an accuracy of 92.1%, tested on a set of 2,000 images.

Newtown High School

Teacher: Timothy DeJulio

Project # 0019

Kim, Yunah

Completed Project, Science, Environmental

Determining the Most Effective Blend of Coagulants for Surface Water Treatment in Varying Temperatures

Determining the Most Effective Blend of Coagulants for Surface Water Treatment Water scarcity is becoming more prominent, leading to the need for more efficient and cost-effective water purification methods. Coagulation is a chemical water treatment method that removes impurities from water through destabilization of suspended particles that make water disinfection difficult. The increased efficiency of blended coagulants in removing physicochemical parameters compared to individual coagulants has been observed. The purpose of this project was to identify the most effective blend of coagulants: alum, ferric sulfate, and Moringa oleifera seed powder in treating surface water. It was hypothesized that alum and ferric sulfate would be the most effective blend as they are both chemical coagulants and frequently used in purification industries. The independent variable was the different blends of coagulants. The dependent variable was the percentage removal of conductivity, water hardness, and total dissolved solids (TDS) from the water. The control was the surface water sample without any coagulants added. The experiment was performed outdoors at home. Water was collected from a local pond and the performance of eight different samples were recorded. Before coagulation, water hardness, TDS, and conductivity were measured. After coagulation, the water was filtered and measured again. Results demonstrated a decrease in water quality amongst most criteria, with an overall increase in conductivity, increase in TDS, and variation in water hardness. This research will provide more knowledge on how to improve the experimental process in the future and provide insight on coagulation as a purification method.

Amity High School

Teacher: Catherine Piscitelli

Project # 0020

Kolb, Antonia

Completed Project, Engineering, Physical Science

DETICKT IT: A Machine Learning-Based Application for Real-Time Tick Identification and Spatiotemporal Disease Risk Assessment

There is an alarming increase in the population of ticks and tick-borne diseases (TBDs), with 475,000 cases reported annually, some of which are fatal. Due to limited training, healthcare providers and the public cannot always accurately identify ticks and their associated infections, leading to delayed diagnoses and treatments. Additionally, the prevalence rates of different disease-causing pathogens vary based on geographic locations. To facilitate the identification process and provide an expedited risk assessment of TBDs, a machine learning-based iOS application, DETICKT IT was created. The app features a ResNet50V2 (transfer learning) deep convolutional neural network (CNN) built in Python for combining real-time tick-species identification with a location-based tick-risk assessment by embedding the Centers for Disease Control and Prevention's (CDC's) spatiotemporal tick and pathogen surveillance statistics. With DETICKT IT, users can now receive an immediate and accurate analysis to determine whether they are at risk of contracting a certain TBD. The app is able to accurately identify the ten most common tick species in North and South America: American dog tick (*Dermacentor variabilis*, *D. similis*), Asian Longhorned tick (*Haemaphysalis longicornis*), Brown dog tick (*Rhipicephalus sanguineus*), Eastern blacklegged tick (*Ixodes scapularis*), Western blacklegged tick (*Ixodes pacificus*), Groundhog tick (*Ixodes cookei*), Gulf Coast tick (*Amblyomma maculatum*), Lone star tick (*Amblyomma americanum*), Rocky Mountain wood tick (*Dermacentor andersoni*), and soft tick (*Ornithodoros*). The overall accuracy is 97% with precision, recall, and F1 score metrics of 0.96, 0.97, and 0.96, respectively. This freely accessible app shows promise in assisting tick bite victims with their decision to seek further medical assistance, particularly those with underlying health conditions.

King School

Teacher: Victoria Schulman

Project # 0021

Kompalli, Nidhi

Completed Project, Science, Health & Medical

Determining The Correlation Between Various Types of Breast Cancer Treatments and Signs of Psychological Stressors in Breast Cancer Patients During Time of Diagnosis and After Treatment

Determining the Correlation Between Various Types of Breast Cancer Treatments and Signs of Psychological Stressors in Breast Cancer Patients During Time of Diagnosis and After Treatment Breast cancer treatments are common treatments for breast cancer patients that help reduce and try to eliminate cancer cells in their bodies. Many patients, when first diagnosed, have doubts and are fearful of what is to come. Furthermore, it was recently discovered that many patients associate their treatment with pain or instability, hence resulting in many signs of psychological problems. These psychological effects can even result in poor health for these breast cancer patients, from the time they are diagnosed to after their treatment is completed. The purpose of this project was to determine the correlation between the breast cancer treatment types, and the stressors presented within each group. If a breast cancer patient is diagnosed and treated with chemotherapy, then they are more likely to show signs of poor psychological health, because chemotherapy has been shown to be one of the most painful and expensive types of breast cancer treatment. The independent variables in this project were the various types of treatments (chemotherapy, radiation, and hormone) and the dependent variable was the psychological health of the patient that was determined using the NCCN distress tool. There were no controls or constants in this experiment. The student gathered data from the mentor's database, and then the retrieved data was sorted into three different treatment groups: chemotherapy, radiation treatment, and hormone treatment. Then, within each treatment group, the patient data was sorted into groups based on their score using the NCCN distress tool (ex. All the 10's will go together, the 9's together, etc.). Additionally, the data was sorted into different psychological stressor groups. The severity of the stressor was determined by their score on the distress tool. If they got a rating of 4 or more, then it was considered a sign of a stressor depending on what was causing them to feel this way (ex. Financial problems, family issues, etc.). The data was analyzed and conclusions were reached as to which treatment group presented the most psychological stressors out of the 3 treatment groups. Data thus far shows that patients treated with chemotherapy were more likely to show severe signs of stressors when compared with the other treatment groups. The role of the student was to conduct data analysis and sort all data, while the mentor oversaw the project, and provided data and help when necessary. This project could help scientists understand the psychosocial ramifications that these treatments have on the patients, and how to treat the cancer in ways that don't have these effects.

Amity High School

Teacher: Catherine Piscitelli

Project # 0022

Koola, Adrian

Completed Project, Science, Health & Medical

Analyzing the Impact of Low-Level Viremia on Treatment Outcome in HIV Infected People Living in Low- and Middle-Income Countries

Currently, research is lacking on HIV for people living in low and middle-income countries. Information is especially lacking on low-level viremia (LLV) when patients have 50-999 copies/mL of HIV in their blood. LLV is associated with higher risks of virological failure and drug resistance. The purpose of this research was to determine the impact of LLV on the treatment outcome for people living in low and middle-income countries. The independent variable was the initial viral load categorized as LLV or non-LLV, and the dependent variable was the treatment outcome. The control in this study was the people without LLV. It was hypothesized that if people in low-and middle-income countries with HIV have LLV, then they are more likely to develop virological failure because studies from high-income countries show that low-level viremia is associated with virological failure. For this research, several articles were collected by the mentor, and data was extracted from the articles by the student. Subsequently, the results of the study were recorded and analyzed by comparing the risk of virological failure between those with and without LLV. The results show that there was a 2.24 risk ratio for people with low-level viremia to develop virological failure. This indicates that low-level viremia increases the risk of virological failure, supporting the hypothesis. Since the hypothesis was supported, the researchers will join other researchers to recommend that the WHO revisit its criteria regarding HIV. This would increase awareness of the risks of low-level viremia and potentially decrease treatment failure.

Amity High School

Teacher: Catherine Piscitelli

Project # 0023

Laryea-Adjei, Sowa

Completed Project, Engineering, Physical Science

Synthetic Intelligence In Motion: Building and Testing a Miniature Self-Driving Car

Self-Driving cars are becoming more relevant to society every day, but almost 70% of drivers are afraid of them, even though automated cars can be trained to be safer than even the average human driver. This made me curious about how automated cars are able to stay on the road and detect motion. I used the Engineering Design Process to prototype a Miniature self-driving car. Then I made an algorithm for it to move on its own, react to different colors, and stop when it detects an object, all on a self-made road with appropriate markings. I also attempted to make a cruise-control mode for the prototype, which lets it follow a moving object, such as a hand or a toy car. I discovered that in order for the car to turn around the road, the sensors need to detect the different colors for it to safely navigate the road. These results suggest that self-driving cars require many sensors and trackers for them to function while abiding by street laws. If I were to do this project again, I would try to refine the automatic steering of the car as much as possible, to the point of replacing the kit, so it would drive perfectly straight without any mishaps.

King School

Teacher: Victoria Schulman

Project # 0024

Li, Emily

Completed Project, Engineering, Physical Science

Algorithm for Multi-Car System Simulation

Newtown High School

Teacher: Timothy DeJulio

Project # 0025

Louizos, Zachary

Completed Project, Engineering, Physical Science

Two-Dimensional Semiconductors: Characteristics and Usages of Graphene and Transition-Metal Monolayers

The properties of two-dimensional semiconductors are of high interest in recent years due to their potentially exceptional performance in optoelectronic devices. Graphene, already known for its exceptional performance as a conductor, is needed in its few-layer form for characterization through the use of Scotch-tape exfoliation. This method involves the thinning of a bulk lattice using Scotch-tape as a separating agent. The tape easily overcomes the forces that hold the graphene lattice together, so it is optimal for producing high-yield few layer graphene. Graphene is then placed onto SiO₂ wafers for contrast with the substrate. Few-layer graphene is identified through methods of 100x magnification, with the transparency of a bi/trilayer indicating the presence of few layer graphene. In addition to graphene, exfoliation methods are used on the TMD semiconductor WSe₂. In this case, however, gold exfoliation is used in which Au foil is placed on a bulk WSe₂ crystal and extracted onto a SiO₂ substrate. WSe₂ stacking methods are prevalent in exerting properties of Moiré superlattices, with our original method involving transfer of a monolayer to a substrate using a polymer. This polymer slides the monolayer onto the substrate and creates potential superlattices dependent on the twist angle. These superlattices and monolayers of both graphene and WSe₂ can be characterized through Scanning Tunneling Microscopy, in which doping levels and bandgap structures are identified using a piezoelectric tip on the atomic level of magnification and charge carrier mobility analysis within 2-D semiconductors and TMD materials. Overall, we aim to optimize and uncover new methods of production and identification within 2-D materials, with the goal being the enhancement of semiconductor properties that can enable materials to be efficiently utilized in optoelectronic devices.

King School

Teacher: Victoria Schulman

Project # 0026

Lu, Nicholas

Completed Project, Science, Environmental

Assessing the Potential Cost Effectiveness of Alternative Meat Sources at Improving Human Sustainability Using a Machine Learning Model

Over the past few decades, increased land use for agriculture has grown to excessively unsustainable levels resulting in the industry accounting for 11% of all human greenhouse gas emissions and the destruction of vast areas of natural habitats. One potential solution to help address this problem is alternative meat sources. Alternative meat, such as lab grown and plant-based meat, produces almost 90% lower greenhouse emissions than conventional meat sources which can help reduce the overall carbon footprint of the meat industry and agriculture as a whole. While some studies have done meta-analysis on the potential benefits of alternative meat sources, this study was the focus on the long-term cost effectiveness of such sustainability solutions. The purpose of this project was to predict the overall impact of alternative meat sources on human sustainability using a machine model in order to assess its viability in reducing the negative environmental impacts of the meat industry. A prediction model was programmed in python to assess the future impact of meat production on human sustainability. The mentor provided guidance on the programming of the model. The model was able to predict future human sustainability based on the adoption rate of meat substitutes. The model predicted that meat substitutes have the potential to greatly reduce the emissions of the meat industry and have a noticeable impact on overall emissions. This model could help provide insight into the benefits of meat substitutes on human sustainability and more accurately map the effects of the adoption of meat substitutes.

Amity High School

Teacher: Catherine Piscitelli

Project # 0027

Luciano, Nathaniel

Completed Project, Science, Environmental

Determining Which Species of Plant Growth Promoting Bacteria in Combination with Fertilizer Has the Greatest Effect on the Plant Biomass of Cynodon dactylon

The use of chemical fertilizers can cause negative environmental effects while being inefficient in providing nutrients to plants. Plant growth promoting rhizobacteria (PGPR) has been observed to be an effective biofertilizer by increasing nutrient uptake while being more beneficial for the environment. The purpose of this project was to compare species of PGPR in combination with fertilizer on the biomass of bermudagrass to suggest which species would be most effective. It was hypothesized that a treatment of 50% fertilizer in combination with a strain of PGPR will lead to comparable results to the full rate of fertilizer. The independent variable was the type of bacteria used and percent fertilizer combination, and the dependent was the biomass of the grass in grams. The positive control was 100% of fertilizer, and the negative was 50% fertilizer. The PGPR isolates to be used in the experiment were collected in the mentor's lab. Each strain was combined with a 50% fertilizer rate. The seeds were prepared and the correct treatments were added for ten replicates of each group. The biomass of the grass was measured. The student analyzed the data to determine the results. Results showed with a high level of significance that 50% fertilizer with PGPR is comparable to the full rate of fertilizer, with *F. solisalsi*, and *B. sphaericus* being the most effective. This experiment helps illustrate the effectiveness of PGPR supplemented with fertilizer. These bacteria can be used in biological products leading to greater crop production and a healthier environment.

Amity High School

Teacher: Catherine Piscitelli

Project # 0028

Maklad, Salma

Completed Project, Science, Behavioral

Investigating the Effects of Media Multitasking on Concentration in Mathematical Tasks

Media multitasking (MMT) is generally defined as interacting with two or more forms of media simultaneously or the usage of media while engaging in a non-media task. Studies have shown that MMT is linked to negative effects on academic performance, cognition, and executive functioning. These studies mainly investigate the link MMT has rather than its direct influence on attention and concentration. Given this, the purpose of this study was to investigate the effects of MMT on concentration in mathematical tasks for high school students. The independent variable of this study was the alternate media (video) scenario. The control trial was the alternate media being off. The dependent variable was the participants' time concentrating on the given task. It was hypothesized that if the background video is playing, participants would struggle more with concentrating on the given task because MMT has been suggested to negatively impact focus levels. Participants completed three six-question worksheets (one per trial) made with pre-algebra Kuta Software questions, all of similar difficulty. While completing the task, the background video was playing (trial 1), paused (trial 2), or closed (trial 3) on their computer screens. Focus was measured with Gaze Recorder, an eye-tracking software. After participants finished, the percentage of time concentrating was calculated for each trial. The student designed and executed the experiment while the mentor provided guidance accordingly. Results thus far are inconclusive. Once completed, this study could be applied in working environments by providing insight into MMT's effect on concentration.

Amity High School

Teacher: Catherine Piscitelli

Project # 0029

Maltese, Dillon

Completed Project, Engineering, Physical Science

The affect of self-driving cars on the everyday world

My grandpa and I share some of the best memories from our car rides together. However, he is becoming old, and his hands are too shaky to drive. The only way to solve this problem is with some sort of other driving, which self-driving cars can do. What my project aims to do is solve the question of whether self-driving cars are ready for the real roads or not. I attacked this problem by using the microcontroller of my choice, an Arduino. I decided to add four motors using a particular motor shield type from this selection. I also added an Iduino controller to make the control group, manually driving the car, and an ultrasonic sensor on a server to represent the test group, the self-driving car. Finally, I added code to move the motors toward where the controller is pointing or where the ultrasonic sensor detected the furthest away object. The part that helped me make it more realistic was adding a camera to the car and using a VR headset to make it feel like I was in the car. To test, I put the robot through a maze in my garage with the sensor and the controller and measured the times. Looking at the results, you can see that although it has been greatly improved over the years, our current technology is not quite ready to drive entirely on the roads. However, using Moore's law, it will hopefully be ready in the next couple of years.

King School

Teacher: Victoria Schulman

Project # 0030

Mannan, Zuhayr

Completed Project, Engineering, Physical Science

Designing and constructing a bioreactor that utilizes an optimal ratio of *Trichoderma harzianum* and *Trichoderma viride* to *Arthrospira Platensis* for the repeated production of biofuel

Fossil fuels have been criticized due to current climate concerns. However, biofuels produced from organic sources such as algae and fungi present an alternative. The only bottleneck is an affordable, consistent harvesting method. The purpose of this project was to design and construct a bioreactor that utilizes a ratio of *T. harzianum*/*viride* to *A. platensis* for the consistent production of biofuel. To begin, the different successful bioreactor models for both algae and fungi subclasses were researched, ending up with a stirred tank membrane bioreactor. A 3D model of what the bioreactor would look like when constructed was designed in FreeCAD, a modeling software specialized for engineering. Simulations were then run using this model, including tests for stress and interior pressure as well as an airflow test that replicated the harvesting process. The reactor was adjusted until it passed all tests. The adjustments made to the bioreactor design suggested that a cylindrical borosilicate glass tube with stainless steel end caps and a thin carbon fiber rod with plastic impellers in the center would be the most resilient design, in both sturdiness and successful execution of the harvesting process. The reactor was equipped with a simple water pump and aerator, as well as an air outlet near the membrane filter to release additional gases. An efficient bioreactor that utilizes an optimal ratio of *T. harzianum*/*viride* to *A. platensis* could make the production of biofuels economically feasible, allowing for the industrialization of biofuels and providing a feasible alternative to fossil fuels.

Amity High School

Teacher: Catherine Piscitelli

Project # 0031

Mathew, Daniel

Completed Project, Engineering, Physical Science

Measuring Improvements of Physical, Thermal, and Mechanical Properties of Arrowroot Starch-Based Bioplastic Films Based on the Incorporation of Various Concentrations of the Plasticizers Fructose and Sugar Cane

Plasticizers, substances added to promote plasticity, are one method used to address insufficiencies in starch-based plastics. The sugar fructose, for example, has been seen to perform very well in wheat starch films at various concentrations with 35% w/w being its best performance. The type of sugar used has been known to impact the produced films, meaning a separate type of sugar, like sugar cane, could further impact the starch's properties. The purpose of this project is to measure the improvements in the physical, structural, and mechanical properties of an arrowroot starch-based film based on incorporating the plasticizers fructose and sugar cane at various concentrations. It was hypothesized that both substances should result in the improvement of the films with 35% w/w having the best performance. For this experiment different concentrations were established (0%, 35%, and 50% w/w) with two more groups being decided based on the results of the 35% and 50% (45% and 55% w/w). Films were produced outside of a lab by the student using a mixture of starch, distilled water, and plasticizer. The solution created from this mixture was casted in glass lenses and dried for 72 hours. After production, films underwent water absorption and solubility % tests before being sent to UCONN, where mentor performed differential scanning calorimetry and thermogravimetric analysis testing. Results of the experiment thus far support the initial hypothesis, although further testing is needed. The experiment's findings can be used to better understand the relationship between plasticizers and starch-based films.

Amity High School

Teacher: Catherine Piscitelli

Project # 0032

Meier, Lucas

Completed Project, Science, Environmental

Mechanistic Analysis of the Driving Factors for Ventilation Dynamics within Macrotermes Michaelseni
Termite Nests

The complex nest architecture of the fungi-cultivating Macrotermes termite species has been widely studied for its demonstrations of air ventilation. Mechanistic analysis of these ventilation dynamics within Macrotermes nests can provide insight into more effective ventilation systems for human buildings with the purpose of limiting the use of energy-intensive HVAC systems and their subsequent fossil fuel release. In this study, I isolated two different theories for ventilation within the African termite species Macrotermes michaelseni and replicated them within two respective models to take steps towards implementing termite architecture within human designs. The first model demonstrated a theory for ventilation driven by alternating day and night temperature cycles and the second model demonstrated a different theory driven by fluctuating wind patterns. Both models were tested under outdoor environmental conditions as well as indoor controlled conditions, with temperature and air velocity within the model measured over time. From the temperature and air velocity measurements of each model under several different testing setups, it was found that the It is expected that while each model will maintain the ability to circulate air, the model based on the diurnal temperature cycles will be more efficient with stronger airflow. Along with clearly demonstrating how the mechanisms of each theory function and showing which one is more efficient, this study also takes steps towards implementing termite architecture into human designs by presenting two baseline models for inspiration that could be adapted into actual human buildings.

Darien High School

Teacher: Guy Pratt

Project # 0033

Mejnartowicz, Mila

Completed Project, Science, Behavioral

Determining Trail Making Test B Accuracy in Predicting Driving Preparedness in Pre-Driving Age Adolescents

New adolescent drivers have the highest crash rates in the United States, largely due to underdeveloped cognitive and executive functioning skills. Adolescents' under-developed attention-switching (AS) and scanning skills make learning how to drive challenging. The purpose of this project was to determine Trail Making Test B (TMT-B) accuracy in predicting driver preparedness in pre-driving-age adolescents. It was hypothesized that the TMT-B would be an accurate predictor of adolescent driving preparedness. Participants reviewed a hazard list, completed one focused simulator (FS) and one distracted simulator (DS) on an online hazard identification driving simulator website, and completed the TMT-B. Changes in simulator scores were calculated by subtracting DS accuracy scores from FS accuracy scores. An R²-test was used to determine the correlation between changes in simulator scores and TMT-B speed and accuracy scores. The data thus far shows a non-significant correlation ($R^2 = 0.150$), and the hypothesis was not supported. AS skills only correlate with 15% of decreases in hazard identification accuracy when distracted, meaning that people with low TMTB scores were not more likely to have lower scores on the DS than people with high TMTB scores. The data thus far does not support the hypothesis of the TMT-B as an accurate predictor of adolescent driving preparedness. This study demonstrates the need for tests that accurately measure adolescent attention-switching skills to aid them and their parents in the crucial decision of when to start driving.

Amity High School

Teacher: Catherine Piscitelli

Project # 0034

Miranda, Bernardo

Completed Project, Science, Health & Medical

Effect of IC100 Antibody on Inflammasome Activation in Traumatic Brain Injury

Traumatic Brain Injury (TBI) has generally unexplored mechanisms, biomarkers, and targets for treatment. The NLRP3 inflammasome has proven to be a major driver of neuroinflammation and neurobehavioral disturbances following TBI, a stage of TBI often referred to as a “secondary injury.” The inflammasome adaptor speck-like protein containing a CARD (ASC) is involved in bridging the interactions between inflammasome sensors and caspase-1. Recent studies have shown that the inhibition of ASC through the anti-ASC monoclonal antibody IC100 can suppress the neuroinflammatory response in neurodegenerative diseases such as multiple sclerosis and Alzheimer’s Disease. In this study, we aimed to see if treatment of post-TBI inflammation with IC100 will reduce inflammasome activation through the inhibition of ASC proteins. We started by inducing mice with TBI using an impactor and then treated them with IC100. The caspase-1 concentration in the mice brains directly correlates with inflammasome activation. We measured caspase-1 concentrations in the right cortex and right hippocampus of the mice using an electrochemiluminescence immunoassay (ECLIA). No significance was measured. We suspect that the mice brains were not stimulated enough for TBI’s secondary injury to initiate, therefore yielding no measurable change in inflammasome activation.

