Project # 1

Anwer, Eshal

<u>Investigating the Impact of Cultural and Demographic Factors on Mental Health Awareness and Access to Services Among South Asian Immigrants</u>

Completed Project, Behavioral

There is a significant gap in the literature regarding mental health issues and access to mental health services within the South Asian American (SAA) community, a population that often faces unique cultural and systemic barriers to care. Factors such as stigma, limited awareness, language barriers, and inadequate knowledge of mental health services may prevent members of this community from seeking appropriate care. Understanding these challenges is crucial to addressing mental health disparities and improving access to care for SAA individuals. The purpose of my project is to assess and address the disparities in mental health awareness and access among South Asian immigrants. It is hypothesized that cultural and demographic factors, such as language proficiency, immigration status, and stigma, significantly hinder mental health awareness among South Asian immigrants, leading to reduced access to mental health services. The independent variable is the cultural and demographic factors affecting mental health awareness and access to care among South Asian immigrants. The dependent variable in the experiment is the level of access to mental health care. The research will begin with an online survey distributed to the South Asian American community. Following the survey, a subsample of participants will be invited to partake in focus groups or one-on-one interviews, which will be conducted in person or virtually. The mentor will provide the student with the data while the student will conduct data analysis and also take part in disseminating the survey. The ANOVA test will compare mental health scores between groups such as the gender differences or differences across ethnic subgroups. A chi- squared test will be used to examine relationships between the relationship between ethnic background and help-seeking behavior. Thus far, the hypothesis has been supported. The chi test score was a 45, indicating a statistically significant difference in access to mental health services across age groups of when individuals immigrated. This project will better help understand the specific cultural and demographic factors that influence mental health awareness and access to services among South Asian immigrants.

Amity High School

Teacher: Lindsay McCarthy

Project # 2

Archibald, Lily

The Effects of Different Breathing Techniques During Swim Workouts on Short-Term Memory in Adolescent Athletes by using Word Recall tests

Completed Project, Health & Medical

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 Word Recall tests, a series of 10 simple words orally given to the participants 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 the consistency in a maximum heart rate zone (Cleveland Clinic, 2023).

Ridgefield High School

Teacher: Patrick Hughes

Project # 3

Arnold, Sadie

Developing an Algorithm to Automate Avascular Necrosis Detection Using Computed Tomography Scans

Completed Project, Health & Medical

Femoral head avascular necrosis (AVN) is a disease caused by lack of blood supply to the bone. There are 10,000-20,000 cases in the US annually. There's no consensus on determining AVN lesion size. Studies are using deep learning (DL) to differentiate transient osteoporosis (TOH)/AVN, which is complicated for radiologists. DL algorithms have detected AVN from radiographs/MRIs; not CT scans. Currently orthopedic surgeons have a CT scan display, which provides less detail of the AVN region: making locating the exact drill trajectories difficult. Developing an algorithm to automate AVN detection is a possible solution. The criteria are that the algorithm must successfully detect the full AVN region intraoperatively. The constraints are the availability of software. First, 3D models were created using Simpleware ScanIP and proven accurate by radiologists. Then a concrete workflow of AVN was created by cropping the CT scan to eliminate other portions of the femur, finding a threshold value that captures the entire AVN lesion and using the island removal tool to eliminate other regions. Then the recorded log was used to create a script that can generate an AVN model. The 3D models previously created were compared to the algorithm's models to determine its accuracy. Results thus far show that with current tools, automating AVN is possible with the inclusion of other parts of the femur. The implication of this project is to provide a 3D view of AVN to aid orthopedic surgeons in being able to match the exact trajectories faster.

Amity High School

Teacher: Sarah Reeves

Project # 4

Balamurugan, Karishma

Developing an Effective and Affordable Hand Tremor Suppression Device for Essential Tremor Patients

Completed Project, Health & Medical

Essential Tremors (ET) is a neurological disorder linked with involuntary, rhythmic movements of the hand, significantly diminishing the quality of life for approximately 5% of the United States population. Current interventions include surgeries, which are often ineffective and expensive, highlighting the need for better solutions. This project aims to develop a comfortable, discreet, and effective fingerless glove for suppressing tremors in Essential Tremors (ET) patients, thereby improving their quality of life. Researchers have been engineering devices to aid those with tremors (e.g. smart utensils, apps, appliances) a notable example is tremor suppression gloves but most using Electric Muscle Stimulation are bulky, and uncomfortable making patient acceptance low. This project will employ an exoskeleton, rubber dampeners, and the usage of compression for tremor stabilization. By incorporating an accelerometer/gyroscope, the device will detect hand movements, and a servo motor will apply precise pressure to stabilize the wrist. A program coded in Arduino IDE will interpret sensor data to identify tremors and adjust compression accordingly. Success will be indicated by achieving at least 80% accuracy in detecting tremors and 80% accuracy in delivering the appropriate servo motor compression. This innovative fingerless glove offers ET patients, and others with wrist-related movement disorders (e.g. Parkinson's), a more comfortable, affordable, and effective solution than existing options. The glove will improve patients' quality of life by offering discreteness, a long-term solution, and independence in daily tasks, ultimately improving their daily lives.

Amity High School

Teacher: Sarah Reeves

Project # 5

Bisset, Luke

Determining If the European Corn Borer Impacts the Yield of Modern Corn Strains

Completed Project, Environmental

In 1917, the European Corn Borer (ECB) was introduced to the U.S., causing significant damage to the corn industry. ECB burrows into corn stalks, causing plants to lean and making harvest more difficult. In 1996, Bt (Bacillus thuringiensis) corn was developed to resist ECB, which worked effectively for two decades. However, in 2023, ECB resistance to Bt was confirmed in Connecticut. The older variety of corn showed a larger yield reduction compared to newer strains. In June, 75 plants of each corn variety were planted, and ECB was introduced in two waves—one in July and the other in August. The corn was harvested in October, with data on each ear of corn recorded by row and column. The number of kernels and the weight of each ear were measured, and physical characteristics were noted. An ANOVA was conducted to assess whether there were significant differences in defense mechanisms between the older and newer strains. This study aimed to evaluate how different corn varieties responded to ECB pressure, providing insights into the adaptation of pests and the effectiveness of resistance. Understanding these variations is crucial for developing more resilient strains, guiding breeding programs, and shaping agricultural practices. The findings of this study may help mitigate the economic risks posed by pest resistance, ensuring sustainable corn production and informing future agricultural policies.

Amity High School

Teacher: Sarah Reeves

Project # 6

Boberski, William

Effect of Diet on Lifespan and Tumor Burden in a Drosophila Apc1/Apc2-RasV12 Model of Colorectal Cancer

Completed Project, Health & Medical

Colorectal cancer (CRC) is the third most frequently diagnosed cancer, and the incidence of early-onset CRC in patients under 50 is rising (Sung et al., 2021) (O'Reilly et al., 2023). While diet may influence cancer progression, the impacts of nutrients like fat or fiber are not fully understood (Ren et al., 2021). A transgenic Apc-Ras cancer model in Drosophila melanogaster (gifted from Dr. Andreu Casali) allows the comparison of standard, high-fat, and high-fiber diets on cancer progression (Martorell et al., 2014) (Bangi et al., 2016). Experimental diets were prepared with