Darien High School

Teacher: Guy Pratt

Project # 0035

Nandy, Mihir

Completed Project, Engineering, Physical Science

Determining if Expansion Microscopy is a Valid Alternative to Electron Microscopy for the Purpose of Imaging Neurons for Connectomics

Connectomics is the study of connectomes, which are systems of neural pathways. The current method for imaging neural tissue for connectomics is electron microscopy (EM). This is unideal because there is a lack of people who have access to and can use an electron microscope. Fluorescence microscopy, a type of light microscopy, does not have sufficient resolution to resolve the structures of interest. Expansion microscopy (ExM) is a new method of light microscopy that uses a gel to expand the neurons. The purpose of this project was to determine if ExM is an effective alternative to EM for connectomics. It was hypothesized that ExM is as accurate as EM and is an effective way of imaging neurons for connectomics. The independent variable was microscopy type. The dependent variable was the accuracy of the microscopy. The images from the EM are currently accepted as a standard for connectomics and were treated as a control which the data from the ExM was compared with. The data for EM and ExM images of mouse neurons exists. The neurons imaged by ExM were annotated to create a 3D model of the neurons. The density of dendritic spines was used as criteria to determine the efficacy of ExM compared to EM. It was found that the ExM was not able to capture the same density of spines as EM. In order for ExM to have an impact in connectomics, research will have to be done on improving the process to preserve more of the neurons.

Amity High School

Teacher: Catherine Piscitelli

Project # 0036

Olvany, Steven

Completed Project, Science, Environmental

The Economic Efficacy of Various Algae Strains for Biofuel Production

Producing fuel products from algae could provide a solution to the draining of fossil fuel reserves and help reduce the detrimental effects of fossil fuel extraction on the environment. This study determined what strain of algae is the most economical for biofuel production. The experiment compared the economic efficacy of 3 different strains of algae: Chlorella, Spirulina, and Scenedesmus. For all algae types, data for the elemental compositions was gathered from various literature and databases. After compiling this data, the values were entered into the NREL Algae farm model. This model produced an estimated cost per ton of biomass for each lipid. From this, the percent lipid compositions, which were also gathered from literature and databases, were used to determine the estimated cost per ton of lipids from each algae strain. This result serves as an indicator of which algae strain is the most cost-effective for biofuel production. Through this research, Scenedesmus was determined to be the most economically efficient algae strain of the three tested.

Darien High School

Teacher: David Lewis

Project # 0037

Petrizzo, Allison

Completed Project, Science, Environmental

Detecting PFAS in Medical, School, and Delivery Uniforms

Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals that provide physical properties such as water repellency and stain resistance. As such, they are widely used in consumer products. The focus of this research was to investigate medical, delivery, and school uniforms for the presence of PFAS. First, as an initial test for PFAS, a water and oil droplet test was completed. In the samples, if the droplet did not absorb into the fabric, this would indicate that the sample was likely to contain PFAS. In particular, the water and oil beaded for five-plus minutes in one sample. Subsequently, samples were tested at the University of Notre Dame to undergo particle-induced gamma-ray emission spectroscopy (PIGE), a surface technique used to measure total fluorine concentrations. Based on the total fluorine values measured, conclusions could be made regarding whether samples contained intentional fluorine. Most of the school uniforms were found to contain intentional fluorine, meaning that PFAS was added to promote stain resistance or water-proofing. A possible reason why school uniforms contain PFAS is that students may be more susceptible to stains than delivery workers.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 0038

Qin, Bo-Jun

Completed Project, Engineering, Physical Science

Simulating CMB temperature signal to analyze the effects of noise

As cosmologists probe the early universe to understand its nature, the development of precise ground-based telescopes has become increasingly important. The cosmic microwave background (CMB) is radiation redshifted from the first light in the universe. It may contain primordial gravitational waves, which would provide evidence for inflation, the theory that the universe started as a tiny, dense ball of matter that expanded rapidly. This project analyzes the effects of environmental and instrumental noise on the precise measurement of the CMB, with the final result of simulating a realistic CMB temperature signal. A raw CMB temperature map from a power spectrum is generated from the NASA Code for Anisotropies in the Microwave Background. Foreground maps of point sources and the Sunyaev-Zeldovich effect are added. A noise map comprising beam convolution, white noise, atmospheric noise, and $1/f$ noise is created and overlaid to complete the simulated CMB temperature signal. In the process, each type of noise is overlaid individually onto the signal at three different values to examine its independent effects. The resulting simulated CMB signal's power spectrum is found to be biased high compared to the accepted power spectrum from the Planck satellite. A better understanding of the noise affecting ground-based telescopes will enhance current and reveal new measurements of the early universe, specifically the energy level required to induce inflation and thus available in the universe. The next steps of this research would be to investigate how to reduce noise in large ground-based telescopes with thousands of detectors.

Darien High School

Teacher: Christine Leventhal

Project # 0039

Rutkowski, Sophie

Completed Project, , Health & Medical

Using Defibrinated Sheep's Blood To Predict Endometrial Cancer

In scientific literature there exists a significant gap in menstrual health research. Numerically quantifying menstrual blood volumes allows patients to objectively track significant changes in menstruation over time, serving as a potential indicator and early diagnostics-tool for endometrial cancer. The purpose of this study was to determine the volume capacity, in milliliters, of the five different sizes of Tampax tampons when different volumes of defibrinated sheep's blood were added. This research is the first of its kind, using defibrinated sheep's blood as a substitute for menstrual blood as a result of both substances lacking the ability to clot. Fitting the tampons into glass vials, volumes of defibrinated sheep's blood were added to induce the tampon to $\frac{1}{6}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$, and maximum capacity of its defibrinated sheep's blood holding volume. Each trial was repeated three times, and a picture of the tampon was taken after each trial. Six images were designed for each of the five tampon sizes to accurately portray the visual pattern when a given volume of blood was added. When Tampax tampon size and induced volume of blood increased, the tampon held a greater volume of defibrinated sheep's blood, in milliliters. Menstrual health, though stigmatized and under-researched, remains highly relevant to doctors seeking to take into consideration new indicators of difficult to diagnose illnesses and diseases. Quantifying menstrual blood output numerically aids in removing bias in patients and doctors, and serves as a new metric for reproductive health as a whole.

Weston High School

Teacher: Christopher Gamble

Project # 0040

Rathjens, Anton

Completed Project, , Behavioral

Mood Congruent Musical Preferences in Adolescents: An Exploratory Study

Mood congruence is the matching of the mood displayed in a song, painting, or other art piece with the mood of its audience. Mood can be measured on the PAD scale, a 3d plane that uses pleasure, arousal, and dominance of an emotion to define a mood. There is little data regarding mood congruence and music, and it is a new field of research. The purpose of this project is to determine any relationships between variables in the lives of adolescent participants and their preference for mood congruent or mood incongruent music. It is predicted that there will be some notable connections from musical mood congruence preferences in teens. There will be multiple independent variables outlined in this study, but the dependent variable (as measured on the PAD scale) will be the difference between the mood of a participant and that of the song that they would like to listen to. A greater difference indicates less congruence. Each participant is given a survey, which asks them a series of basic questions about their life (the independent variables). Then, they are asked what song they would most like to listen to when experiencing specific moods. The PAD score of each song is determined, and the difference between the value of the songs and that of a participant's moods is recorded. The personal answers from each participant will then be scrutinized individually to determine any outstanding relationships. The results of this project could be used to develop hypotheses for later research.

Amity High School

Teacher: Catherine Piscitelli

Project # 0041

Roche, Tyler

Completed Project, , Environmental

Determining the moisture percentage and water absorbency of various potential litter substrates, to determine which is optimal for keeping birds dry

Many different litter substrates are used in the rearing of commercial broiler chickens. The water holding capacity of litter affects how clean broilers are and ammonia production. The purpose of this study was to find the best litter substrate to keep broiler chickens driest. It was hypothesized that if pine wood shavings, chopped straw, hemp bedding, and shredded paper are tested to determine % of moisture and water absorbency, then straw will have the least % of moisture and will absorb the most water because straw is typically pre dried to become edible for animals. The independent variable was the type of litter used. The dependent variables are percentage of moisture and how much water is absorbed by each litter. The first part of the experiment was done by heating 125g of each litter substrate in an incubator at 55°C for 48 hours. After heating the litter was reweighed to find moisture percentage. The second part of the experiment was done by stirring each litter substrate in 1000mL water. The litter was then drained, the amount of water remaining was measured. Straw had the highest moisture percentage of 8.6%, followed by paper with 6.8%, then hemp with 6.56%, and pine shavings with 4.4%. Thus far, the second part of the experiment which suggests that hemp absorbs the most water, followed by paper, then straw, then pine. Hemp is shown to be the best substrate as it absorbed the most water. A healthy litter substrate for broilers was found.

Amity High School

Teacher: Catherine Piscitelli

Project # 0042

Santomaro, Sophia

Completed Project, , Health & Medical

The Effects of Temperature and Diet on Mutated Drosophila Melanogaster to Reduce Familial Migraines

A large percentage of people in the world, including me, suffer from familial migraines. For my project, I aimed to rescue a common mutation (occurs in TRPM8 gene) that leads to these genetic migraines. I tested different diets as well as environment temperatures on fruit flies, *Drosophila Melanogaster* to see the effects of these factors. *Drosophila Melanogaster* were selected for my research because they are 70% genetically similar to humans, therefore indicating that the methods used on these flies, if effective, can likely be used to help humans suffering the same problem. I first had to create the mutation, by crossing two types of the fruit flies to create the same mutation commonly seen in humans who suffer from those migraines. This in total took about 1-2 months. I tested both a relatively cold (18°C) as well as a relatively hot (around 24°C) environment on the mutated fruit flies. I additionally examined the reactions of the non-mutated fruit flies as a control group. I also created a high sugar diet (diet with 20% added sucrose) in order to see the effects that this had on both the mutated and non-mutated flies. In order to determine whether or not I had rescued the mutation, I assessed the movements of the flies. Flies with the mutation that had been “turned on” were supposed to move in a jerkily fashion, therefore making this movement pleiotropic with the migraines. Therefore, when examining the effects of the altered temperatures and diet, I can assume that if the jerky movements have stopped, the migraines have also gone away.

King School

Teacher: Victoria Schulman

Project # 0043

Scanlon, Madeline

Completed Project, , Behavioral

Assessing the Public's Willingness to Accept Cancer Vaccines

In the U.S. alone, each year more than 64,000 people will be diagnosed with pancreatic cancer, and about 50,550 people will die from this disease. The Pancreas is concealed behind multiple abdominal organs, resulting in difficulty for scanning methods - for instance, computerized tomography scans - to diagnose Pancreatic Cancer. Additionally, awareness of this disease is low; for example, 74% of the UK does not know a single symptom of this form of cancer. Provided with these challenges, it is clear that a proactive approach - such as vaccination - is needed to prevent Pancreatic Cancer. Furthermore, with the advancements in the vaccination field provided by the mRNA-based COVID-19 vaccine developments, the scientific community has a new tool to induce immune responses. One challenge with vaccines is that there has been an increase in hesitancy due to misinformation propagated through social media. Thus, before embarking on creating a ground-breaking pancreatic cancer vaccine, through the creation of a survey I aimed to gauge the public's interest and determine whether those hesitant towards vaccines could be convinced to accept an mRNA-based cancer vaccine. Furthermore, I aspired to determine if hesitancy towards vaccines is regionally based in the U.S. and abroad. It was discovered that the public's awareness about vaccines was relatively high. Additionally, although there was no significant change in the public's openness to vaccinations in a majority of the U.S., in the South there was a decrease in Pancreatic cancer vaccination hesitancy, after providing the participants with statistics on vaccinations.

King School

Teacher: Victoria Schulman

Project # 0044

Shah, Layla

Completed Project, , Health & Medical

Gender-Related Differences in a Murine PCSK9 and HFD Model of Atherosclerosis

Cardiovascular diseases are the leading cause of death worldwide, taking an estimated 17.9 million lives annually. Although these stats are frightening, there are several predictors and known risk factors to aid in identifying diagnosis early on. One such cardiovascular condition, atherosclerosis, is the buildup of fats, cholesterol, and other substances in and on the artery walls called plaque. There are several factors that can induce atherosclerosis including high cholesterol and triglyceride levels, and gender, which also affects the intensity of atherosclerosis. It is hypothesized that males are more prone to developing atherosclerosis, especially at an early age. In addition to susceptibility, gender also affects the characteristics of the plaques, cholesterol levels, and body weight. To test this, male and female C57BC/6 mice were sacrificed and the heart tissues were isolated, sectioned, stained, and imaged at the aortic root to assess the plaque buildup. A total cholesterol and triglyceride assay was performed to assess the makeup of the plaque. The results show the male mice had a stronger onset of atherosclerosis in terms of lesion area, cholesterol, and triglyceride levels. The purpose of this work is not to explain why there is a difference between the sexes, but to highlight that there is a difference in plaque characteristics between the sexes. With this new knowledge on the gender differences in atherosclerosis, we can begin to develop personalized therapies that can be applied to either males or females, and can be safely and effectively used in the entire population.

King School

Teacher: Victoria Schulman

Project # 0045

Sidhartha, Aditi

Completed Project, , Health & Medical

Identification of a DNA Enhancer For CCR5

Tens of millions of people have died because of HIV, and about 39 million people are living with HIV, but there is still no cure. C-C chemokine receptor type 5, also known as CCR5, is an HIV co-receptor, which is a binding protein on a cell that can connect viruses to cells. Removing CCR5 is an important aspect to curing HIV, and DNA enhancers are what increase the transcription for reproduction of viral cells, which is why it is important to identify one. When identified, it can be removed with CRISPR-Cas9. The purpose of this experiment is to identify a DNA enhancer for CCR5. The independent variable was the different enhancers identified, and the dependent variable was the FFLUC activity after the cells were electroporated. First, enhancers from healthy blood donors were cloned, and plasmids were electroporated into cells. If an enhancer was identified, it was removed with CRISPR-Cas9. Data was sent to the student, and the student analyzed the graphs to see how successful each enhancer was. Graphs sent show that almost all of the enhancers' expression was low compared to the control. The data collected so far shows how none of the enhancers show increased expression as compared to the positive and negative control, meaning an enhancer for CCR5 still has not been found. However, more enhancers are to be tested to see if any match CCR5. This study can help with understanding CCR5 and finding a cure for HIV.

Amity High School

Teacher: Catherine Piscitelli

Project # 0046

Sifrovich, Mark

Completed Project, Science, Physical Science

Designing a Video Game to Boost Performance in Algebra I

Education today doesn't engage and immerse students in the subjects getting educated. As such, many students are not interested in what's getting taught and therefore aren't learning. On the contrary, video games have exploded in popularity over the past few years, with millions of people spending their time playing them. What video games have to their advantage is the ability to attract and immerse people. Gamification is known as the combination of video games and education or using video game features in non-recreational environments. This project aims to create a video game to teach high schoolers Algebra I using a game with gamification features such as currency and difficulty upgrades. Last year, a game was created that could supposedly teach Algebra I, but did not have Graphics and was not tested. This year, the graphics for the game were made and all the bugs were fixed. When running it, all menus and gameplay features worked as intended. The next phase of this project would be to give the program to a group of Algebra I students for a week and compare their change in skill to another group that was given a traditional study packet. If this game is effective at teaching math skills, it can be used in a classroom to teach Algebra I in an immersive and engaging way.

Amity High School

Teacher: Catherine Piscitelli

Project # 0047

Stannard, Charlotte

Completed Project, Science, Health & Medical

Investigating If There Is a Correlation Between Maternal Age At Time Of Pregnancy Loss And The Number Of Trophoblast Inclusions In The Placenta

Approximately 23 million miscarriages occur each year worldwide, equating to 44 pregnancy losses every minute. Rates of miscarriage and stillbirths increase with maternal age but often the cause of pregnancy loss is unexplained. Trophoblast inclusions (TIs) are microscopic morphological abnormalities of the placenta due to atypical infolding of the trophoblast bilayer into the villous core and have been identified in pregnancies with adverse birth outcomes. The purpose of this project is to investigate if increased maternal age impacts the number of TIs found in the placentas of lost pregnancies. It is hypothesized that increasing maternal age corresponds to a greater number of TIs, thus contributing to pregnancy loss. The independent variable is maternal age. The dependent variable is the number of TIs. Data from the Yale University School of Medicine Reproductive and Placental Research Unit was obtained. The student worked with Dr. Harvey Kliman to sort and analyze data from 1,256 cases of pregnancy losses from 922 patients that demonstrated 878 (69.6%) miscarriages and 378 (30.4%) stillbirths. A regression analysis was performed yielding a weak positive correlation between maternal age and number of TIs. The hypothesis can be refuted because there is not likely an age dependent correlation to number of TIs. This data demonstrates that pregnancy losses are due to random genetic problems that may occur at any age.

Amity High School

Teacher: Catherine Piscitelli

Project # 0048

Stoltenberg, Ian

Completed Project, Science, Environmental

Developing Thermodynamic Models to Accurately Predict the Performance of Solar Powered Desalination Systems for Concentrated Brine Solutions

Finding a way to desalinate water is becoming an important issue in many places because of constant droughts and lack of water. Also, there is an increased need for systems like this to be powered by renewable energy because of the climate crisis. The purpose of this project is to develop thermodynamic models to accurately predict the performance of solar-powered desalination systems for concentrated brine solutions. The model was created using the Julia programming language. Previous related models were used as a starting point for the creation of the new model. The models were then developed further to be made more specific for the project, and then they were tested in different locations along the East Coast of the United States. The model looked at the different effects desalination has on the economy of the region, energy usage, and how well it can make potable water. The results of these tests determine the optimized desalination method for certain areas and certain needs. Data was analyzed by compiling and comparing the results of the different tests run by the computational models. It was found that overall, the model's optimized renewable desalination plan could save regions up to millions of dollars if implemented correctly. The implications for this project are helping find reliable ways to desalinate salt water using renewable energy, which could greatly help regions' economies and well-being.

Amity High School

Teacher: Catherine Piscitelli

Project # 0049

Storeygard, Jacob

Completed Project, Engineering, Physical Science

Optimizing an Algorithm Used for 3D Printing on Uneven Surfaces for Commercially Available 3D Printers
with TPU Filament

Conventional FDM (Fused Deposition Modeling) 3D printing is a method of additive manufacturing in which melted plastic is extruded layer by layer onto a flat print bed. 3D printing on uneven surfaces involves altering the G-code file in order for the extruded material to lay correctly on an altered surface. Various algorithms already exist to transform G-codes to be able to print onto these uneven surfaces; however, they are not optimized for standard home-use printers or for printing PLA (Polylactic Acid) filament. The purpose of this project was to modify and test a current algorithm used for non-planar 3d printing so that it is optimized for home use and PLA filament on Uneven Surfaces. To optimize the algorithm factors such as the temperature of the nozzle and bed, print speed, and fan speed needed to be adjusted. The new code was tested on a variety of uneven surfaces to measure the effectiveness. If the objects were printed onto the surfaces using the altered G-code file without any complications such as warping, layer shift, or bed adhesion issues, it was considered a successful trial. The original algorithm printed successfully 80% of the time, however, the modified algorithm, however, printed successfully 100%. In addition to a 25% increase in successful prints, the modified algorithm showed a significant improvement in print quality indicating that the modifications were successful. The results from this project could help people with standard 3D printers create more complicated projects with less wasted material.

Amity High School

Teacher: Catherine Piscitelli

Project # 0050

Trudel, Evelyn

Completed Project, Science, Behavioral

An Investigation of Stone Reusual Construction Techniques Used in the Anasazi Community From 800-1200 AD In Southwestern United States Based on Stone Length-Width Ratios

The American Southwest has a rich history with the Ancestral Pueblo. They lived in Great Houses, which consisted of many rooms and kivas, which are religious semi-subterranean structures and served as centers for politics and economics. This study focuses on the reuse of stones in these structures, a concept passed down orally in the American Southwest and briefly explored in a few articles. It aims to quantify the concept. We turned to the classic archaeology term for stone reuse, Spolia, to delve deeper. We predicted that length-to-width ratios in stones at the Haynie Archaeological Site would show evidence of Spolia construction techniques in ancestral pueblo. Haynie is located in southwestern Colorado and is maintained and utilized by the Crow Canyon Archaeological Center. Then, a data set was compiled with different length and width measurements (cms) of stones within the site. A total of 8 structures were documented, which were broken up into 11 more focused structures, seven based on room walls and four based on kivas. The earliest stones were from Middle Pueblo I(800-850 CE), and the latest were from Late Pubelo II(1100-1140 CE). Box and whisker plots were created and provided means and medians of varying structures, which helped establish interpretations. The results indicate that stones with similar length-thickness ratios were used in Pueblo I and Late Pueblo II kiva and room walls. This interpretation suggests possible stone reuse between these two periods. Further analysis using a more comprehensive range of attributes could enhance this interpretation.

Darien High School

Teacher: Guy Pratt

Project # 0051

Tsai, Michael

Completed Project, Engineering, Physical Science

Preventing Catastrophic Forgetting in Continual Learning by Controlling Node Gradients

Sequential task learning without forgetting is a critical challenge in deep learning, often referred to as continual learning or lifelong learning. While existing regularization-based methods primarily emphasize node importance evaluation, they often overlook optimization strategies for neural networks, potentially hindering performance and underutilizing network capacity. To address this, we propose a novel optimization framework that synergistically combines node importance evaluation with gradient descent regularization. This framework leverages a regularization-based method to assess node importance, which subsequently dictates the determination of optimal gradient directions for all neural network nodes. Experiments conducted on the CIFAR-100 dataset demonstrate that our approach effectively enhances regularization-based methods and maximizes the utilization of fixed-capacity neural networks.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0052

Twitchell, Nathan

Completed Project, Science, Environmental

The Effect of Road Usage Frequency on the Quality of Soil

In the use of automotive travel, many factors contribute to particulate pollution in the local environment. Fuel consumption releases trace amounts of heavy metals, such as nickel, into the local air, which then settles in the soil due to surface runoff. Other parts of automotive travel release heavy metals, such as tire and brake wear, oil consumption, and road abrasion. In addition to this, leaking oil or any other petroleum based product is also distributed into the environment by some cars. The deposition of such metals and pollutants into our soil is highly detrimental for the local environment, and can negatively impact other important resources, such as drinking water due to leaching. Because of its constant growth and development, automotive traffic load is increasing day by day, thus increasing the amount of metals and other pollutants being distributed into the environment. In order to view the impact of increasing traffic load on soil composition, studying the soil on roads with varying usage would simulate this development. In this simulation, we are given information of how the further increase in road traffic could affect the quality of soil.

Newtown High School

Teacher: Timothy DeJulio

Project # 0053

Vivanco, Lucia

Completed Project, Science, Environmental

Assessing Coral Bleaching Resilience with Additives

Coral reefs are known to be essential organisms to the global marine environment, but they are in severe jeopardy due to anthropogenic environmental changes, such as rising ocean temperatures, which can disrupt the symbiotic corals share with zooxanthellae, a classification of dinoflagellates. Several studies in the past have successfully explored probiotics consisting of different marine bacteria as a way of mitigating the effects of coral bleaching, highlighting Dimethylsulfoniopropionate (DMSP) as an essential compound for understanding the complex microbial interactions of the coral holobiont. This this study, I hoped to discover how multiple compounds related to DMSP affect coral's ability to resist bleaching under temperature stress. I hypothesized that increasing the concentration of tropodithietic acid (TDA), copepods, and dimethylsulfide (DMS) in the coral's environment would increase the coral's resilience to bleaching and result in a lower percentage of mortality because these additions to the microenvironment would support microbial health and increase pathogen resistance. Testing by simulating a marine environment and adding these compounds resulted in the finding that TDA could partially mitigate the effects of bleaching at 32°C over the course of 20 days when compared to control groups and other experimental groups. The corals treated with TDA bleached after an average of 13 days under stressful conditions, whereas the control group bleached after an average of 9 days. With the addition of future research, these findings could result in a way to prevent and mitigate coral bleaching microbially.

King School

Teacher: Victoria Schulman

Project # 0054

Walsh, Gianna

Completed Project, Science, Behavioral

The Effects of Long Term Immersion in Character on Sense of Self and Empathy in Experienced Versus Novice Adolescent Actors

The study sought to investigate the impact of complete immersion in a character on the sense of self and empathy levels among novice and experienced teen actors. Limited research has delved into the long-term effects of character immersion, particularly in the context of teenagers. Given the developmental vulnerability of teens to character-centric pressures, there exists the potential for a distortion in self-perception. The experiment utilized online surveys, ethically approved by the Institutional Review Board (IRB), to assess the self-perception of teen actors both before and after their performances. Two distinct groups were examined, consisting of trained and novice actors across varying age ranges. Employing the ESSS and modified empathy scales, the study aimed to measure the sense of self and empathy experienced by these actors. While initial expectations anticipated a deeper connection with characters among experienced actors, the results revealed an unexpected outcome. The analysis demonstrated an increase in empathy levels for both groups, accompanied by a decrease in the sense of self when comparing pre- and post-performance data. Although these findings deviate slightly from the initially hypothesized outcomes, they consistently support the overarching theory that complete embodiment of a character, whether in movies, shows, plays, or musicals, carries inherent risks.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 0055

Wang, Leon

Completed Project, Science, Environmental

Exploring new realms of renewable energy by harnessing the electronegative properties of bacteria

In today's world, renewable energy solutions come at a high cost. According to a recent study by Yale School of the Environment, transitioning the United States power grid would cost more than four trillion USD (Schwägerl, 2019), which is more than ten times the US government revenue in the 2024 fiscal year (Fiscal, 2023). This alarming statistic points to one of the biggest key issues facing the transition towards renewable energy, especially in developing countries. The initial investment in constructing renewable energy infrastructure is simply too expensive for many developing countries, and that is because traditional forms of renewable energy like nuclear plants and wind farms rely on advanced mechanical systems. However, in this project, a new domain of renewable energy is explored: the harnessing of energy through bacteria via microbial fuel cells. By harnessing common bacteria readily found in wastewater, and the greater environment, this method has the potential of greatly reducing the cost to consistently generate renewable energy, thereby encouraging developing nations to transition to renewable forms of energy. Thus, this project seeks to explore

King School

Teacher: Victoria Schulman

Project # 0056

Wijesekera, Soumya

Completed Project, Science, Health & Medical

Determining an Individual's Typing Efficiency while Injured

Wrist pain is the third most common work-related injury, affecting 19.1% of the adult population. The wrist is a joint that connects the radius and the ulna to the carpals in the hand. A splint is commonly used when a wrist injury occurs. Short arm splints immobilize hand and wrist joints and long arm splints immobilize the upper extremities. The most common wrist rotations when typing are wrist extensions and ulnar deviation. The purpose of this project was to determine an individual's ability to type while being injured. It was hypothesized that if an individual is placed in a short arm splint, they will be less efficient while typing than if they completed the typing task with the long arm splint, or no splint at all. The independent variable was the type of splint, and the dependent variable was the typing score and speed. Constants included the typing test and the splints. The control was the trials performed without splints. A short arm splint was placed on the participant's dominant hand. The participant completed a typing test and score and speed was recorded. The same procedure was repeated for the long arm splint and the no splint trial. The order of the splints tested was altered to ensure no extra variables were included. Results thus far support the hypothesis. The mentor provided the splints and advice during the project. The findings of this project can help gauge one's ability to return to activities that require typing movement.

Amity High School

Teacher: Catherine Piscitelli

Project # 0057

Wempen, Ryan

Completed Project, Science, Environmental

Utilizing Ground and Space-Based Sensors to Track Trajectories of Vehicles/Dangerous Objects and Monitor Climate Change/Environmental Issues

As the number of satellites in low and high earth orbit increases beyond the 10,000 mark and the concentration of space debris increases exponentially, the risk to satellite launch and orbital operations is similarly increasing. This strains the ability of existing systems and algorithms to analyze the data, even before taking into account orbital drift and errant meteorites. Nevertheless, recent sensor technology leaps are poised to make a permanent change in this landscape, resulting in an immediate demand for new and updated simulations to apply the technology to existing problems. To address this demand, a simulation was developed to design an appropriate satellite launch trajectory and orbital path based on chosen mission and operational parameters, and then track a simulated launch from liftoff to final orbit within the designated satellite constellation. After successful orbital positioning, the simulation then continues operating on a designated mission to track evidence of climate change on the ground, from identifying wildfires to tracking flooding, while utilizing its sensors to simultaneously protect the satellite from external threats, including other satellites in decaying orbits, space debris, and exo-orbital threats including meteors and asteroids. As additional simulations working together come online utilizing existing data gathered by satellites, projects such as this one have the potential to both significantly benefit communities threatened by wildfires and flooding by creating an early warning system and to provide the scientific community with an additional tool against the threat of climate change.

King School

Teacher: Victoria Schulman

Project # 0058

Womer, Molly

Completed Project, Science, Environmental

Determining a Correlation Between the Seasons and Florida Zooplankton Community Biodiversity to Help Protect Endangered Manta Rays

Manta Rays were designated a threatened species under the Endangered Species Act in 2018. A large part of a Manta Rays diet is zooplankton, and different species of zooplankton offer different nutrients when consumed. The purpose of this research was to analyze how temperature trends associated with the seasons affect the biodiversity of zooplankton communities in Florida. It was hypothesized that there would be more zooplankton biodiversity in the spring and summer compared to the fall and winter, because of the increased temperatures commonly observed during the spring and summer seasons. The independent variable of this project was the season in which the zooplankton was collected, while the dependent variable was the zooplankton community's Simpson's Diversity Index. There was no control, as this was a comparison project. Data on temperature was collected by the student from a NOAA buoy, and the biodiversity was analyzed using the Simpsons index. The highest average temperature was seen in the summer of 2022, with the lowest average temperature seen in the winter of 2022. The highest average Simpson's index occurred in the winter and fall of 2022, while the lowest occurred in the summer of 2021; furthermore, the highest Simpson's Index occurred in the summer of 2022, while the lowest occurred in the summer of 2021. The mentor supplied the student researcher with the zooplankton data, as well as provided general mentorship. Work from this project can help to understand how the endangered Manta Rays prey population changes between the seasons, which can help to protect the endangered species.

Amity High School

Teacher: Catherine Piscitelli

Project # 0059

Yan, Iris

Completed Project, Engineering, Physical Science

Creating a Novel Decision Tree-Based Change Point Detection Machine Learning Algorithm Employing Unsupervised Learning for Real-Time Earthquake Detection

Earthquakes occur when tectonic plates release energy and move suddenly, causing devastating damages to surrounding areas. Resulting seismic waves provide valuable information for detecting earthquakes and their locations. Because of the variability and large amount of data, human labeled detections are incomplete and subject to bias, highlighting a need for unsupervised learning. Current models are not sensitive enough and do not provide real-time detections. This project created a decision tree-based machine learning algorithm that used unsupervised learning for detecting earthquakes in real time. The algorithm was trained on seismic wave data from the STanford EArthquake Dataset (STEAD). The decision tree-based algorithm, which used a hierarchical tree structure to categorize data, automatically detected changes within the distribution of data itself, removing the need for learning from labels. The multidimensional data were split at each node of the decision tree based on projected values along the principal direction, which resulted in a sorting that exposed the distribution of data points. When new data was analyzed continuously, significant differences in the distribution of data indicated change points of earthquake occurrences. A machine learning classification model was created to learn distribution patterns resulting from the procedure described. It was tested on different magnitude earthquakes in different locations to determine accuracy and sensitivity. The algorithm was more accurate and more sensitive than existing research, while providing detections in real time. By accurately detecting earthquakes in real time at a high sensitivity, this algorithm can help experts understand natural phenomena better and significantly mitigate earthquake damages.

Amity High School

Teacher: Catherine Piscitelli

Project # 0060

Yee, Emily

Completed Project, Science, Health & Medical

The Effect of Plant vs. Animal Protein: Soy Protein vs. Beef Protein on Sleep Quantity

Plant based proteins have shown association with increased sleep quantity and quality in previous research. This research seeks to directly compare the effect of plant based protein (soy) with animal based protein (beef) on sleep quantity in drosophila. Plant based proteins typically contain more tryptophan, than animal based proteins making them more effective in increasing sleep quantity. Tryptophan is an essential amino acid that also serves as a building block for melatonin, a neurotransmitter responsible for sleep and regulating the sleep cycle. Previous research shows that plant based proteins, especially in combination of fiber, are successful in increasing sleep quantity and sleep quality. Drosophila has been proven to be an effective model organism to measure sleep in humans as they share the same circadian rhythm patterns. Sleep can be measured by analyzing video data by hand over the course of 24 hours (if there is no access to a Drosophila Activity Monitoring, DAM, system). This research analyzed video data of drosophila with their respective diets over a course of 24 hours (in each of the 3 trials). This research is important because the amount of people adopting vegetarian or vegan diets has increased significantly in the past 30 years, and there is limited research regarding plant based diets, especially its effects on sleep.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0061

Zhang, Tony

Completed Project, Science, Behavioral

How Working Memory Load Affects Decisions Under Uncertainty in Highschool Students

The tendency to take risks is influenced by how people perceive and treat uncertainty, possible rewards or punishments. Their perception is also influenced by outside factors such as what they are doing at that moment. Risky decision making (DM) is one where outcome probabilities are known. Working memory (WM) is a limited capacity store for retaining information for a brief period while performing mental operations. The purpose of this project was to investigate the effects of working memory load on decision-making under uncertainty. It was hypothesized that if working memory (WM) load is present, there is an increase in risk aversion and an increase in consistency. The independent variable was the working memory load- none, low, and high. The dependent variables were choice proportion, the number of times the risky option was chosen and the consistency of which each lottery was chosen. The control was when there was no WM load. Participants from Amazon Mechanical Turk completed two tasks simultaneously in a program, a dot memorization task and then a risk decision making task. For the control, participants were given the complete dot task and the DM task separately. The mentor collected the data, while the student analyzed the data. The overall trend was that participants were more consistent without WM load and they chose the risky choice more without WM load. This partially supported the hypothesis. This suggests that although WM does affect risk DM to some extent, there are outside factors that affect an individual's decision making.

Amity High School

Teacher: Catherine Piscitelli

Project # 0062

Abraham, Jacob

Project Proposal, Science, Health Research Proposal

Unraveling the Genetic Basis of Adult-Onset Leukoencephalopathy With Axonal Spheroids and Pigmented Glia: Investigating Mutations in the CSF1R Gene

Adult-onset leukoencephalopathy with Spheroids and Pigmented Glia (ALSP) is a rare neurological disorder characterized by white matter abnormalities and an inhibition of neuron communication through myelin loss and axonal swellings. The objective of the study is to pinpoint specific nucleotide sequences and DNA bases within the gene that is associated with the mutations responsible for this disorder. For the study, genomic DNA samples from the CSF1R gene will be collected from individuals diagnosed with ALSP as well as unaffected control group members through extraction from peripheral blood. Following the extraction of DNA, CSF1R gene segments will be amplified using Polymerase Chain Reaction (PCR) to clearly reveal the nucleotide sequence of the given sample. Subsequently, DNA sequencing techniques such as Next Generation Sequencing (NGS) will be conducted to analyze the CSF1R gene segments and pinpoint nucleotide differences between gene samples from those affected with the disorder, and those unaffected (control group). This sequencing technique will be used to reduce error in the comparative analysis of the gene segment's nucleotides. This will allow scientists to distinguish the nucleotide sequences present in ALSP patients with those in unaffected patients, giving way to the discovery of the specific nucleotides responsible for ALSP in the brain. By identifying these mutations, researchers can improve their understanding of the mechanisms contributing to ALSP, bringing them closer to making genetic alterations with processes such as CRISPR/Cas9 as well as other targeted approaches for gene editing.

Darien High School

Teacher: Guy Pratt

Project # 0063

Accinelli, Stella

Project Proposal, Science, Behavioral Research Proposal

The Effects of Color on Psychological Functioning

The Effects of Color on Psychological Functioning This experiment will be focused on testing how color can impact psychological functioning with butterflies as the model organism. This information can be used to display the impact that color has on humans and how this can be further used to our benefit. This is going to be done with the use of colored light. Butterflies will be kept in an enclosure while different colors of light are projected into the space. Any movement or behaviors the butterflies display will be recorded throughout the experiment. The collected data will then be analyzed and any noticeable changes will be examined further. This information will then be applied to humans and the impact color has on us.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0064

Accinelli, Leighton

Project Proposal, Science, Behavioral Research Proposal

Associative learning with shrimp

During this experiment, nine zebra fish will be quarantined for one to two weeks, and each will be trained individually with one colored shape out of nine shapes. In the training, each fish will be taught to swim to their paired colored shape, if they successfully swim to their shape they will receive a food reward. This is a process of associative learning which is key to this experiment. Once the 2 weeks of training are over, each zebra fish will be put into a testing three-tunnel maze with three shapes, but they will only recognize the one they have been trained with. If they successfully choose the familiar object, the zebrafish will earn a food reward.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0065

Archibald, Lily

Project Proposal, Science, Behavioral Research Proposal

Effects of Different Breathing Techniques During Swim Workouts on General Cognitive Function in Adolescent Athletes

Delving into the potential correlation between the sport of swimming and cognitive function, this study investigates the cognitive implications of anaerobic and aerobic workouts on adolescent athletes ages 13-18. The participants will be tested using the Nonsense word tests, a series of 3-letter phrases in order to assess cognitive ability and memory (Hill, 2016). The research will be conducted over a four-week period, where their baseline cognitive measurements are established on three consecutive Mondays prior to practice sessions, employing a comprehensive pre-test protocol. Upholding ethical standards, the test administrator will solicit parental consent via a Google form, as well systematic labeling by a staff member to ensure anonymity. This study aims to show the potential cognitive effects of aerobic and anaerobic physical exertion on adolescent swimmers. Anticipating notable distinctions, it can be hypothesized that aerobic workouts will have a larger increase in cognitive function, due to consistency in a maximum heart rate zone (Cleveland Clinic, 2023).

Ridgefield High School

Teacher: Patrick Hughes

Project # 0066

Bachner, Barrett

Project Proposal, Science, Physical Science Research Proposal

The Effects of Cloth Type and Cleaning Method on the Activity of Contaminated Clothing

In the uranium mining industry contamination is an ever-present danger to those working in the mines. Miner's clothing can play an important role in mitigating the danger presented by contaminants. Using a generic contaminant, uranium oxide in the form of the mineral Uraninite, pieces of cloth can be set to a consistent activity. Through testing of three common cloth types, such as denim, nylon and flannel, using common decontamination methods, such as dry methods of using a piece of duct tape to pull particles from the surface of clothing, or wet methods such as washing with different chemicals, it is possible to determine the rate the different cloth types decontaminate. It is projected that cloth types with a finer grain and a generally slicker surface will decontaminate faster and it has been shown in previous research that finer-grain cloth types pick up contamination less than more coarse ones, whereas the rougher cloth types decontaminate faster. Materials like denim or flannel will take fewer decontaminated cycles as compared to nylon whereas nylon will not contaminate as quickly due to fiber size. These results can be used to determine which cloth types are better suited for use in the mining industry and can help provide more information for risk assessments in the industry. Once this research is completed further research can be done on the danger presented by different levels of contamination for different cloth types to further inform decisions made in the uranium mining industry and improve worker safety.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0067

Ballard, Gracie ; Bailey Meghan

Project Proposal, Science, Teams (Research Proposal)

Analysis of the Decompositional Effect of Concentrations of Cytochrome P450 on Oxybenzone in Salt Water Environments

Oxybenzone is an organic chemical commonly used in sunscreens due to its ability to absorb ultraviolet rays. This chemical has also been found to have negative impacts on aquatic ecosystems, known to bleach and kill coral. Certain marine organisms, such as coral or various sea anemones, add a sugar to oxybenzone molecules to metabolize it. Instead of producing the desired effect, when the sugar is added, this alters the oxybenzone and turns it into a substance that, when activated by sunlight, releases unstable and highly reactive free radical molecules, which damage the coral. Cytochrome P450 is an enzyme that is used in the human body to assist in the metabolism of certain substances. When exposed to oxybenzone, Cytochrome P450 is able to remove the methyl groups from the oxybenzone in order to nullify the harmful qualities the chemical has on coral. The purpose of this study is to analyze the efficiency at which concentrations of Cytochrome P450 can decompose Oxybenzone. While this experiment was not conducted, this project outlines how trials may be completed to determine the effects of Cytochrome P450 on Oxybenzone in replicated oceanic environments containing coral. If conducted, a yield of the expected results would allow a solution to be found on how to implement Cytochrome P450 into oceanic environments containing coral to protect the coral and its surrounding aquatic ecosystem from suffering the damages caused by oxybenzone.

Newtown High School

Teacher: Timothy DeJulio

Project # 0068

Belluscio, Emma

Project Proposal, Science, Health Research Proposal

Improving Wound Care Treatment Plans: Evaluating Infrared Thermal Imaging Efficacy

Effective wound assessment is essential in healthcare, yet challenges persist, especially for individuals with darker skin tones, where conventional visual inspection may be less precise, leading to delayed diagnoses. This proposal introduces the Ray One device, a handheld infrared imaging camera that offers a non-invasive solution. Utilizing thermal imaging, it displays heat signatures in color hues and fluorescent lighting, aiding in the visualization of bacterial burden. Our research seeks to assess its efficacy in enhancing physician decision-making, with a focus on diverse ethnicities to address the limitations of standard visual inspection methods. The trial comprises two groups: a control group undergoing visual inspections alone and an experimental group receiving both visual inspections and Ray One imaging of their wound site. Integrated with the Swift Skin and Wound App, the Swift RAY ONE device records temperature changes and bacterial load, enabling a more comprehensive assessment. Participants provide informed consent during enrollment, where they are informed about the study's duration, outcomes, and their right to withdraw without penalty. Data collection involves thermal images, clinical observations, and adjustments to treatment plans. We anticipate fewer treatment plan adjustments in the experimental group, highlighting the challenges of visual inspection on pigmented skin. The diverse patient population underscores the significance of thermal and fluorescent imaging in influencing physician decision-making. Anticipated results will support our hypothesis that RAY ONE contributes to a reduced rate of inaccurate diagnoses, thereby fostering equity in wound care.

Darien High School

Teacher: David Lewis

Project # 0069

Bose, Arnav

Project Proposal, Science, Physical Science Research Proposal

Optimizing Extraction of Chitin From Crustacean Shells

Lithium is one of the most common metals used in batteries, but it is not very sustainable. Once the batteries are used up, the Lithium cannot be reused, so there is a lot of wastage. Fortunately, there is a clear alternative. Chitin is one of the most abundant biopolymers on the planet, and Chitosan, a result of Chitin undergoing deacetylation, can be used as a biodegradable electrolyte for Zinc batteries. Once disposed of, the Chitosan electrolyte will completely break down within approximately five months, and the Zinc can be reused in another battery. As mentioned earlier, Chitin is highly abundant, being found in many places in nature such as the cell walls of fungi, shells of crustaceans and insects, and wings of butterflies. Because of this, there are many different potential sources of Chitin. In addition, there are many different methods for extracting Chitin from these sources, mainly divided into Biological methods and Chemical methods. The goal of this experiment is to determine the best combination of sources and methods to optimize the extraction of Chitin. During the experiment, different sources and methods will be tested, and the quality of the products will be compared. In addition, the practicality of the sources and methods will be weighed in order to determine which will perform the best on an industrial scale. According to previous research, biological methods using Lactic Acid-producing bacteria provided Chitin of superior quality, so it is to be expected that the experiment will provide similar results.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0070

Bozzuto, Ian

Project Proposal, Science, Behavioral Research Proposal

Method of Equal Shares Analysis using real-world Single Transferable Vote data

Currently, 38% of countries use a proportional voting method, with another 16% using a mixed system. In addition, there has been a recent increase of interest in voting theory. I hypothesize that given a similar analysis to the one in "Proportional Participatory Budgeting with Additive Utilities," the Method of Equal Shares (MES) will outperform Single Transferable Vote (STV) on STV election data. This study will compare the voting methods of MES and STV in multi-winner elections. Unlike traditional voting that is limited to one candidate, MES uses scored ballots, while STV uses ranked ballots. MES has recently been analyzed for its viability in participatory budgeting, and this study will be about how well it would perform in committee elections, compared with the most common proportional ranked method, STV. In some STV elections, the full ballot data is released, so these can be converted into scored ballots and run through MES. Then, the STV result and the MES result can both be analyzed through both the total utility produced and the distribution of utility. It is expected that MES will be superior in its results, as it follows strong proportionality criteria (like Extended Justified Representation). This research will put more focus on the new method of MES (created in 2019) in the context of committee elections. Some possible further avenues of research could be using this data to compare MES to other Multiwinner Cardinal voting rules, and comparing different ways to compute scored MES as well in these multi-winner elections.

Darien High School

Teacher: David Lewis

Project # 0071

Brandon, James

Project Proposal, Science, Behavioral Research Proposal

Artificial Intelligence's adaptability and data efficiency using online learning compared to batch learning

Artificial Intelligence's adaptability and data efficiency using Online Learning compared to Batch Learning. What justifies the usage of Online Learning against Batch Learning when teaching artificial intelligence over evolving data streams? Artificial Intelligence revolutionizes our world, showcasing exceptional adaptability when it comes to learning tasks. This study aims to examine the success of two prominent AI learning patterns: Online Learning and Batch Learning. Batch learning, which utilizes single-use data, has been the more approachable option, Online Learning, a system of learning that includes large-scale data taught in a cycle offers a new and efficient approach, enabling AI systems to adapt in real-time to evolving data streams. The study proposes the adaptability of AI models trained using Online Learning against Batch learning. The study will utilize dynamic datasets such as financial markets and social media streams to highlight the strengths and limitations of each process and their key functionalities: model accuracy, computational efficiency, and re-interpretation. Through experiments and analysis, this study would provide insights into the comparison between the two learning approaches concerning adaptability to changing data distributions and resource utilization. It is predicted that initially before data has been recycled Batch learning will be the preferred method of learning, but given time Online Learning's cyclical abilities will overtake Batch learning in efficiency and efficacy.

Darien High School

Teacher: Christine Leventhal

Project # 0072

Brennan, Kelsey

Project Proposal, Science, Health Research Proposal

X-Ray Diagnosis Threshold Between Paget's Disease and Osteoarthritis

Osteoarthritis is a bone degenerative disease that results in bone with higher densities. Paget's Disease disrupts the body's bone growth process, causing bone to have increased density. Both diseases affect the pelvis and hip joint. On X-rays, bone that is denser appears a brighter white compared to a bone of normal or low density. Comparing the pixel colors of X-rays of each disease from three locations on the pelvis provides insight into a diagnosis threshold. Comparing data at the femoral head was helpful for distinction between Paget's Disease and osteoarthritis, but not between the Paget's Disease and the control or osteoarthritis and the control. However, using data from the inner and outer pelvis shows a distinct difference between the control compared to Paget's Disease, as well as the control compared to osteoarthritis. There is not enough data to feel confident about the diagnosis threshold between Paget's Disease and osteoarthritis based on this data alone; a greater sample size will be needed. However, there is promise looking into this data for further exploration.

Newtown High School

Teacher: Timothy DeJulio

Project # 0073

Not Participating in the Fair

Teacher:

Project # 0074

Buchesky, Anastasia

Project Proposal, Science, Behavioral Research Proposal

How exercise levels correspond with canine PTSD levels

Canine posttraumatic stress disorder is a disorder that many dogs suffer from, but there is limited research in this field. Recent studies on humans with PTSD have shown that exercise can limit the effects of their disorder. This study seeks to understand how canines with PTSD respond to different amounts of exercise over six months. I hypothesize that an increase in exercise will serve as an effective treatment for canines with PTSD. The experimental group will include dogs that have been diagnosed with PTSD through a questionnaire completed by the owners. This questionnaire was used in a previous study on canine PTSD. This questionnaire included questions about symptoms of PTSD, stressors, gastrointestinal health, sleep disturbance, training methods, and punishment. The control group would include dogs who were not diagnosed with PTSD. Dogs will be separated into four categories; Exercising for 15 minutes, 3 times a day; 15 minutes, 6 times a day; 30 minutes 3 times a day; and 30 minutes 6 times a day. After six months, the owners will answer the questionnaire again. I hypothesize that the groups of dogs with PTSD who have a higher rate of exercise will have fewer symptoms of PTSD. The implications of my research would be to find a viable treatment for canine PTSD that doesn't include medication with harmful side effects. The next steps could be to research other correlations between canine and human PTSD to increase our knowledge of mental illnesses in dogs.

Darien High School

Teacher: David Lewis

Project # 0075

Buchesky, Alexia

Project Proposal, Science, Health Research Proposal

An Increased Concentration of Type I Collagen in Intervertebral Disc Degeneration

Intervertebral Disc Degeneration (IVDD) is the leading cause of lower back pain. IVDD is the accelerated aging of intervertebral discs through increased apoptosis and decreased proliferation. This can lead to stenosis, pinched nerves, intervertebral disc herniations, and bone spurs. The two main types of cells in the intervertebral discs are nucleus pulposus cells (NPCs) and annulus fibrosis cells (AFCs). The extracellular matrix (ECM) of NPCs and AFCs undergoes changes during IVDD, specifically the change in collagen structure. The collagen structure changes during IVDD may be due to changing concentrations of proteoglycans which may be affected by the changing concentration of estrogen. This study will measure the concentrations of estrogen and proteoglycans in NPCs and AFCs of murine models using Atomic Force Microscopy (AFM). AFM can be used for imaging proteins on the nanometer scale. Images will be taken in both nondegenerate and degenerate intervertebral discs. It is expected that the estrogen and proteoglycan concentrations will decrease which may indicate that estrogen and proteoglycans play a key role in the composition of the extracellular matrix. A greater understanding of the extracellular matrix of intervertebral discs may help in the development of disease-modifying therapies for IVDD.

Darien High School

Teacher: Guy Pratt

Project # 0076

Calderbank, Chelsea

Project Proposal, Science, Environmental Research Proposal

Analysis of Which Areas are Most Affected by Noise Pollution

Noise pollution is when excessive amounts of sound cause harm to human or animal life. Although typically associated with urban areas, it is likely that noise pollution exists in other areas such as the ocean, highways, and more. This research will find which area has the highest decibel level. This will be achieved by using a device called a sound level meter. For areas like the highway, the device will be held out of a car window to record the sound. For the ocean, I will pair up with an organization or an expert to find a waterproof and safe way to lower the device into the ocean and record the sound. For other areas like neighborhoods, I will stand on grass or a sidewalk and simply record the sound while standing still. Measuring the sound levels of different areas is important because when the areas that have the most noise pollution are discovered, then it will be easier to make changes to lower noise levels, and protect different species.

Newtown High School

Teacher: Timothy DeJulio

Project # 0077

Cardamone, Shawn

Project Proposal, Science, Environmental Research Proposal

Effect of Trails on Dispersion and Redistribution of Invasive Species in Woodland Areas

At present, invasive species pose a greater risk than ever before. As they spread, threatening ecosystem services, it will become critical to develop a greater understanding of these organisms. Investigating their methods of dispersion will be especially crucial for the creation of proper management plans. The goal of this project is to add to this area of study by investigating the effects that trails have on invasive species dispersion. The experiment itself will involve a series of surveys that collect information on the type and abundance of plant species in quadrants of forested land. Surveys will be performed in two groups, one with areas of land located adjacent to trailways, and another consisting of more isolated areas. During analysis, these groups will be compared based on their average abundance of invasive plant species in comparison to all recorded vegetation. The projected outcome of the experiment is a measurable increase in invasive species abundance in trail-side quadrants, suggesting that such trails may have facilitation effects on the invasive plant species observed. Should the experiment proceed as expected, it will provide important insight into the dynamics of invasive species dispersion, and may be succeeded by larger scale experiments in the future.

Newtown High School

Teacher: Timothy DeJulio

Project # 0078

Chan, Claire

Project Proposal, Science, Health Research Proposal

Effect of male-origin fetal cell microchimerism in hepatitis C-exposed women with hepatocellular carcinoma

Hepatic cancers account for over 800,000 deaths annually, with about 90% of these being hepatocellular carcinoma (HCC), which disproportionately affects men. While efforts have been made to understand the causes of HCC, the potential risk factors leading to HCC are still unclear and can vary greatly. One such risk factor, hepatitis C virus (HCV) exposure, has been shown to increase the risk of cirrhosis-related HCC incidence 17-fold, and exhibit sexual dimorphism. A relatively novel phenomenon unique to women is fetal cell microchimerism (FCM), the transfer of fetal cells between mother and child across the placenta. Previous studies have shown that FCM is present in both healthy female livers and those affected by disease, and affords protection to parous women from certain cancers and HCV. This project aims to investigate if FCM reduces the risk of HCC in previously HCV-exposed women. In this study, purified buffy coat samples from women exposed to HCV will be divided into those with HCC and those without. The samples will be tested for the Y chromosome gene *DYS14* via qPCR, with samples positive for *DYS14* indicating FCM presence. Other potential factors known to cause FCM and HCC will be taken into account through a baseline survey, including age, number of pregnancies, and obesity, and evaluated with linear regression models. FCM incidence is expected to be increased in HCV-exposed women without HCC. This study may provide an insight into the evolutionary understanding of FCM and aid in determining risk and protection factors for HCC.

Darien High School

Teacher: David Lewis

Project # 0079

Cheng, Kendra

Project Proposal, Science, Environmental Research Proposal

The Effect of Exogenously Added Diacetyl on Long-term Thermotolerance of Thermally Acclimated *Breviolum minutum*

The Effect of Exogenously Added Diacetyl on Long-term Thermotolerance of Thermally Acclimated *Breviolum minutum* Insufficient thermotolerance of zooxanthellae is a primary initiator for the coral bleaching pathway (Douglas, 2003). Heat acclimation treatments have stimulated short-term thermotolerance of the coral-symbiont system, but not long-term thermotolerance (Gibbin et al., 2018). Administering heat acclimation treatment during inhibited algal growth from exogenously added diacetyl may epigenetically modify the algae to long-term heat tolerance (Achard et al., 2009, Colebrook et al., 2014, Wu et al., 2022). Exogenous diacetyl will be added to two *Breviolum minutum* experimental groups according to concentrations obtained from a dosing curve that initially tests 0.3 μ M, 1 μ M, 3 μ M, 10 μ M, and 30 μ M diacetyl to 2×10^5 *B. minutum* cultures. No exogenous diacetyl will be added to two control groups. All groups except one control will experience heat treatment at 29° C for 11 days and then recovery treatment at 25° C for 4 days (Gibbin et al., 2018). All samples will undergo a lethal temperature simulation at 34° C for 2 days (Gibbin et al., 2018). A hydrogen carbonate indicator will measure photosynthetic activity, reactive oxygen species tests to evaluate oxidative stress, and hemocytometers to quantify cell densities. It is expected that heat treated zooxanthellae under slowed growth conditions will exhibit greater phenotypic plasticity of long term acquired heat tolerance through higher rates of photosynthesis, larger cell densities, and fewer reactive oxygen species. Additional studies are required for introducing long-term thermally acquired zooxanthellae of the same species to endangered reefs to increase survivability.

Staples High School

Teacher: Amy Parent

Project # 0080

Costello, Nick

Project Proposal, Science, Health Research Proposal

Diesel emissions and the effect on Fruit flies sleep

Diesel Emissions are a significant problem in the world. As time moves on the problem gets worse and worse. Many people do not know why these emissions are so bad and why they hurt the environment. The research that is going to be conducted is to show the side effects of diesel emissions on Fruit Flies. This project digs deeper into the chemicals and production of diesel emissions and how fruit flies respond by their circadian cycle. The flies will be tested in two different testing groups with one being regular environment and food, while the other contains diesel particulates and their regular foods. Both of these groups will be tested for the sleep patterns and how much the diesel particulate affects this.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0081

Coughlin, Carolan

Project Proposal, Science, Behavioral Research Proposal

Whale Shark behaviors

Whale sharks are important to study because they are endangered apex predators. Understanding their role would help protect them from extinction, which has a large impact on the environment. In this study whale sharks temporarily living in captivity would have less developed survival skills over time compared to their wild counterparts. The independent variable will be the habitat, and the dependent variables to be observed will be hunting and depth-diving abilities. Hunting abilities will be tested by finding the successful hunt rate of the two groups, and depth-diving abilities will be done using satellite trackers. Satellite trackers are tagged to the dorsal fin of a shark and measure general movements and depth movements. It is expected that wild whale sharks will have higher hunt success rates as well as lower max depths. Integrated Marine Observation System (IMOS), is a database that collects the data from the satellite trackers, and will be used to collect the data from the satellite transmitters. This research could be used for aquariums to find new ways to improve the natural skills of their captive animals, as well as to see what areas they need to improve upon in their animal stimulation activities. Other implications are deciding whether an animal is fit or ready to be moved back to the ocean after living in captivity due to medical reasons or danger and giving medics an idea of how long they have before a whale shark starts losing its natural abilities.

Darien High School

Teacher: Christine Leventhal

Project # 0082

Cullen, Viola

Project Proposal, Science, Health Research Proposal

Drosophila Melanogaster As a Potential Model For Host-Microbe Interactions in IBD: Comparing the Efficacy of Different Probiotic Species on Dextran Sodium Sulfate-Induced Colitis in Drosophila Melanogaster

Inflammatory bowel diseases (IBD) are disorders involving chronic inflammation of tissues in the digestive tract, likely resulting from a disrupted intestinal microbiota. There has been increasing interest in the application of probiotics for treatment of IBD because of its possible curative effects in modulating the gut microbiome. As the use of probiotics for IBD treatment has increased, research lacks specificity in the types of probiotic bacteria that are best for regulating disturbed intestinal microbiota. This proposed study aims to compare the effects of different probiotic bacteria species on DSS-induced colitis in *Drosophila melanogaster* to further IBD research by exploring the reliability of the fruit fly model in studying host-microbe interactions and increasing specificity on the type of probiotic bacteria that best regulates disturbed intestinal microbiota. Six experimental groups with induced colitis and one control group without will be measured by fly lifespan, fecal gram stains, and gut immunofluorescence. Each experimental group will be fed a different type of probiotic: kefir, fermented cabbage, or probiotic supplements. Based on past research, it is predicted that the fruit flies fed with kefir will have the best outcome, in which the average fly lifespan would be greatest, gram staining would show an increase in gram-positive bacteria and a decrease in gram-negative, and gut immunofluorescence would show a higher decrease in antigen levels. This study could provide comparisons for which probiotic bacteria best regulate the gut microbiome, which offers more information for IBD researchers and patients looking for an effective holistic treatment approach.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0083

Denkin, Sierra

Project Proposal, Science, Environmental Research Proposal

Impact of Diacetyl Treatment on Plant UV Stress Immunity

With increasing climate change, UV Light is increasing which is posing an abiotic stress for plants. A plant's ability to resist abiotic stressors is vital in their survival. The chemical compound diacetyl (DA) may protect from abiotic stress, as DA treatment has been associated with increasing levels of Anthocyanin (ACN) (Marsillo et al,2020). ACN is increased through the gibberellin (GA) signaling pathway. DELLA proteins, which negatively regulate GA, increase with treatment of diacetyl. GA negatively regulates ACN accumulation, with less GA it allows more ACN to be present. ACN provides resistance to UV light. *Arabidopsis thaliana* will be grown in petri dishes containing a 0.5 strength MS Medium containing 1.5% sucrose and 0.7% agar for a 5 day germination period, then transferred to a new petri dish with fresh medium treated with a concentration of 9.7ul/ml free space of DA. Seedlings will either continue under a traditional grow light for control or be introduced to UV light stress exposed for 12 hours every 24 hour cycle. 11 days after treatment (DAT), UV light and control plants will have ACN levels quantified by putting grounded leaves into an extraction buffer and measuring optical density (OD) at 657nm and 530nm using a UV/VIS spectrometer. (Laby et al, 2000). Dead cells will be stained with Trypan Blue staining and observed under light through a microscope, in order to assess cell death. (Marsillo et al, 2020). While certain functions of DA within the abiotic stress system is unknown, it is anticipated that ACN will increase with the treatment of DA and cell death will decrease, therefore increasing stress resistance. Based on this data, diacetyl treatment might be a valuable additive to treat agricultural crops, which could possibly assist them with different stressors.

Staples High School

Teacher: Amy Parent

Project # 0084

du Pont, Sophie

Project Proposal, Science, Behavioral Research Proposal

The Relationship Between Appearance-Motivated Social Media and the Development of Self-Criticism and Disordered Eating

The exposure to appearance-focused content on Instagram has raised concerns about the social media platform's impact on mental health in terms of fostering self-criticism and contributing to disordered eating behaviors. This study aims to investigate the relationship between appearance-motivated social media (Instagram) use and the development of self-criticism and disordered eating. To establish statistical associations between Instagram use and the outcomes of interest, a quantitative coded survey and questionnaire will be employed to gather data on participants' social media habits, self-criticism levels, and disordered eating behaviors. The survey will also collect demographic information and assess the frequency and intensity of appearance-related content consumption on Instagram. Using this baseline of the participants' responses, a second phase will be initiated to provide context and depth to the understanding of Instagram use with self-criticism and disordered eating. This will be completed through group discussions mediated by psychologists, which will allow for the exploration of the specific mechanisms of body image ideals, cyberbullying, perceived social norms, and comparisons between celebrities and influencers. Discussions will be voice-recorded, tracked, and entered into a coded system for a qualitative analysis. Findings are expected to reveal a correlation between heightened appearance-motivated Instagram use and increased levels of self-criticism and engagement in disordered eating behaviors. These results are likely to be crucial for academic research, practical applications in designing mental health interventions, and influencing public policy surrounding social media governance.

Darien High School

Teacher: Guy Pratt

Project # 0085

Fernandez, James

Project Proposal, Science, Health Research Proposal

Sleep and its Effects on the Brain and Memory

Through various research and many tests, sleep deprivation has been proven to affect memory and the brain as a whole. In terms of memory, it can be seen that sleep deprivation can affect both cognitive and declarative sides. (Potkin, 2012) Those are the memories of how to perform tasks and general memory. It can also lead to a risk for Alzheimer's Disease during the latter stages of life. Getting more or less than 7-8 hours a night consistently is considered unhealthy sleep. (Bubu, 2017) As previously stated, many tests were done to measure these effects on the brain. However, most of these tests measure the relative risk of sleep-related to Alzheimer's or short-term memory. Very few of these studies had to do with the academic aspect or effects on daily life due to lack of sleep. The proposed experiment will have to do more with the everyday life aspect of adolescence. The idea for this experiment is to have each student go about life as normal and record how much sleep they get every night. Samples will be taken of handwriting from a few select students. 100 words that the students have written will be run through "My Script" a handwriting interpretation software. How many errors the machine makes will be recorded, illustrating the sloppiness of the handwriting. This will be compared to how much sleep the student got during the previous night. This will assess cognitive function.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0086

Finn, Maggie

Project Proposal, Science, Environmental Research Proposal

Comparing Tomato seeds planted in just soil and Tomato seeds planted in soil and sand Under the same conditions

Climate change is one of the largest threats to the growth and quality of tomato crops since heat negatively affects their developmental growth. Tomatoes are one of the most commonly produced and consumed fruits, but production loss occurs due to drought. This study will address the effect of water stress, also known as drought stress, on tomato plants because this is one of the main effects of climate change. This study will compare the development and growth of SubArctic tomatoes and Early Girl tomatoes in pots with just soil and pots with a mix of soil and sand (sandy soil). The ideal mix of soil and sand will be determined. The seeds will be placed on petri dishes to sprout, and germination success will be measured. The sprouts will then be moved into pots. The control will be soil alone and the variables will be just soil and a 1:1 volume mix of soil and sand. All plants will be grown under artificial grow lights in a room with windows receiving natural light as well. All plants will be compared over several months. It is hypothesized that the non-water-stressed plants will produce successful pollination and growth when exposed to grow lights and natural light.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 0087

Foley, Nora

Project Proposal, Science, Behavioral Research Proposal

The effect of positive thinking techniques on high school athletes

Mindset is everything in athletics. Research has shown that a good mindset has the power to drastically improve performance without practicing. Many strategies and methods designed to improve attitude and positive mindset have been developed and assessed over the years. This research aims to explore the impact of incorporating two positive thinking and mindset techniques (affirmation and visualization) on high school athletes. Athletes will be asked to perform an athletic drill. Before the drill, they will be asked to visualize themselves practicing the task mentally or self affirm themselves by writing out three positive attributes. One of the three attributes athletes would elaborate on. Data measurements will be collected by analyzing athletic performance of a specific activity. Previous studies have shown that visualization and self-affirmations can improve self esteem and self image by reducing cortisol levels, in addition to improving decision making skills through stress. This study is expected to show that those same visualization and self-affirmation techniques can improve athletic performance and overall empower athletes helping them to optimize their performance through mental exercise.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0088

Foley, Charlotte

Project Proposal, Science, Health Research Proposal

The Effect of Ultraviolet light on Yeast growth

UV light is very helpful in terms of removing germs from many surfaces but it is now used for UV lamps in nail salons and UV tanning beds, which can be harmful leaving us with harmful side effects/mutations. This experiment will focus on the Growth of Yeast Under, various types of UV light. The goal of this is to see how many cells die or are mutated by UV light. This experiment will be conducted by having yeast which would be put in the dark under a cabinet and left there for around 30 hours, then put in direct sunlight, one under an Ultraviolet lamp, one with, far UV light, and extreme UV light to test these on cell growth. In terms of what would be put in the plates Agar plates would be put and have a changed variable. After UV exposure spectrophotometry would be used to measure the optical density (OD) of each test set, then a hemocytometer to count yeast cells and test the quality of cell density. Then recording measurements and documenting observations, comparing the growth of the UV-exposed samples with control groups, calculating the growth rates, and looking for differences between them. As well as also looking for if something is rutile and anatase proteins. Finally, repeating the tests to test the credibility of the data.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0089

Fossum, Samantha

Project Proposal, Science, Behavioral Research Proposal

Investigating the Therapeutic Potential of Hypnosis in Modulating Brain Pathways for Mental Health Disorders

This study looks into how hypnosis could help with mental health issues, especially PTSD. Even though many people use hypnosis, we don't really know how it works in the brain. This research tries to figure that out to improve our understanding of mental health and find better ways to help people. The study checks if hypnosis alone can help with PTSD, considering how well it works, its long-term effects, and who benefits the most. The idea is that hypnosis might reduce PTSD symptoms, providing a non-invasive option for mental health problems. In the study plan, safety and trust are big priorities. It involves talking to people, explaining hypnosis, and making sure everyone feels comfortable. The hypnosis process includes making people feel relaxed, giving them personalized suggestions, and helping them cope with trauma if needed. Safety is always kept in mind, especially for those who might find it hard. The study aims to help make mental health care better and less stigmatized by understanding how hypnosis could be a useful and easy option for people dealing with mental health challenges.

Newtown High School

Teacher: Timothy DeJulio

Project # 0090

Frantz, Tyler

Project Proposal, Science, Health Research Proposal

Creating a model to determine the likelihood of developing post-traumatic epilepsy as a result of traumatic brain injury

Post-traumatic epilepsy (PTE) is a severe complication of traumatic brain injury (TBI). An electroencephalogram (EEG) is a noninvasive procedure that measures electrical activity in the brain. There is not currently a defined way to predict whether someone is going to develop PTE after TBI. The purpose of this project was to test and validate a new natural language processing model (NLP). The NLP will first look through patient charts and medications from known people who have epilepsy and then it will determine whether the NLP thinks they are or are not going to develop PTE. Next, the NLP will be evaluated and adjusted based on the findings from the patient charts. After the adjustment, NLP will be run on TBI patients to help try and develop an accurate prediction model to be able to detect PTE after TBI. The experimenter will help read through patient charts and medications after getting the proper training and do the bulk of the data analysis. The mentor will be doing most of the coding on the NLP. The data collected from the original read-through of the initial patients with known epilepsy by the NLP will next be put into an Excel spreadsheet along with the data collected from patient charts which will be compared and used for adjustments on the NLP. Implications for this project will be creating a reliable NLP to help more easily detect PTE. Also, after being modified, the NLP could be adjusted to detect other neurological disorders.

Amity High School

Teacher: Catherine Piscitelli

Project # 0091

Gallo, Julianna

Project Proposal, Science, Health Research Proposal

Investigating the Combined Treatment of Curcumin and Probiotics and their Effects on the Longevity, Motility, Inflammation, and Fat Deposits of *Caenorhabditis elegans* with Obesity

Obesity is a global crisis. Inflammation is a concern associated with obesity; it causes a continued cycle of adipose tissue in the body to secrete proinflammatory factors (Ellulu2015). Chronic inflammation causes an imbalance in the gut microbiome (Ellul2015; Liu2017). It has been found that there is a direct correlation between gut microbiome dysbiosis and development of obesity (Ellulu2015). To create obesity in *C. elegans* larvae (Carolina Biological Supply) will be given an 80mM glucose diet, through nematode growth medium (NGM), to increase adipose cells/obesity. A 1 cm² section of obese *C. elegans* will be transferred and cultured onto separate plates with different supplemental diets. NGM will be supplemented with 0.25mM curcumin, to decrease inflammation, or with probiotics *Lactobacillus rhamnosus* GG and *Lactococcus lactis* ssp *cremoris* to regulate the gut microbiome and reduce pro-inflammatory factors (Yun2022; Nune2022). Lifespan, reactive oxygen species (ROS), and mobility (thrashing assays) will be measured (Jones, 2019). Curcumin and probiotic supplementation in obese *C. elegans* has shown positive impacts (Aranaz2020; Barathikannan2022). However, their combined treatment on the impacts of obesity has not been tested. The effects of combination treatment will be studied to determine if the impact is additive or synergistic. It is anticipated that curcumin will increase the lifespan of obese *C. elegans* by decreasing the stress of inflammation on the model, and the probiotics will regulate the gut microbiome to decrease the negative reactive cycle of obesity as measured by the ROS. Positive data could support use with these low-cost supplements in obese individuals.

Staples High School

Teacher: Amy Parent

Project # 0092

Giles, Keira ; Kelly Bridget

Project Proposal, Science, Teams (Research Proposal)

The Efficacy of Trichloramine on Eyebrows

There's a farrago of chemicals in swimming pools. Athletes from Barlow Mountain pool have continuously noticed repeated hair loss to their eyebrows and head hair. This peaked a sudden interest in the "why" behind this strange phenomenon. Inferring that trichloramine is the chemical most damaging to hair cells, this study will identify the level at which trichloramine causes a hair strand to begin to break. Trichloramine is the combination of chlorine with ammonia, a mixture of sweat, urine, and other bodily fluids. If there is a breakage in the hair strand at a certain level of trichloramine, we can infer that this chemical plays a large role in hair loss. This study will initially find which level of trichloramine there is noticeable hair breakage. Which will then be compared to the previously measured level in Barlow Mountain swimming pool in order to find any correlation.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0093

Halvorsen, Sydney

Project Proposal, Science, Environmental Research Proposal

Ecological conversation methodologys in small sharks

The extinction of sharks presents a critical ecological and environmental concern that demands attention and action. Sharks play a pivotal role in marine ecosystems, regulating prey populations and maintaining balance within species diversity. Pressure from overfishing, habitat degradation, and climate change decrease shark populations. The objective of this study is to identify hotspots for Blue shark population decreases which could lead to extinction. Researchers employ various techniques such as satellite tagging, genetic analysis, and acoustic telemetry to track shark movements, study their behavior, and assess population dynamics in efforts to understand the drivers behind their decline. The SSG assessed chondrichthyan species, analyzing factors like taxonomy, population trends, habitat preferences, threats, and conservation measures using the IUCN Red List Categories and Criteria and coded each species for habitat preferences, threats, and conservation actions, entering data into the IUCN Species Information Service for analysis. Subpopulation and regional assessments were conducted for many species before global assessments could be made, particularly for wide-ranging species. Challenges in determining overall Red List categories for globally distributed species arose due to incomplete trend data, regional uncertainties, data-poor regions, varied management approaches, and moderate productivity levels. The Blue shark exemplifies these challenges, with conflicting abundance trends in the Atlantic and uncertainties regarding its status globally. Further research and data on Blue sharks are needed to improve the assessment of population stability and the results of conservation efforts.

Darien High School

Teacher: Guy Pratt

Project # 0094

Hardy, Alexandra

Project Proposal, Science, Health Research Proposal

Stress Modulation and Memory Performance in Rats

The amygdala, a key structure within the brain's limbic system, has a crucial role in processing emotions and modulating responses to stressors. Its connections with other brain regions allow it to influence memory formation and stress responses. This study will look into the critical role of the amygdala in stress modulation and the impact of the amygdala on hippocampal memory in rats. The hypothesis assumes that removing part of the amygdala will prevent some of the consequences of stress and enhance memory performance. Spatial memory and working memory will be assessed. Rats will be split into control (no stress exposure), stress (restraint stress), and amygdala lesions combined with stress groups. The stress group experiences real-life stress conditions, while the amygdala lesions combined with stress group face amygdala manipulation before being exposed to stress. Memory performance will be evaluated through hidden and visible platform tasks within the Morris water maze. Behavioral data analysis will determine the effects of stress and amygdala lesions on the performance of memory in the rats. It is likely that the findings will support that amygdala lesions block stress-induced changes in memory performance, illustrating the amygdala's role in handling stress effects on the hippocampus. The study emphasizes the significant function of the amygdala in this process. This will provide a lot of insight into memory processes and will have implications in future studies, possibly in humans. It is possible that therapeutic solutions may be discovered based on this research.

Darien High School

Teacher: David Lewis

Project # 0095

Hardy, Madeleine

Project Proposal, Science, Environmental Research Proposal

Analyzing the effects of psychedelics on migraines

Over the past 30 years, there has been a 40% increase in patients suffering from chronic migraines. Migraine symptoms manifest themselves differently in each patient; symptoms range from drowsy auras to debilitating light sensitivity and nausea. Current migraine remedies include Triptans, Ergot Derivatives, and NSAIDs. Although these drugs are mostly effective, they have chronic side effects such as hypertension and numbness. To discover a more effective solution, researchers have turned to hallucinogenic drugs; more specifically, psilocybin. Psilocybin is a hallucinogenic drug that is most commonly found in the Psilocybe strain of mushrooms. Administration of psilocybin does not produce the side effects that Triptans, Ergots or NSAIDs do, which makes the drug a more viable option for patients. This study aims to discover if a repeated low dosage of psilocybin will have prolonged effects of migraine suppression. In a double-blind, placebo-controlled study, patients will receive either a 0.1 mg/kg dosage of psilocybin or a matching placebo (microcrystalline cellulose). Administration will happen every 2 weeks over the course of 1 month in a controlled environment. This allows for 4 test sessions in which migraine symptoms and side effects will be evaluated along with blood pressure and heart rate levels. Using the MS-Q questionnaire along with the POUND Mnemonic questionnaire, migraines will be accurately screened and recorded. Discovering if psilocybin is a viable option for migraine patients will open up a new world of medicine that works towards lessening the migraine "pandemic."

Darien High School

Teacher: Christine Leventhal

Project # 0096

Harron, Jayden

Project Proposal, Science, Health Research Proposal

Stem Cells Research Proposal

A Cure to Baldness: Mesenchymal Stem Cells in Combination with Follicle Transplants About one in every two men go bald by the age of fifty, and 25% experience hair loss before 30. For many men, this crushes self-esteem and causes insecurity. One of the current methods being used to treat baldness is follicle transplants, however they aren't always effective. Combining follicle transplants with a stem cell injection derived from umbilical cords may have better results. If we use umbilical cord derived mesenchymal stem cells, then we can increase regenerative growth of hair and improve patients' lifestyles with baldness and people that have had follicle transplant. This experiment will have 3 different groups: control, people with follicle transplant, and people with both stem cells and the transplant. To acquire the stem cells a extraction will need to be done on a human umbilical cord or potentially an bovine umbilical cord. In each group there will be 10 people. The experiment will take a total length of one year. After the initial procedures are completed there will be a check up every 3 months. Results will show the combined group with the highest rate of success. This experiment will indicate the benefits of stem cells and increase in men's hair growth.

Darien High School

Teacher: David Lewis

Project # 0097

Hassan, Lourdes

Project Proposal, Science, Physical Science Research Proposal

STUDYING THEORIES OF PREBIOTIC CHEMICAL EVOLUTION AND ABIOGENESIS BY TESTING THE PRESENCE OF THE PRECURSORS OF LIFE IN CLAY RESEARCH

Abiogenesis, also known as the prebiotic chemical evolution theory, proclaims all living things originate from organic molecules from the Earth, and pre-life chemical reactions gave way to the creation of living organisms. Taking clay and observing adsorption of primordial soup solutions can aid an understanding whether the condition for life arose organically was possible. This experiment will mimic the environment of primordial Earth and test those solutions similar to those that would have formed under these conditions. Controlled variables such as humidity, temperature, and light are important qualities that will be considered when developing this environment. These solutions used will include (1) cytosine and calcium chloride, (2) cytosine, calcium chloride, and ammonia, and (3) cytosine, calcium chloride, ammonia, and carbon dioxide. 4 different types of clay will be exposed to these solutions are calcium montmorillonite (CCM) clay, micaceous clay, illite clay, and kaolinite clay. Qualitative and quantitative measurements will be used to measure pH of the solutions before and after introduction of clay, and scanning electron microscopy to examine the surface morphologies of the clay and adsorption. This can help us identify chemical qualities of carbon, oxygen, and nitrogen. It is projected that the solutions will adsorb into clay structures, specifically the CCM clay the most, showing surface morphology and exhibiting qualities that indicate amino acids and proteins would have developed. CCM clay has the best affinities, with incorporated metal dictations and silicate layers. Future work conducted in this area of study is found in astrobiology studies and genetic engineering.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0098

Hill, Sarah

Project Proposal, Science, Health Research Proposal

Lyme Disease and the Effect of Climate with Survival

Lyme disease contributes to the mental and physical parts to the body as well as the way that it alters life itself. Many people are in need of medical attention through their physical and mental health and Lyme disease can put a very negative impact onto a person's life. To understand and contribute to the possible realization on how to understand the survivability on ticks and their survival rates in a plethora of states of temperatures and humidities could possibly help understand how to create a safer understanding of the disease and help to stop the constant spread of it. This study will be conducted with creating a space to understand the survival rates over a period of 2 weeks in a service of temperatures and humidities. With three different types of ticks in a series of vials with a constant of food source as well as being under constant observation from a camera. Allowing the data to be observed through the footage and the understanding of the reason for different survival rates. The series of temperatures will be provided from cooling and heating technology as well as creating a constant change in humidity with different the observation of different water levels. This experiment will be with ticks that do not have the borrelia burgdorferi to allow a safe environment for this experiment to be conducted.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0099

Hoffman, James

Project Proposal, Science, Environmental Research Proposal

Detecting and Identifying Novel Fungal Endophytes of *Ceriops australis*

One of the most endangered and the most vital habitats to both humans and the environment are mangrove forests. An array of bioactive compounds that have the potential to be made into novel medicine and treatments can be found in this unique biome, a large amount of these originating from endophytic fungi. Endophytic fungi reside in the intercellular space of the majority of plant species without causing harm to the host. They have been shown to contain a diverse group of secondary metabolites with a range of bioactive properties. The candidate for testing, the Yellow Mangrove (*Ceriops australis*), is native to northern Australia. It has not yet been studied nor tested for endophytic fungal relationships, but is used by native peoples as traditional medicine, a quality hosts of potentially bioactive endophytes often have. 60 samples would be taken of three sections of the plant: the inner bark, the leaves and the stems. To avoid contamination, they would be superficially cleaned through a minute soak in 70% alcohol, then washed with warm, sterile water. Then, the samples would be segmented in pieces 2 cm by 2 cm, and placed on bacteria-inhibiting chloramphenicol petri dishes containing potato dextrose and incubated under 12 hours of light and 12 hours of dark for 20 days. When endophytes are observed, they would be isolated to separate petri dishes and identified using morphological aspects, DNA sequencing and microscopic examination of spores. With a later study, these fungi could then be tested for bioactive properties.

Darien High School

Teacher: David Lewis

Project # 0100

Jackson, Hope

Project Proposal, Science, Environmental Research Proposal

Elevated water temperatures lead to premature spawning in bay scallops.

This research investigates the influence of water temperature on the reproductive behavior of bay scallops (*Argopecten irradians*). Elevated sea temperatures associated with climate change pose a potential threat to marine ecosystems, and understanding their effects on key species is critical. The study aims to address this gap by subjecting mature bay scallops to controlled temperature conditions, simulating both current and elevated sea temperatures. The experiment involves monitoring water quality parameters, observing scallop behavior, and conducting regular gonadal tissue samplings. The research hypothesis posits that elevated water temperatures will lead to premature spawning in bay scallops compared to those under current sea temperature conditions. The engineering goal is to develop a comprehensive understanding of the relationship between water temperature and reproductive activity in these marine organisms. Anticipated outcomes include increased spawning events and advanced reproductive development in bay scallops exposed to elevated temperatures. The experimental design incorporates rigorous data collection methods, including continuous monitoring with data loggers and video recording of scallop behavior. Safety precautions are implemented, considering potential risks associated with handling scallop tissues and working with water tanks. Data analysis involves statistical methods to identify correlations between temperature and spawning behavior.

Darien High School

Teacher: Christine Leventhal

Project # 0101

Keating, Riley

Project Proposal, Science, Health Research Proposal

The Use of Flortaucipir Positron Emission Tomography Scans to Test for Depositions of Tau Protein in Former Amateur Football Players Exhibiting Symptoms of Chronic Traumatic Encephalopathy

Chronic Traumatic Encephalopathy (CTE) is a progressive and fatal disease caused by repetitive head impacts (RHIs), often associated with former football players. CTE is associated with atrophy of the brain and an increase in depositions of tau protein. Flortaucipir Positron Emission Tomography (PET) Scans have been used to detect tau protein in former professional football players exhibiting symptoms of CTE. The level of competitiveness of football that one must play in order to be at risk for CTE is not yet understood. I propose that through the use of Flortaucipir PET Scans, depositions of tau protein would be analyzed in former Amateur Football players (former highschool and college football players). These results would then be compared to former Professional Football Players (both cohorts exhibiting symptoms associated with CTE). A qualitative method referred to as the Standard Uptake Value Ratio (SUVR) will be used to analyze the depositions of tau protein from the PET scans. I will analyze the data collected from the PET scans and SUVRs to determine if amateur football creates an increase in tau protein and risk for CTE. Amateur Football Players will have increased depositions of tau protein similar to professional football players. While Amateur Football Players may not have the same longevity of a career as professional football players, the severity of head impacts will result in similar tau depositions. This research could further the understanding of the risk factors for CTE and determine what preventive measures are needed to decrease RHIs in all divisions of football.

Darien High School

Teacher: Guy Pratt

Project # 0102

Keehlwetter, Lily

Project Proposal, Science, Health Research Proposal

The Effect of Calciferol and Erythrosine on Livers in Rats

Erythrosine (Red No. 3) is a synthetic food colorant used for aesthetic purposes. Although approved by the FDA, recent studies have demonstrated erythrosine's carcinogenic properties with long-term use. Cholecalciferol (Vitamin D3) is a supplement aiding anti-inflammatory activities. Cholecalciferol has shown potential success in countering erythrosine's negative effects and preventing pancreatic cancer. This study will investigate how the liver, an organ that detoxifies blood, is affected when consuming erythrosine and cholecalciferol. If rats are fed cholecalciferol, then their livers will be protected from the harmful effects of erythrosine. This proposed experiment will use 40 male Albino Wistar rats, aged 6-8 weeks. Rats will be divided into 4 groups: 10 controls, 10 fed erythrosine, 10 fed erythrosine and cholecalciferol, and 10 fed cholecalciferol. Drugs will be crushed and combined with pellets for oral consumption. Blood samples will be collected twice: before the consumption of drugs and after. Three blood tests will be performed: blood serum bilirubin, serum albumin, and prothrombin time. After 6 weeks, rats will be sacrificed and their livers will be removed. The Paraffin Embedding Method will help examine liver structure. It is predicted that cholecalciferol will prevent erythrosine from damaging liver tissue. Evidence is expected to show no change in the control group, negative change in the group fed erythrosine, minimal/lesser change in the group fed erythrosine and cholecalciferol, and positive change in the group fed cholecalciferol. Results from this experiment will provide information regarding the role of erythrosine in an organism and the benefits of cholecalciferol.

Darien High School

Teacher: David Lewis

Project # 0103

Kennedy, Ava

Project Proposal, Science, Environmental Research Proposal

How does human proximity impact Northern Long-eared bats' hibernation areas?

This study will be held to determine the effects of human proximity and activity on the hibernation areas of Northern Long-eared bats. The bats will be studied with radio trackers for a longitudinal study. With the radio trackers, it will be possible to watch and record in the fall which roosting areas they choose and, in the winter, which caves and hibernacula will choose. With this information, it will be feasible to conclude whether human activity and proximity contribute to the extreme drops in populations of Northern Long-eared bats and what the next would be. This study will figure that human proximity is impacting the hibernation areas of Northern Long-eared bats, spreading disease and driving the bats away from winter hibernacula.

Weston High School

Teacher: Christopher Gamble

Project # 0104

Kholmanskikh, Maria

Project Proposal, Science, Health Research Proposal

Proximity Ligation Assay (PLA) as a Method for Finding Downstream Effectors of RhoA

RhoA and RhoC are part of the family of small GTPase proteins, and they play an important role in many physiological processes and cellular function which include endothelial barrier function, vascular smooth muscle contractility and proliferation, vascular function and remodeling as well as angiogenesis.

However, though the downstream effectors of RhoA and RhoC are known, there is no current method which is extremely effective in determining which downstream effector of RhoA or RhoC is involved in a particular process. The approach will consist of two parts: validation of primary antibodies followed by testing the feasibility of proximity ligation assay (PLA) in this context. Specificity can be tested using RNAi mediated gene knock-down; the data will be collected and signal intensity will be analyzed using Fiji. Specific antibodies will show reduction in immunofluorescence signal when RhoA or RhoC proteins are specifically reduced. After this specificity is tested, PLA will be tested by subjecting cells to treatments known to activate or suppress activity of RhoA and/or RhoC and therefore increase or decrease their interactions with downstream effectors, as should be shown by an accumulation of fluorescence spots in areas of high levels of protein-protein interaction between RhoA or RhoC and its effectors. By using PLA to look at the downstream effectors of RhoA and RhoC, it is possible to find therapeutic targets for diseases that are caused by the dysfunction of RhoGTPases or their pathways.

Darien High School

Teacher: David Lewis

Project # 0105

Kwarcinski, Alexa

Project Proposal, Science, Health Research Proposal

Observations of the Difference in Brain Function between Cochlear Implanted Individuals and Normal Hearing Individuals

Purpose: Cochlear implants provide deaf individuals the ability to hear at a near normal level compared to hearing peers. However, there is limited research available as to how this device affects the function of the brain. The current study aims to explore auditory and occipital brain activity in hearing and cochlear implanted children when presented with auditory stimuli. Methodology: Using Positron Emission Tomography (PET), examiners will measure the amount of biochemical and metabolic activity occurring within the auditory and occipital brain regions of two groups of children, ages 7-9, while presented with auditory stimuli. The glucose uptake in these regions will be measured and compared between groups. Results: It is anticipated that between 30-50 children will be recruited for each group. Consistent with the hypothesis, it is expected that the children that are implanted at a later age will have lower metabolic activity in the auditory cortex compared to hearing peers. Variables including age, gender, type of cochlear implants are not expected to impact results. However, the length of time since implantation would have a positive relationship with activity within the auditory cortex. Conclusion: This study confirms that the auditory cortex is less active for auditory stimuli for children with cochlear implants with concurrent higher occipital lobe stimulation compared to normal hearing peers. These findings demonstrate preliminary metabolic differences regarding brain function in late implanted children. Future research might compare the activity of the auditory cortex in early implanted children versus late implanted children to advocate earlier intervention in these children.

Newtown High School

Teacher: Timothy DeJulio

Project # 0106

Li, Matthew

Project Proposal, Science, Health Research Proposal

The effect of different stroke transport methods for patients with suspected acute ischemic stroke (AIS), measured by functional outcome in the Modified Rankin Scale (mRS)

Title: The effect of different stroke transport methods for patients with suspected acute ischemic stroke (AIS), measured by functional outcome in the Modified Rankin Scale (mRS) Rapid transport for patients with a suspected acute ischemic stroke is crucial. In-hospital stroke treatments are critically time-dependent, hence the need for optimized transport methods. This study aims to analyze three different transport paradigms including drip-and-ship (DS), drip-and-drive (DD), and mothership (MS), based on functional outcomes in patients measured by the Modified Rankin Scale (mRS). The mRS measures a patient's functional outcome and neurological competency following a set time period. Patients in this trial who present with an acute ischemic stroke (AIS) and large vessel occlusion (LVO), as indicated by a score ≥ 5 on the Rapid Arterial occlusion evaluation (RACE) prehospital scale, will be randomized to one of three different transport paradigms, including DS, DD, and MS. After 90 days, these patients will then be measured by mRS, to determine which paradigm yielded the best functional outcome results. Additional time parameters that will be measured include onset to groin time, or the time between the onset of stroke symptoms to the insertion of a catheter, and onset to needle time, which measures the time between onset to the administration of IVT. This trial will enroll approximately 300 members positive for LVO and eligible for IVT. Due to the formatting of each paradigm, it is expected that the onset to needle time will be quicker in DS and DD, and the onset to groin time will be quicker in MS. Moreover, it is hypothesized that MS will provide the best results in the mRS following 90 days.

Darien High School

Teacher: Christine Leventhal

Project # 0107

Loneragan, Isabella

Project Proposal, Science, Health Research Proposal

Daptomycin-Rifampin is a Better Antibiotic to Use for Methicillin-Resistant Staphylococcus Aureus Infected Fractures Than Vancomycin-Rifampin

The best antibiotic for Methicillin-resistant Staphylococcus aureus (MRSA) infected fractures isn't known. A MRSA infection is a type of staph infection that is more difficult to treat. This infection can get into open fractures which can result in nonunion and later complications. Frequently, people carry MRSA but aren't affected by it; however if someone has an open fracture it can become infected. Without proper treatment, the infection can lead to more fatal complications, which is why finding the best antibiotic treatment is critical. Daptomycin-Rifampin and Vancomycin-Rifampin are both combinations of two antibiotics. Vancomycin is the more standard antibiotic used whereas Daptomycin has less research for MRSA infections. I hypothesize Daptomycin-Rifampin is a better antibiotic to use for MRSA infected fractures than Vancomycin-Rifampin. In recent years, Daptomycin has seen less clinical failure. In this study, I will assist doctors in gathering and organizing the data collected from the trials. 60 mice with MRSA infected femur fractures will be randomly selected to be injected with Daptomycin-Rifampin, Vancomycin-Rifampin or nothing after infection. Then the mice will be selected randomly to be injected either within 15 minutes or 24 hours. The fracture will then be repaired. I will collect data from the radiographic imaging to see which group still has a visible fracture line. I will then collect the data on if the MRSA infection was still present after four weeks. This information will help doctors in the future to find the best antibiotic for patients with an MRSA infected fracture.

Darien High School

Teacher: Christine Leventhal

Project # 0108

Not Participating in the Fair

Teacher:

Project # 0109

Manfredonia, Alexa

Project Proposal, Science, Behavioral Research Proposal

The Effect of COVID on Relationships

The global pandemic of COVID-19 starting in March of 2020 led to a worldwide lockdown measures leaving us to be shunned to our homes with our loved ones for long periods of time. My research is an investigation on the satisfaction of people in romantic relationships after being in close quarters with their partner for so long. Its main focus is to see how their satisfaction in the relationship has changed from pre-pandemic to post-pandemic. It is a deeper dive into the understanding of whether the person feels more attached to their partner or wants more space from them with the goal of understanding why they feel this way and if there is a trend within certain genders/age groups that have the same feelings. From research, I came up with the hypothesis that women in long term relationships will be more likely to have attachment anxiety to their partner after the pandemic. I will be testing this by surveying couples who were in the same living space during lockdown to gauge their feelings of the relationship now that the pandemic is over. Participants ranging from age 25-80 will be asked to rate their happiness in the relationship on a scale from 0-3 from pre-lockdown, to lockdown to post-lockdown while also assessing their mental well being during each stage. This research is important so we can understand the mental health effects behind the pandemic and get the people the help they need.

Newtown High School

Teacher: Timothy DeJulio

Project # 0110

Matyszkowicz, Adrian

Project Proposal, Science, Physical Science Research Proposal

Observing and Analyzing Pulsational Behavior in Type II Supernova Progenitors to Reveal Effects on Surrounding Systems.

This research delves into understanding the pulsations of massive stars, focusing on their behavior before undergoing explosive core-collapse events known as Type II supernovae. Observing these stars in the infrared spectrum before their explosions can display significant periodic brightness variations that can characterize and identify specific stars. This study seeks to unravel the intricate pre-explosion evolution of these stars, revealing the mechanisms driving Type II supernovae and the factors influencing the final stages of massive star evolution. Furthermore, ground-based and space telescopes will be used for monitoring, and through Spectral Energy Distribution (SED) modeling, key stellar parameters: such as temperature, luminosity, and mass, will be derived to provide insights into the massive star's characteristics while utilizing techniques such as Lomb–Scargle periodograms to reveal patterns between behaviors and stellar parameters. Ultimately, these observations can be used to infer the composition and characteristics of Supernovae and how they could affect nearby spectral systems. This study contributes to a broader understanding of the correlation between pulsational behavior, pre-supernova evolution, and core-collapse supernova events that affect planetary systems. With the explosion of stars, elements may pass into other systems that could affect surrounding spectral bodies. This research leverages imaging data and investigates specific mechanisms of Type II Supernovae, exploring how instabilities such as pulsations offer insight into their impacts. The overarching goal is to expand knowledge of the final evolutionary phases of supernovae and the ultimate effects they will have on their surrounding systems that could impact astronomical activity.

Darien High School

Teacher: David Lewis

Project # 0111

Meade, John

Project Proposal, Science, Physical Science Research Proposal

Testing the effects of lift force on different airfoil designs through the construction of a sub-sonic wind tunnel

Without the use of a wind tunnel, calculating the lift force of an airfoil design is less efficient and less accurate. Data collected from wind tunnels allows individuals to directly measure the aerodynamic forces and movements of a model. Without this data, individuals must first solve for the coefficient of lift. Because the process of solving for this variable is slightly challenging, testing multiple designs in a short time frame is near impossible. This research aims to figure out which shape/design for an airfoil creates the most lift force without needing to perform many complex calculations. I hypothesize that the airfoil design with greater camber, or curvature along the upper part of the wing, will produce the greatest lift forces. To calculate the camber of different airfoil designs one must first figure out the mean camber line. To calculate this, one must create an imaginary line that fits the following criteria; must lie halfway between the upper and lower surfaces of the airfoil, and must intersect the chord line at the leading and trailing edges. By changing the camber of the airfoil, the lift force produced will either increase or decrease. This is because the lift is generated by a difference in pressure between the top and bottom of the surface of the airfoil. Ultimately, testing many different airfoils, that vary in camber size, would take hours. However, the testing process is shortened dramatically when a wind tunnel is used.

Newtown High School

Teacher: Timothy DeJulio

Project # 0112

Medeiros, Malin

Project Proposal, Science, Health Research Proposal

Human Natural Killer Cell Development: Early Terminal Maturation as a Result of The Epstein-Bar Virus

The Epstein Bar Virus (EBV) genome comprises 85 genes that take control over cells which can result in lymphoproliferative diseases, cancer, and other malignancies if improperly treated. The Natural Killer (NK) cell is a part of the innate immune system and is responsible for recognizing and neutralizing infections and malignant cells. NK cells are lymphocytes, such as EBV, that target viral infections to eliminate them. EBV-derived proteins and those that modulate cytokine stimulatory molecule expression in infected cells likely influence human NK cell development and promote the protection of early terminally differentiated CD56 bright NK cells. Using the CRISPR-Cas9 system, the effect of specific EBV genes will be analyzed from 9 specific genetically knocked out genes and cultured in vitro for 4 weeks with infected stromal cells. It will therefore be determined which gene affects the maturation of NK cells. It is expected that the gene LMP-1 will have the greatest impact on NK cell differentiation because it promotes a decrease in the production of IL-1 β signaling in NK cells. This study aims to evaluate the effect of EBV on NK cell development using an in vitro culture of stromal cells infected with wild-type EBV KO strains. If this process does not produce successful results, B cells can be used as an alternative to stromal cells. This research is important to gather more information on immunodeficiency treatments and the effect that immune cells can have on the treatment and development of diseases.

Darien High School

Teacher: David Lewis

Project # 0113

Meyers, Emma

Project Proposal, Science, Environmental Research Proposal

Stony Coral Tissue Loss Disease (SCTLD) Progression And Transmission Rates Among 3 Caribbean Coral Species In A Controlled Environment

Stony Coral Tissue Loss Disease (SCTLD) attacks corals' live cover, causing rapid death. Without protection, environmental stressors of rising ocean temperatures and acidification can lead to a weakened immune system, increasing susceptibility to infection. Mass outbreaks of SCTLD are common in reef locations due to its transmission process, either through direct contact or water circulation. Previous studies have shown indices of susceptibility and species with higher disease progression rates, but it's unclear whether or not certain species have characteristics that can resist the disease. A combination of genetic testing and transmission studies will be used to identify characteristics of resilience to SCTLD in coral species, along with factors that correlate to increased transmission rates. In this experiment, four aquariums will be set up, all consisting of samples of each species: *Acropora palmata*, *Acropora cervicornis*, and *Diploria strigosa*. Each tank will have a different diseased coral fragment, and the fourth tank will be a control, with all visually healthy fragments. From there, genetic testing will be conducted to determine genetic differences in the resilient species versus susceptible species. Coral fragment samples will be taken from the US Virgin Islands due to the popularity of the disease there and the unknown status of those corals regarding the disease. It's predicted that progression rates will vary between species, but all will get infected. Results from this study will focus relief efforts on specific species, and reconstruction in popular SCTLD locations can use species with a higher tolerance for the best chance of survival.

Darien High School

Teacher: Guy Pratt

Project # 0114

Mihopoulos, Luke

Project Proposal, Science, Physical Science Research Proposal

The Impact of 2D Perovskite Mol% on Efficiency and Stability in a 2D/3D Perovskite Solar Cell

Title: The Impact of 2D Perovskite Mol% on Efficiency and Stability in a 2D/3D Perovskite Solar Cell One of the best alternatives to using fossil fuels is solar cells, which produce energy from our abundance of sunlight. Silicon-based solar cells have dominated this market, however, their inefficiency and manufacturing complexity are limiting. A common approach to bypassing this issue is the implementation of perovskite-based solar cells(PSCs). Recently, their power conversion efficiency(PCE) has nearly met that of silicon-based ones, and they will soon surpass the PCE of silicon-based solar cells. However, the longevity of these novel PSCs is shorter than its silicon-based counterparts. This project aims to explore a solution to this problem by testing various perovskites in PSCs. There are two classifications of perovskites: 2D and 3D. 3D perovskites, which are most widely used in research, boast superior PCE while 2D perovskites tend to be more durable. Both of these perovskites can be combined to make 2D/3D perovskites, however, the composition of these perovskites is up for debate. This project will test multiple 2D/3D perovskites, where the percentage of 2D perovskite in each cell will be variable, with a purely 3D perovskite serving as a constant. These perovskites will be tested for PCE, thermal stability, and stability towards humidity. It is predicted that a higher percentage of 2D perovskite will result in increased stability with decreased PCE, while the mid-ranged percentages will have the best balance of both factors. If successful, this research will help improve the stability of PSCs to achieve practicality.

Darien High School

Teacher: Christine Leventhal

Project # 0115

Mills, Lloyd

Project Proposal, Science, Behavioral Research Proposal

Impact of Headline Features of a YouTube Video on Users Expectations of Potential Clickbai

Clickbait, or content that's sole purpose is to get clicks, has been an issue on every platform since the internet began, and in recent years it seems to have skyrocketed in prevalence (Zannettou, 2018). So, in this age where maintaining control over our attention is vital, it is important to understand what we are clicking on, and to know the human limitations regarding identifying clickbait. Any content whose main purpose is to get people to click on it is considered clickbait. For this research the focus will be on clickbait that intentionally misleads in order to get clicks. The research will be conducted in the form of a survey where people will determine which images (consisting of the thumbnail and title) that they think are clickbait. The survey will include one section with a couple questions where they pick which video they would choose out of 2. There will also be sections where they will instead be determining which one of a set of videos is clickbait, regardless of which ones they choose. To close out the survey there will be a few questions at the end regarding their opinions on clickbait and if it is an issue. This survey will be distributed on sites like Reddit and survey-specific sites like SurveyCircle. The expected results from this study are that people will not be incredibly accurate at determining clickbait which is important to know in order to determine to what degree it is necessary to control and mediate clickbait.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0116

Mohr, Ava

Project Proposal, Science, Health Research Proposal

Muscular Kinetic Injuries In High School Athletes

Musculoskeletal pain affects almost one-fifth of the population. This creates a huge risk for athletes who participate in sports. Common injuries associated with musculoskeletal pain such as sprains, strains, and tears are frequent occurrences. Physical therapy is a known crucial part of recovery. The purpose of this study is to find how adherence to prescribed exercise routines, where patients train specific joints, impacts injury recovery rates in athletes. The rate of adherence will be found after patients exercise, where they will complete exercise logs, and patients could also be monitored by physiotherapists. The drills could be different for each patient, along with the amount and duration, this will depend on the injury. This data will help to see if adherence to exercise is beneficial for the recovery process. The rate of adherence will be measured through wearable technology: devices that track patient's movement, behavioral interventions: set and achieve goals with coaches, and biofeedback: sensors to provide feedback on physiological responses. Results are expected to show that wearable technology and behavioral interventions will increase the recovery speed. Data will be analyzed through comparison of recovery rates and adherence level. This data could lead to improved treatment and rehabilitation personalization along with improved initiatives to see what exercises work best and identify different adherence patterns that people make. This information is crucial to athletes in recovery who want to get back to their sport as fast as possible.

Darien High School

Teacher: Guy Pratt

Project # 0117

Moore, Bridget

Project Proposal, Science, Health Research Proposal

Utilizing Machine Learning Sensors (Accelerometer) to Detect Muscle Fatigue in Athletes and Reduce Injury Rate

Athletes face a constant risk of injury, whether in the weight room, during training, or in competition. One of the leading factors that cause injuries in athletes is muscle fatigue. Affected muscles are less able to coordinate movements effectively, leading to decreased control over joint movements. This reduced coordination increases the likelihood of awkward movements or poor technique, which can strain muscles, tendons, ligaments, and other structures, potentially resulting in injury. Machine learning sensors can detect signs of fatigue or neuromuscular fatigue by analyzing changes in movement patterns, muscle activation, and physiological parameters. A type of sensor, an accelerometer, measures the decreases in amplitude or variability in acceleration patterns which signal fatigue-induced alterations in movement indicating potential injury risk. The objective of this study is to determine the effectiveness of utilizing machine learning sensors, specifically accelerometers, to detect signs of muscle fatigue in athletes and subsequently adjust training protocols to reduce the risk of injury. Participants will be separated into two groups, a control group that does not use machine learning sensors and the study group that uses the sensors. The accelerometer sensor will be placed on the athlete's upper arm, pelvis, wrist, thigh, and ankle to retrieve data. By using the data collected from these accelerometers, athletes and coaches alike can adjust workload, intensity, and recovery strategies to prevent overtraining and minimize injury risk. This is predicted to lead to a reduction in the incidence of injuries caused by muscle fatigue.

Darien High School

Teacher: Guy Pratt

Project # 0118

Morey, Cameron

Project Proposal, Science, Environmental Research Proposal

Axolotl RA Regeneration

Axolotls (*Ambystoma mexicanum*) exhibit remarkable regenerative abilities, prompting an investigation into the potential for branching limb regeneration. This proposed study will investigate the sequential effects of Fibroblast Growth Factor-2 (FGF-2) and Fibroblast Growth Factor-8 (FGF-8) in conjunction with retinoic acid (RA) on gene expression patterns during axolotl limb regeneration. Non-regenerative wounds would be induced on axolotls' original limbs, followed by the insertion of either FGF-2 or FGF-8 beads/pellets along with RA. According to recent studies, subsequent regeneration as a result of the growth factors will lead to the emergence of new limbs, separate from the original limb. After complete limb regeneration, the procedure will be repeated on the regenerated limbs. Additional non-regenerative wounds would be created, and the same growth factor and RA treatments would be applied. The regeneration process will be monitored, and gene expression patterns, including *Alx4* and Sonic Hedgehog (*Shh*) genes, will be analyzed to understand variations in regulatory mechanisms compared to initial regeneration. The success of the second procedure, including the extent of regeneration and gene expression levels, would be documented and compared to existing data. If conducted, this study will advance our knowledge of the impact of FGF-2/FGF-8 on the expression of the *Alx4* and *Shh* genes and how they affect the biological structures within the axolotls. This study also identifies the success rate of a full, identical extra digit forming due to the procedure. These new findings will offer potential medical implications for regenerative medicine and tissue engineering.

Darien High School

Teacher: David Lewis

Project # 0119

Morton, Kehara

Project Proposal, Science, Health Research Proposal

The effects of alcohol consumption on the white matter tracts in the adolescent brain

White matter tracts connect regions of the brain and are essential for the development of the white matter structure of the brain. They send signals to other parts of the brain, affect the ability to learn, and help us stay balanced. Binge drinking may result in deficits in adolescent brains. The objective of this study is to determine the effects of binge drinking on white matter tracts in adolescents. A case-control study consisting of a sample of adolescent mice will be conducted. This period of a mouse's life that corresponds with that of human adolescents occurs 21 days after birth until day 59 post-birth. Excessive amounts of alcohol will be administered to the experimental group of mice instead of water during at least three times every 12 hours and the control group will remain alcohol free throughout the study period. With the use of DTI (diffusion tensor imaging) analyses of the whole sample, the fractional anisotropy (which is a proxy of the integrity of the brain's tissue; FA) value of the white matter tracts will be compared between the control and experimental group. The results of the DTI scans are predicted to support the hypothesis that binge drinking affects the adolescent brain of the mice as the FA value of the white matter will show tremendous deficit compared to that of the mice who remained alcohol free. This study hopes to further understand the complexities of the effects of alcohol on the developing brain.

Darien High School

Teacher: Christine Leventhal

Project # 0120

Mukka, Nikita

Project Proposal, Science, Health Research Proposal

The Application of Ostrich Antibodies to Treating Psoriasis

Psoriasis is a common chronic skin condition that impairs the quality of life for many individuals who have it due to the lack of treatment. Using ostrich antibodies through a topical treatment proves to be a treatment that could improve their quality of life and treat the rashes on psoriasis patients, because of its previous effectiveness in treating atopic dermatitis and allergic reactions. Psoriasis vulgaris is the most common type of psoriasis that will be treated through this therapy, once ostrich immunoglobulins are extracted from the yolk of an ostrich egg. This ostrich IgY is combined with a moisturizing base that is fitted into a topical treatment and then several patients with psoriasis vulgaris will receive it. Through multiple trials as well each patient will apply the treatment to the infected area in intervals of one week across two months after which the severity of the inflamed psoriasis patches can be evaluated. These patches can be evaluated with the PASI (Psoriasis Area Severity Index) which is a set of criteria that a professional uses to assess the severity of a person's psoriasis patch. Using these test results, the effectiveness of the ostrich immunoglobulin treatment can be viewed with a graph. Another test to be done is a skin biopsy to see qualitative data. The expected results will be that after the treatment period is completed the score of the patches will advance and improve the quality of these psoriasis patients' lives.

Newtown High School

Teacher: Timothy DeJulio

Project # 0121

Nardi, Sophia

Project Proposal, Science, Health Research Proposal

The Affect of Chronic Versus Need-Based Stimulant Use on Sensitivity to Natural Reward

As the number of ADHD diagnoses is on the rise, so is the prescription of stimulant medication. This study will investigate the effects of caffeine, a common stimulant, on sugarbag bee (*Tetragonula Carbonaria*) reproduction and its correlation with dopamine levels in the brain. The sugarbag bees will be exposed to caffeine in sugar water solutions, one group will be consuming it every day-while the other will irregularly be given it to replicate someone taking stimulants on a need basis. Their reproductive output will be measured during the two weeks on caffeine and the 2 weeks after-to take into account the withdrawal period. Since dopamine is the chemical behind natural reward, and reproduction is a form of reward, it can be determined whether or not the stimulants decreased the bees' sensitivity to reward. This study has clinical implications for those taking stimulant medications, as it may be hindering their natural ability to produce dopamine.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0122

Nehro, Marin

Project Proposal, Science, Behavioral Research Proposal

The Effect of Trauma on the Brain During its Sensitive Period as Shown Through Activity in the Amygdala

Over 223 million people in the US have experienced some form of trauma. Studying how trauma affects the human brain can better our understanding of how to treat it. It is expected that if one experiences trauma during their brain's sensitive period (0-12 years) there will be excessive activity in their amygdala shown on Magnetic Resonance Imaging (MRIs). This experiment will be conducted on three groups. One group will not have witnessed trauma, the second will have witnessed trauma from 0-12, and the third will have witnessed trauma from 13 and up. Both groups will assess themselves using the Davidson Trauma Scale. Each group will be exposed to the sound of an alarm to trigger their amygdalas while undergoing an MRI. To analyze, the amygdala of each patient will be examined, and a bar graph will be created showing the level of activity or chemical signals in each patient's amygdala. It is expected that there will be higher activity in the amygdala of the first experimental group (0-12) than in the second experimental group (13 and up) because their trauma was witnessed at a younger age. Some possible implications of this research are that it could unveil better treatment plans based on the age of exposure and the level of activity in the amygdala. These results could teach more about the susceptibility of the developing brain and help us personalize treatment depending on the age when one witnessed trauma.

Darien High School

Teacher: David Lewis

Project # 0123

Nehro, Stella

Project Proposal, Science, Health Research Proposal

Stella Nehro - VNS Project Proposal

Comparative treatment of implanted vagus nerve stimulation and transcutaneous vagus nerve stimulation (tVNS) for generalized anxiety. Around the world, 301 million people suffer from anxiety. Often these patients do not respond positively to standard treatments such as medication and therapy. Vagus nerve stimulation (VNS) has been developed to create a more effective alternative treatment. VNS has been shown to have a greater clinical outcome in patients suffering from major depressive disorder compared to standard treatment. There are two main types of VNS, implanted and transcutaneous. Implanted VNS has been shown to have better clinical outcomes in patients suffering from major depressive disorder. The goal of this study is to determine if implanted VNS is more effective than transcutaneous VNS (tVNS) in the treatment of generalized anxiety patients. In this experiment, two hundred patients suffering from generalized anxiety who have failed four or more treatments would participate. One hundred of these patients would receive implanted VNS and the other hundred would receive tVNS. Efficacy would be determined by using the HAMA scale as well as MRI image monitoring activity in the prefrontal cortex. It is expected that patients treated with implanted VNS would have higher levels of activity in the prefrontal cortex and lower scores on the HAMA scale compared to patients treated with tVNS. The results obtained from this study will provide critical insight into which treatment is more effective, and demonstrate the efficacy of a new treatment that will improve the lives of millions.

Darien High School

Teacher: David Lewis

Project # 0124

Not Participating in the Fair

Teacher:

Project # 0125

Ou, Ellen

Project Proposal, Science, Environmental Research Proposal

The effect of various bioremediation techniques on the concentration of heavy metals in soil

Cadmium (II) and copper (II) are carcinogenic heavy metals which contaminate landfills. Prolonged exposure/digestion can lead to serious health complications (Wu, 2020). Removing heavy metals from soil with machinery is a slow, expensive process (Wu, 2020). To compare the effectiveness of copper (II) removal by various bioremediators, three bioremediators (Common Earthworms, Green Algae, and Oyster Mushrooms)(Leta, 2017) were selected; these bioremediators have proven to be effective in copper removal (Cavaletti, 2022), but their comparative efficiency and the impact of life cycle has not been studied. These bioremediators will be grown in uncontaminated soil (earthworms), sterile grain (oyster mushrooms), and algae media (green algae). The worms and mushrooms will then be seeded with 40mg/kg of copper in the form of copper (II) chloride and the algae medium will be seeded with 1.15mg/L copper in the form of copper (II) chloride with no seeding as control. 6 earthworms will be in each group. Algae bioremediation will be initiated at an OD680 of 1.2 and 0.4 to represent static and logarithmic growth phases (El-Sheekh, 2020). Copper levels will be determined after two weeks of bioremediation compared to no copper seeding through acid digestion and flame atomic absorption testing done at Western Connecticut State University. The health of the bioremediators will be monitored through observing growth rate. Through directly comparing the effectiveness of environmentally friendly, prolific organisms, it is possible that this research could open the doors for more accessible bioremediators in community spaces.

Staples High School

Teacher: Amy Parent

Project # 0126

Patel, Aakarsh

Project Proposal, Science, Environmental Research Proposal

Projections of Critical Global Warming Thresholds Using Data Analytics

Climate change is a major challenge that affects Connecticut in various ways, such as rising temperatures, extreme weather events, rising sea levels, and greenhouse gas emissions. This project aims to create a predictive model that can forecast the changes in temperature and emissions in Connecticut up to 2050 under different scenarios and assumptions. The project will use historical and projected data from various sources and apply regression analysis and scenario analysis techniques using Jupyter Notebook and Python libraries. The project will also analyze the results and provide recommendations for policymakers, stakeholders, and the public on how to adapt to the impacts of climate change and enhance the resilience and sustainability of Connecticut. The project will contribute to the scientific understanding and practical application of predictive analytics for climate change research and decision making.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0127

Pineda, Katerin

Project Proposal, Science, Health Research Proposal

Investigating miR-30a-5p Modulation and its Impact on Glucose Uptake and Insulin Sensitivity in Subcutaneous Human Adipocytes for Metabolic Disorder Research

Diabetes stands as a widespread global health concern, affecting millions across the globe, with its prevalence continuously on the rise. Research has correlated adipocytes and their functions with metabolic disorders such as type 2 diabetes. An important area of research revolves around the manipulation of miRNA in adipocytes regulating energy expenditure to improve insulin sensitivity. This experiment specifically explores the manipulation of the miRNA, miR30a, in mice adipocyte cells and its effect on glucose uptake. There will be four experimental groups conducted with cultured mouse cells. One will be transfected with miR-30a mimic, designed to elevate miR-30a levels, while the other three will be a positive control, negative control, and untransfected control groups. Glucose uptake will then be measured using fluorescent microscopy for each of the four groups to assess the effects of miR-30a-5p modulation on cellular responses through 2-NBDG fluorescent glucose analog. In previous research studies, blood glucose levels which are inversely related to glucose uptake, were decreased by over half from approximately 150 dg/mL to 50 dg/mL in the miR30a-induced cell cultures enhancing insulin sensitivity significantly. Therefore, it is expected that the cell culture where miR30a has been overexpressed glucose uptake will be more than doubled. This will be seen through higher fluorescence intensity and more prominent fluorescence in the cells with overexpressed miR-30a. The anticipated increase of glucose uptake, if confirmed, underscores the significance of miR-30a in cellular responses, offering a promising avenue for future therapeutic interventions in metabolic disorders such as type 2 diabetes.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0128

Platt, Taylor

Project Proposal, Science, Behavioral Research Proposal

Interpreting emotions in visual cues is different in adult Spanish speakers versus adult English speakers

Because of cultural and linguistic differences, there are barriers between cultures across the world. How these cultures interpret the same situation may shine light on why cultures form such different customs because of their ability to specify emotions. The purpose of this project is to examine and compare the differences between adult native Spanish bilinguals whose second language is English (NS) and adult native English bilinguals whose second language is Spanish (NE) in how they interpret and describe emotions in visual cues across both languages. This study can recognize linguistic and cultural nuances between English-dominant and Spanish-dominant speakers, and uncover how the two groups note specific emotions with different language perspectives. The differences in how NS and NE speakers describe emotions will be documented by the participants' describing as specifically as possible emotions they see in visual cues (both video and image) in their native language and second language. Electrodes on their fingers will record their skin conductance response, and eye-trackers will see where their focus is in the visual cues; these are to measure reactions to the visuals. It is hypothesized that the participants will be more accurate and precise in describing emotions in their native language and that NS speakers will be slower in their Spanish descriptions than NE in their English descriptions. The findings of this study could improve cross-cultural communication, create a better grasp of international linguistics, and create empathy for bilinguals speaking their second language.

Darien High School

Teacher: Guy Pratt

Project # 0129

Prince, Lucas

Project Proposal, Science, Health Research Proposal

Epigenetics

DNA Methylation is one of the most commonly studied biomarkers for epigenetics. Because they are inherited genetically, identical twins have identical epigenetic markings at birth, though these change because the twin's lives are not identical. This study would help acquire more knowledge about how and the rate at which the epigenetic landscape changes over time. Several sets of identical twins aged from 18 years old to over 75 years old will have their DNA Methylation examined as the study's epigenetic marker. Each set of the twins' DNA Methylation patterns will be observed with Illumina Infinium Methylation EPIC. This genome-wide scanning technique looks at over 850,000 CpG sites across the epigenome and can accurately track epigenetic patterns over time. Their results will be organized into several groups by age: 18-25, 26-35, 36-45, 46-55, 56-65, and 66-75 years old respectively. The similarity of each twin's epigenetic pattern compared to their counterpart will be given a similarity rating based on the percentage of epigenetic patterns that are the same. The data will be put into a table and graphs based on the similarity of the twins' DNA methylation patterns and what age group they fit into. This study would confirm scientists' assumptions concerning how epigenetic markers change over time by comparing the difference in Methylation patterns over time trends among the differently aged sets of twins. This has been suspected but not confirmed by any study yet, and doing so would prove useful for future research about topics like the epigenetic clock.

Darien High School

Teacher: Christine Leventhal

Project # 0130

Raskopf, Charles

Project Proposal, Science, Physical Science Research Proposal

Development of a LCE-based Passively-Controlled BEV Thermoregulation system.

EVs are increasingly prevalent as ICE cars are phased out. However, Li-ion batteries experience reduced charge retention and lifespan in temperatures below -1°C or above 45°C . Developing a tunable system capable of regulating temperature is important to ensure reliable function. This can be achieved through using thermally responsive LCEs with supplementary contemporary systems. I aim to design an ambient air-temperature controlled thermally responsive LCE Li-ion B.E.V. thermoregulation system. This involves utilizing both thermally responsive and thermally conductive LCEs. Thermally responsive LCE actuators will insulate the Li-ion battery from external air and environmental factors, while LCE conductors will be placed between high-temperature surfaces and their respective coolers, such as between a battery hotspot and heatsink. Production of thermal conductors will involve DIW additive manufacturing combined with thermally conductive fillers like graphene, and the thermally responsive modules will be made with DIW and SLA printing. Standard liquid cooling systems will also prevent battery overheating during operation, regulated by PWM control from a computer. Temperature sensors inside and around the battery insulation module will show temperature regulation effects. Compared to standard cooling systems, preliminary testing should show a reduction in thermal transfer between the battery and ambient air at temperatures below -1°C . Experiments will involve graphing thermal regulation at different power draws, recording internal and ambient temperatures, battery voltage pre-and-post-test, and time, with two runs for each temperature set. EV battery thermoregulator systems are significant for optimizing electric vehicle performance, prolonging battery lifespan, ensuring consistent performance, and reducing battery production and recycling waste.

Darien High School

Teacher: Guy Pratt

Project # 0131

Roche, Natalie

Project Proposal, Science, Behavioral Research Proposal

Task-selective place cells won't stabilize during learning or maintain task selectivity during memory recall under periodic attention and periodic learning rules.

Place cells are vital for memory formation. They are the building blocks for creating maps in the brain that help with navigation, especially in the wild. The creation of these memories are both vital and frequent, yet little is known about the specific conditions in which place cells are best formed. In a previous study, when environmental conditions were constant, hippocampal place maps were formed and stabilized during memory recall. Although this left little room for error, they used a structured path that is unrealistic to a path that a mouse would make in the wild, or any natural environment. It is important to test the stability of place maps in memory recall after sporadic, more realistic, conditions. With a post, harness, and treadmill system, the mice are designed to keep on a path with textured floors that mimic that of nature. Unlike the original study, the mice will also experience breaks in the repeated track. With a memory formation experience that is interrupted by other experiences, mice interpret a level of information that is more accurate to the wild than the original study. This is why it is predicted that place maps will not stabilize during memory recall during the same 7-day learning period as the original study, and instead, place maps will stabilize at a slower rate, of about 10-14 day learning periods. This is important to our understanding of both mice and human place cells because it mimics natural circumstances much more accurately.

Darien High School

Teacher: Christine Leventhal

Project # 0132

Rodriguez, Sebastian

Project Proposal, Science, Physical Science Research Proposal

The effect of changes in model and model sizes on the functionality in terms of grasping positions, material strength, and grip strength of 3D printed hand actuated prosthetic limbs.

3D printing has become a solution to those in need of inexpensive prosthetics. E-Nable has been successful in developing 3D printed prosthetics, yet there is a lack of data to support selection based on model size and maximum functionality. The E-Nable websites offer little guidance on which device would be most appropriate, mainly offering advice for photogrammetric sizing (unattainable in areas of biggest need) due to technology insufficiency. Functionality of a prosthetic has not been objectively measured. To determine the simplest approach to make an optimal prosthetic, using a comparative study format, three different 3D printed prosthetic models sized and scaled using the simplest low-tech method, will be assessed on functionality and strength. For three different sized volunteers (small child, teenager, and an adult), three prosthetic models, the Raptor reloaded, Kinetic hand, and Phoenix V3, will be studied. Following a model's print, controlled for infill and layer height ratio, the model will be tested via a series of functionality tests (Box and block and Jepsen Taylor) and strength analysis using a vernier materials tester. It's hypothesized that changing the size of different 3D printed prosthetic limbs will affect the functionality of the prosthetic. Gaining objective functionality and strength data on how sizing impacts different models using an easy-to-follow sizing method, will provide valuable insights to printers in third world countries or war zones where cheap prosthetics are required. (Mahdi 2021).

Staples High School

Teacher: Amy Parent

Project # 0133

San Jose, Lydia

Project Proposal, Science, Physical Science Research Proposal

Effects of Exosomes Secreted by Hypoxia-Stimulated Bone-Marrow Mesenchymal Stem Cells and Hydroxyapatite/Collagen Paste on the Acceleration and Promotion of Tendon-Bone Tunnel Healing in an ACL Reconstruction

After an ACL reconstruction, integration of the grafted tendon into the bone tunnel remains a challenge, and therefore, the revision rate of the surgery is relatively high. Exosomes from hypoxia-treated stem cells (Hypo-Exos) have been found to promote angiogenesis, and therefore reduce bone loss at the graft site, and hydroxyapatite/type I collagen (HAp/Col I) paste has been found to promote tendon-bone interface regeneration. This study will use these two injectables together to create a faster and more effective healing process after ACL reconstruction. Angiogenesis will be evaluated by observing capillary-like structures using optical microscopy, the viability of cells evaluated with fluorescent microscopy, and cell proliferation determined by cell counting KIT-8 and a microplate reader. Experiments will be tested on cells injected with Hypo-Exos and HAp/Col I paste together and separately to determine if the injectables together are more effective than individually. The postulated results for these experiments are based on the results from the literature and the conjecture that the Hypo-Exos and HAp/Col I paste combined will be the most effective. It is projected that the total tube length of capillary-like structures will be around 8mm, the intensity of green fluorescence will increase, specifically around day 7, and the relative absorbance of the cells at 450 nm will have a final value of around 4.0 optical density. If the results are successful, this study could be translated into in vivo experiments, and it could be a novel and successful method of healing ACL reconstructions.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0134

Savone, Stella

Project Proposal, Science, Health Research Proposal

The Effect of PDGFR Inhibition Through CP-673451 and Nrf2 Inhibition Through Bexarotene on the Chemotherapy Resistance of Non Small Cell Lung Cancer Cells to Cisplatin Treatment.

Non-Small Cell Lung Cancer has a low chance of 5-year survival and successful treatment in its late-stages, with one of the reasons for this being chemoresistance. The activation of the KEAP1/Nrf2 pathway is one of the causes of chemoresistance of cancer cells to Cisplatin treatment. This study is comparing the effectiveness of the inhibition of PDGFR with CP-673451 and the inhibition of the Nrf2 Neh7 domain with bexarotene in increasing apoptosis and decreasing resistance to Cisplatin NSCLC treatment through the targeting of the KEAP1/Nrf2 pathway. A Confocal Microscopy, ELISA assay, cell proliferation assay, flow cytometry, ROS and GSH assays, ARE-luciferase assay and reporter plasmid, western blotting, RT-PCR, siRNA transfection and statistical analysis will be conducted to compare these 2 methods of KEAP1/Nrf2 pathway inhibition. Results will be obtained based on the expression of Nrf2 and Caspase 3/7 expression in the NSCLC cells after Cisplatin and inhibition treatment. The results of this proposal could start to differentiate which part of the KEAP1/Nrf2 pathway best stops the cascade of cytoprotective genes that are triggered by Nrf2's activation, and therefore contribute to a more successful treatment plan and process for patients with NSCLC. Based on past research, the proposed result of this study is that cisplatin treatment with CP-673451 will inhibit Nrf2 at a greater rate. The subsequent research to this study should be making sure both methods are safe for the rest of the body and its protective biological processes.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0135

Schroeder, Ivy

Project Proposal, Science, Physical Science Research Proposal

Biosignatures are detectable within replica Kukaklek sample

Kukaklek is a regolith sample from the Perseverance rover on Mars expected to return by 2033. Experiments involving the sample need to be planned in advance particularly those involving testing presence of organic molecules. Martian soil can be recreated using the five most common materials within the samples, which account for 90% of all samples. These include SiO₂ - 49.5%, Fe₂O₃ - 17.9%, Al₂O₃ - 7.2%, MgO - 7.7%, and CaO - 6.7%. Once a mock Kukaklek sample is created, the potential presence of organic molecules can be determined by Raman Spectroscopy and can provide insight on which molecules would produce significant Raman bands. Raman Bands may not show up based on the environment in which the sample was exposed to, namely cosmic radiation. The Martian analogs will be mixed with 7 biomolecules to measure their detectability after being in martian simulated environments. In an experiment with the Kukaklek sample, we can combine the sample with the same biomolecules, expose them to the same exposure conditions that the Kukaklek sample was in, and then analyze which were detectable.. Before measuring the Raman bands after exposure, the molecules will be analyzed to find the strongest Raman bands, and will be compared with the molecules strongest bands after space exposure and combination with the sample simulant.

Darien High School

Teacher: Guy Pratt

Project # 0136

Seymour, Ella

Project Proposal, Science, Environmental Research Proposal

Domestication of Rainbow Trout

Over the past decade, the wild trout (*Oncorhynchus mykiss*) population has decreased due to polluted streams, overfishing, and hydroelectric dams. Conservationists and scientists have worked hard building hatcheries to reinforce the trout population by growing and raising trout in hatcheries and then releasing them to the wild. However, hatchery-raised trout are heavily domesticated and inferior in a variety of categories compared to wild trout. For the future of their population, it is important to understand how hatcheries affect the fitness of trout. It is hypothesized that if generations of *Oncorhynchus mykiss* are domesticated, then they will be less fit and less likely to sustain a population of trout over time. This proposed experiment would release dozens of domesticated/hatchery trout to a remote river where they would be monitored. Collection of eDNA would be used to track the presence and quantity of the population, therefore proving the existence of trout over time in a specific area. Without restocking this river, revealing the ability of trout to survive and reproduce, testing the fitness of domesticated trout. TruSeq RNA Sample Preparation Kit v2 will be used to collect RNA and then be analyzed by Illumina Genome Analyzer 2500 to get an image of the genomes of these domesticated trout and the effect on the offspring. Sustainability of hatchery bred trout populations are expected to show the difference in fitness from hatchery to wild trout. This experiment may support the improvement of trout hatchery facilities.

Darien High School

Teacher: David Lewis

Project # 0137

Sisca, Layla

Project Proposal, Science, Behavioral Research Proposal

The Effects of Temperature on Drosophila Melanogaster Sleep

This experiment will focus on whether higher or lower temperatures are more beneficial for sleep quality. This will be determined by drosophila melanogaster and then will be related back to humans, finding a solution for sleep amnesia and sleep difficulties. This experiment will obtain 2 vials and around 5 drosophila melanogaster will be in each. 1 vial will be placed in a climate around 85 degrees and another vial in a temperature around 65 degrees. I would then put cameras on each one and observe for 3 days. Then, I will watch the 3 days of film and determine if the flies slept more in the higher or lower temperature. The drosophila melanogaster sleep quality will be determined by at least 5 mins of no movement. After observing which flies slept more, the data collected will then be related it to humans, determining whether higher or lower temperatures are better for sleep quality.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0138

Smith, James

Project Proposal, Science, Health Research Proposal

Testing the Efficacy of Rituximab, Ocrilezumumab, and Ofatumumab on Murine Lupus

The proposed study is based on the autoimmune disease lupus which affects 1.5 million Americans. The study tests the efficacy of three different antibody drugs on murine lupus. Studies have linked B cell depletion to successful treatment, specifically regarding the CD20 B cell. In clinical studies, All three of these drugs have proven that they can successfully deplete B cells at a sustained high rate, but shown varying efficacy in older patients with complications arising. How can we differentiate these different drugs to maximize their effectiveness for patients of all ages; shortest time to remission and greatest overall disease improvement? The study will take 3 groups of mice ranging in age from five to seven months by group. Each age group will be split into 3 subgroups, correlating to the drug administered. The mice will receive a standard dosage for each drug administered and they will be bled biweekly for 8 weeks. They will then be bled again two weeks after the treatment is finished. The study aims to find which drug has the highest efficacy in each age group. The study was simulated online with the use of AI to find expected results. When applied during the early stages of the disease, all three drugs were more effective than when applied during the late stages of the disease. Rituximab showed the greatest efficacy in time to remission and overall improvement was seen, followed by Ocrelizumab. Overall, Rituximab was the most effective for all three age groups.

Darien High School

Teacher: David Lewis

Project # 0139

Sullivan, Flynn

Project Proposal, Science, Health Research Proposal

Efficacy of Donanemab on Cases of Likely CTE

Alzheimer's Disease is one of the most important age-associated diseases, and is increasingly common. However, it is not the only form of dementia that poses a problem. Chronic Traumatic Encephalopathy (CTE) is extremely common in former athletes but is not currently distinguishable from Alzheimer's. As a result, certain groups may be misdiagnosed with Alzheimers. One of the most promising drugs for the treatment of Alzheimer's is Donanemab; it is a monoclonal antibody that targets the Amyloid beta protein. Due to CTE's lower dependence on the Amyloid beta protein, this treatment is less likely to be effective in cases which, due to demographics of the patient (such as age and time of onset of disease), are likely to be CTE. This study would use data from the trials of Donanemab. The study would take cases of dementia in younger patients with a history of contact sports, as these individuals are likely to have CTE misdiagnosed as Alzheimer's. Then, it would compare the efficacy of the treatment on them, compared to the rest of the cases. It is expected the efficacy of Donanemab in cases where CTE is likely to be lower, as cases of CTE would not respond to a drug targeting a protein that doesn't impact it in the same way. This work could likely have implications in best practice for treatments for different patients of dementia; if the hypothesis is supported, other drugs could be the best practice for certain cases.

Darien High School

Teacher: David Lewis

Project # 0140

Taleb, Eva

Project Proposal, Science, Environmental Research Proposal

The Effects of Nitrogen Runoff on Local Plants in the Northeast Region.

In moderate and cold ecosystems, nitrogen has long been considered the component most likely to restrict forest growth. Human activities have increased the release of nitrogen in the last century. (Driscoll, 2003) For plants to prosper, they need to absorb nutrients from their surroundings. In particular, phosphorus and nitrogen contribute to photosynthesis, which in turn promotes growth. Waterways abundant with nutrients due to fertilizers high in nitrogen and phosphorus become eutrophic due to algal blooms from agricultural runoff. This leads to fish suffocating to death and oxygen depletion. Approximately 1400 species in the continental United States are classified as endangered or threatened due to nitrogen pollution, an inorganic water pollutant affecting two-fifths of US lakes and one-third of US streams. (Hernandez, 2016) Communities are impacted by excess nitrogen because it changes the ecosystem, favoring invasive species that grow faster than native plants that have evolved to nutrient-deficient soils. For this reason, too much nitrogen is beneficial for invasive plants but harmful to other species. The purpose of the experiment is to investigate how nitrogen pollution affects native and invasive species differently and compare plant growth. The species of plants studied will be local and tested in the same habitat while sharing the same constant parameters and environmental conditions. It is expected that the invasive species will show higher levels of growth. These results could be beneficial to local community efforts to combat the negative effects of invasive species.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0141

Thompson, Adeline

Project Proposal, Science, Physical Science Research Proposal

Equus Caballus and Human Heart Rate Variability Synchronization as a Model for Potential Atrial Fibrillation Treatment

Atrial fibrillation (AF), the most common type of cardiac arrhythmia, is a growing crisis in the United States and around the globe. In 2017, 37,574 million cases of AF were diagnosed and projections forecast a diagnosis increase by more than 60% by 2050. Currently available treatments are expensive, cause extreme side effects, and yield poor prognoses, making it critical that new treatment innovations are explored. The project aims to begin exploration of a novel AF treatment method, using the equine heart as a model of an external “device” which can impact the rhythm of the human heart, non-invasively and naturally correcting an arrhythmia such as AF. This project aims to demonstrate that proximity to an equine’s heart causes synchronization of the human participant’s heart rate variability (HRV), or variability in heart rate interbeat intervals, with the equine’s. The methodology for this project utilizes Polar H10 electrocardiogram monitors to measure the HRVs of both equines and humans when in proximity to each other. In order to compare the proximity HRV reading to the control HRVs, when the participants, human and equine, are measured separately, HRV analysis with Kubios HRV software will calculate the RMSSD, SDRR, and pNN50 ratios for the data. Case study analysis will indicate the correlation between the HRV measurements, indicating the ability of the equine heart to correct human heart arrhythmia. This project contributes towards the eventual goal of building an equine heart inspired medical device which allows for effective AF treatment.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 0142

Thorburn, Grant

Project Proposal, Science, Environmental Research Proposal

Modeling Solutions for Freshwater Salinization in the Northeastern United States

Freshwater salinization has the potential to disrupt the ecosystems surrounding water bodies and people that use them for drinking water and developing a model to assess solutions could help manage this issue. One problem created by excess salt is when chemical cocktails are produced as salts cause the release of other toxic substances. This could be through pipe corrosion, or when salt mobilizes substances and causes other substances like nutrients in fertilizer and radium to move from the soil into the water. Freshwater salinization syndrome is the result of increased salinity and alkalinity. It may cause drinking water to be unsafe, especially for people who need to maintain a low salt diet. It can indirectly lead to algae blooms and low oxygen levels in lakes and rivers. Generally excess salt makes purifying water for drinking more difficult and expensive. Some anthropogenic sources of salts in freshwater include road de-icing salts, landfills, wastewater, fertilizers and weathering of concrete and building materials. If it is possible to reduce salt levels through different methods of de-icing or other practices it could help preserve ecosystems and drinking water. This project aims to model chloride and conductivity levels and predict levels under different conditions to assess the effectiveness of different solutions.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0143

Travaglini, Catherine

Project Proposal, Science, Health Research Proposal

Caffeine's Effect on Athletic Performance

Caffeine's effect on plant growth Caffeine's effect on plant growth This experiment is about caffeine grounds and caffeinated substances' effect on an organism/plant's performance. The plan is to research this effect using coffee grounds or caffeinated substances and then record the plant growth. The experiment would record the growth of different levels of caffeine intake and the pros and cons that are related to the substances. The mg or amount of caffeine could be changed based on the plant used throughout the study. This experiment would record these plants' growth levels, health, and lifespan, and as a result, the impact would be revealed based on the outcome. This should help the science community and other individuals knowledge, regarding caffeine's effect on the growth period of these plants and what minerals support the growth or harm it.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0144

Turner, Luke

Project Proposal, Science, Health Research Proposal

Pharmaceuticals

Pharmaceuticals are synthetic or natural chemicals that are typically found in veterinary drugs, over-the-counter drugs, or prescription medicines. These chemicals create reactions within bodies and can evoke pharmacological or therapeutic results. The effectiveness of pharmaceuticals depends on the amount that is consumed. Pharmaceuticals are now reaching public drinking water systems as well as other waste water or natural water cycles. The MTD, or lowest clinically effective dosage, as well as the ADI and TDI (Acceptable/Tolerable daily intake) are the amounts that are consumed that can be deemed safe. These are based on calculations that are applied to selected points of departure, or PoD, with the most widely accepted being the no-observed-adverse-effect level (NOAEL). If the amount of pharmaceuticals in water exceeds these amounts, it can lead to serious effects on an individual's health. For the experiment, water samples from different drinking water sources will be taken and tested for pharmaceuticals. The amount of pharmaceuticals will be measured to determine the amounts and to see if they could cause any health risks to the people that consume the water.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0145

Valji, Allison

Project Proposal, Science, Physical Science Research Proposal

Transit Observations of TESS Exoplanet Candidates: TOI-1858, TOI-3856, and TOI-5451

Scientists have been searching for planets that could contain life for decades. However, before these exoplanets, or planets outside the solar system, can be studied for this possibility, they must first be discovered and confirmed. The Transiting Exoplanet Survey Satellite (TESS) is a space telescope designed to search the entire night sky for exoplanets using the transit method, which observes the exoplanet indirectly through the change in brightness when the planet passes between the star and the observer. Once a star that could potentially contain an exoplanet is detected by TESS, the planet is considered a candidate planet. But these candidate planets can sometimes be false positives where a decrease in stellar brightness is seen for reasons such as an eclipsing binary star. Therefore, it is necessary to perform follow up transit observations of exoplanet candidates to confirm their existence. This study will perform transit observations of TOI-1858, TOI-3856, and TOI-5451 using the Phillips 24" Telescope on Mount Lemmon in Tucson, AZ. Using the images taken during observation we will perform multi-aperture photometry using AstroimageJ to produce a light-curve, or brightness vs. time graph. We expect to see a significant decrease in brightness, and to disprove the possibility of a false positive, due to the planet being considered a candidate. Once a planet is confirmed, follow up observations with telescopes like the James Webb Space Telescope can be done using spectroscopy to determine the chemical composition of the planet and its atmosphere, and see if the planet could inhabit life.

Darien High School

Teacher: Christine Leventhal

Project # 0146

Veeder, Samantha

Project Proposal, Science, Health Research Proposal

Exploring Genetic Markers for Mast Cell Tumor Susceptibility in Domesticated Canines: A Population Study

Mast Cell Tumors (MCTs) are a type of malignant tumor that is commonly found in domesticated canines. They can form on top of the skin or under the skin and can affect several parts of the body such as their spleen, liver, and bone marrow. There is limited research on what causes MCTs except for the studied hereditary and genetic possibilities. This study will allow researchers to take sample collections of DNA from a population of domesticated canines to validate if there is a genetic marker that increases the susceptibility of MCTs. Using statistical analysis in this study can analyze genotypic data to determine the genetic markers that are most common in those who are affected. These findings allow researchers to understand if there is a genetic marker that contributes to the increased susceptibility of MCTs. The purpose of the study is to determine if there is a genetic marker that increases the susceptibility to Mast Cell Tumors in domesticated canines.

Darien High School

Teacher: Guy Pratt

Project # 0147

Vohra, Roopshi

Project Proposal, Science, Environmental Research Proposal

How Glyphosate affects overall bee health as measured by weight and life span.

Bees are important agricultural pollinators, but the act of foraging on flowers can expose them to harmful environmental toxins used in pesticides. Environmental stressors, such as glyphosate in many popular weed killers, can indirectly compromise bee health. This research aims to analyze how different concentrations of glyphosate affect overall bee health, as measured by weight and life span. Newborn worker bumblebees will be kept in the hive for a week, allowing them to form normal gut microbiota. The bees will then be moved to wooden nest boxes, and split into three groups that will be administered different concentrations of glyphosate dissolved in sucrose solution (control group, low dose, high dose) for a week. The weight will be measured pre and post-treatment and the average life span of each group will be calculated. In bees, the microbiome plays a vital role in the immune response (protecting bees against pathogens) and promotes host weight gain. Xenobiotics, such as antibiotics or glyphosate, affect the bee gut microbiome and are known to induce dysbiosis. Therefore, bees administered the highest concentrations of glyphosate should have the lowest weight and shortest life span, and bees administered no glyphosate should have the highest weight and longest life span. Bee populations have been declining over the past decades and reasons for colony failure are not fully understood but have been linked to environmental stressors such as pesticide exposure. Therefore, analyzing the effects of active ingredients in weed killers (such as glyphosate) on bees and their health is crucial.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0148

Wang, Teresa

Project Proposal, Science, Health Research Proposal

Exploring the Genotoxicity of MSG (monosodium glutamate) with Fruit Flies (*Drosophila melanogaster*)

In the 1920s and 1930s, MSG, or monosodium glutamate, was introduced to America through Chinese immigrants as many of them began to settle in America and establish their own restaurants. However, soon after, many customers began reporting health concerns such as dizziness, weakness, etc. after consuming food from these restaurants, pinning it on the Chinese restaurants' use of MSG in their cooking. Since then, MSG has become an extremely controversial topic in the culinary field regarding the consumption of MSG and its side effects. This project is designed to investigate the effects of MSG, specifically the genotoxic properties of the substance, by exposing fruit flies to MSG and investigating its effects. Fruit flies would then be exposed to varying concentrations of MSG for two months before their cells would be harvested and put through single cell gel electrophoresis, where their DNA would be investigated for damage. Through this experiment, it would effectively explore whether or not MSG truly has any harmful effects on DNA, evaluating if the accusations targeting MSG have any support or weight.

Weston High School

Teacher: Christopher Gamble

Project # 0149

Weng, Mingze (Steven)

Project Proposal, Science, Environmental Research Proposal

Determining the Effects of Spent Coffee Grounds on *Taraxcum officinale* in order to Eliminate Invasive Common Dandelions in Parts of the World

Invasive weeds heavily harm the ecosystem, and cause many biodiversity problems that occur in the world. One of these invasive weeds, *Taraxcum officinale*, or the Common Dandelion, is invasive in the world. The study will be using different types of spent coffee grounds (SCGs) (Arabica, Robusta, Liberica) with different caffeine concentrations. The purpose of this project is to determine the effects of SCGs on dandelions in order to find the best SCG to eliminate dandelions. The hypothesis is if Robusta coffee is used to kill the dandelion, it will reduce the height more than the other coffee types. The IV is the type of SCG and the DV is the change in height (cm). Six individual dandelions will be grown indoors in different pots for 20 days, being watered as needed. On the 20th day, trials will be performed specifically for each pot. 3 pots will be treated with 100g of SCG, and 2 will be left alone as backups. All the pots will have their initial heights recorded, and one of them will be left alone. After 10 days, the pot's final height will be recorded. An ANOVA will be run on the data to obtain the reliability of the results. If the hypothesis is correct, there will be a method to remove invasive weeds with SCGs, which is more eco-friendly and more resource efficient. Further research will be needed to create a safer way to treat invasive weeds while avoiding harm towards non-target plants.

Amity High School

Teacher: Catherine Piscitelli

Project # 0150

Whitbeck, Alex

Project Proposal, Science, Environmental Research Proposal

Using AI to Combat Climate Change

This research will hopefully help create a model of artificial intelligence that can predict and lessen the impacts of extreme weather on the ability to attend school and after school activities, including sports and clubs. Artificial neural networks (ANN) have specifically been developed and enhanced over recent years. Further being applied to research ecological issues, such as global warming. These systems are very effective while used in these settings, due to their complex non-linear systems. This means that these systems can adapt to time varying dynamics or emergent behavior, which is why it is very useful when used to research ecosystems. So, this research will use ANNs to track and record extreme weather events over a period of time. Additionally, these systems are constructed from three basic processing elements, including the unit, network topology, and training rules. This information can help improve and expand the overall understanding of our climate and eventually mitigate the effect of climate change. However, there are some potential risks concerning unfair bias and the greenhouse gasses emitted by developing certain models of intensive AI systems. The results of this experiment will bring to light the growing impact of severe weather on our everyday lives.

Ridgefield High School

Teacher: Patrick Hughes

Project # 0151

Williams, Cate

Project Proposal, Science, Health Research Proposal

The Implementation of AI-Assisted Documentation on Doctors' Workflow, Patient Care, and Reduction in Error in the Hospital Setting.

Healthcare workers, specifically physicians, spend a significant amount of time documenting patient information in electronic health records, taking away attention from direct patient care. Artificial Intelligence (AI) offers a solution by facilitating tasks within note-taking, transcription, and data entry, reducing time and errors in charting. The addition of AI tools in healthcare allows physicians to focus more on patient care while maintaining accurate records and potentially reducing legal errors. To assess the efficacy of AI-powered tools in healthcare, a three-week observational study shadowing physicians at a local hospital will be performed. A group of physicians will follow the routine method of charting, without AI, while the second group will use the new AI charting tools. It is hypothesized that the implementation of AI can streamline documentation, and enhance efficiency and patient care. The study will collect data on the time physicians spend charting to identify areas where AI can be integrated. The AI tools being used can capture patient visits through recordings, generate notes quickly, then undergo physician review, and be integrated into Electronic Health Records. Patient care outcomes, including satisfaction and treatment adherence, will be assessed post-implementation of AI. Despite the study's non-laboratory setting, adherence to HIPAA procedures and patient confidentiality will be followed. Statistical analysis will compare charting efficiency data before and after AI implementation. The study aims to determine the impact of AI on healthcare processes, emphasizing streamlined practices and improvement of patient care. It is expected that upon implementation of AI, doctors will spend significantly less working time charting, which can lead to an increase in direct patient care and more sufficient patient outcomes.

Darien High School

Teacher: Christine Leventhal

Project # 0152

Wright, Elayna

Project Proposal, Science, Behavioral Research Proposal

The Effects of Taste on Memory in Apis

Apis have been facing harsh environments and have learned to adapt to these new environments is this because of their memory or something else's? The research goal will be to see if Apis shows signs of memory. When the sugarbag bees first arrive, they are placed inside a bee hive. Keep bees at 39–45 degrees Fahrenheit to stay docile and asleep. Take the bee hive out of it, transfer the bees with tweezers, and shine a red light on them to keep them calm. Place them in a clear box with red, blue, and yellow colored flowers in a row of 4 by 3s. There will be 4 flowers stacted with vanilla extract which will be rewarding flowers. Another 4 flowers will have peppermint which is the unrewarding flower. The remaining flowers will have just nectar on them to be controlled variables. The Apis will be let fly around in the clear box for 15 minutes to allow them to land on the flowers multiple times. Repeat this process 14 times each morning at the same time. Monitor the bees on a camera and review the data collected. Keep the bees in the bee hive and avoid the experimenting zone. After 6 to 9 days of keeping them in the Apis hive move them back into the experimental zone. Monitor what paths they take and what flowers they land on. After the data is collected this will show that Apiss can take care of themselves and show how they can adapt to new environments.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0153

Yurkovsky, Elijah

Project Proposal, Science, Environmental Research Proposal

The Effects of Water Consumption on Polystyrene Consumption in Tenebrio Molitor

The irresponsible disposal of mass-manufactured plastic has damaged soil, harmed marine life, poisoned groundwater and led to significant environmental damage in general. Recycling and responsible disposal of plastic waste, although commendable, have so far proven to be insufficient solutions since the vast majority of manufactured plastic is not biodegradable. Tenebrio Molitor larvae have demonstrated an ability to degrade polystyrene plastic, making them a promising natural solution to the plastic apocalypse. This research explores how varying levels of water availability affect the rate of polystyrene consumption and degradation in T. Molitor larvae. In this research, groups of T. Molitor larvae will be allocated with varying amounts of water. All larvae will be provided with a diet of polystyrene foam, and their consumption and degradation of polystyrene will be monitored. Past studies suggest that water availability may influence the larvae's consumption patterns and potentially their degradation efficiency. Specifically, larvae with water access displayed heightened activity and consumed more polystyrene compared to their water-deprived counterparts.

Ridgefield High School

Teacher: Ryan Gleason

Project # 0154

Zerboulis, Joanna

Project Proposal, Science, Health Research Proposal

Botulism Competition

Clostridium botulinum (C. Botulinum) poses a significant threat to both plant health and agricultural productivity, particularly when present in soil ecosystems. It is most known for its production of botulinum toxin, which specific strains are lethal to plants. This study will investigate the efficacy of Penicillium chrysogenum (a bioagent for plant diseases) in combating the growth of C. botulinum in soil while simultaneously supporting healthy plant growth. The experiment will be conducted using a series of controlled conditions with soil artificially contaminated with C. botulinum spores. Different Penicillium chrysogenum treatments, including a control group with no agent, will be applied to the soil samples planted with a cucumber plant. The survival of C. botulinum will be monitored over time through colony counting and activity. Simultaneously, the effects of this antibiotic treatment on plant growth will be assessed by monitoring parameters such as germination rates, plant height, and overall plant health. Additionally, soil spore activity will be monitored to assess changes in the amount of the C. Botulinum. Expected results are that Penicillium chrysogenum will show promising efficacy in suppressing the growth of C. botulinum in the plant and the soil. Also, the plant tissue samples will be assessed for C. botulinum spores. These findings may suggest that targeted antibiotic applications have the potential to stop the threat of C. botulinum contamination in agricultural soils without significant adverse effects on soil health.

Darien High School

Teacher: David Lewis

Project # 0155

Zhai, Scarlett

Project Proposal, Science, Health Research Proposal

Determining the effect of the protein SAMP-1 on chromosome segregation in *C. elegans* embryos

Caenorhabditis elegans, known as *C. elegans*, is a nematode that lives in temperate soil environments. Many of the genes in the *C. elegans* genome have functional counterparts in humans, making it a helpful model for human diseases. Metaphase is the second stage of mitosis, where chromosomes attach to the fibers of the mitotic spindle & align at the center of the cell. Anaphase follows metaphase, where chromosomes split & move away to opposite poles of the cell. SAMP-1 is an important inner nuclear membrane protein that serves various functions within the cell, including formation & stabilization of the mitotic spindle & maintenance of nuclear integrity. Previous research shows that loss of SAMP-1 in *C. elegans* embryos leads to 100% embryonic lethality. It's important to understand SAMP-1's functions during mitosis. The purpose is to determine the effects of the protein SAMP-1 on chromatin segregation in *C. elegans* embryos. The hypothesis is that removing SAMP-1 from *C. elegans* will cause chromosome segregation defects, leading to a failure in embryonic development. The independent variable is SAMP-1 protein depletion. The dependent variable is chromosome segregation features. The control is the worms that don't have the SAMP-1 protein altered. Physical experimentation will be accomplished by the mentor. The student will conduct all data & statistical analysis. Data analysis of the acquired images will be conducted using ImageJ & Excel for statistical analysis. Studying the effects of SAMP-1 on the processes of mitosis will help scientists understand the importance of the protein during chromosome segregation & its misregulation in diseases such as cancer.

Amity High School

Teacher: Catherine Piscitelli

Project # 0156

Zhang, Lauren ; Liu Phydena

Project Proposal, Science, Teams (Research Proposal)

Leveraging Atherosclerosis-induced Inflammation to Predict Cardiovascular Disease through Cross-Cohort Analysis

Atherosclerotic complications are responsible for one-third of all deaths annually. Atherosclerosis is caused by plaque buildup in the arteries, which limits blood circulation. Inflammation is a factor of atherosclerosis not commonly targeted in treatment, though several clinical trials have suggested its key role in the disease. This project aims to define the importance of inflammation in atherosclerosis, in addition to inflammatory regulators and pathways important to atherogenesis. To do this, transcriptomics datasets from four atherosclerosis-related studies with 461 total samples will be used to perform cross-cohort analyses in order to identify differentially expressed genes (DEGs) and top gene ontology terms. R programming will be used to filter for DEGs and deep learning tools (Atherospectrum, Ingenuity Pathway Analysis) will be used to evaluate the importance of inflammation. DEGs will then be uploaded to pantherdb.org for annotation. Then, DEGS from top gene ontology terms and pathways will be prepared and normalized with machine learning programs (Smoother, Min-Max). Feature selection will be conducted using programs such as Lasso and regression models. For modeling building, selected features from Lasso will be used to perform Bayesian-based linear discriminant analysis (LDA) and multivariate regression analyses using the training data. We expect to observe that the inflammation index, and inflammation-related pathways and GO terms will be selected by feature selection programs. They should contribute positively to the model to identify atherosclerosis cases.

Darien High School

Teacher: David Lewis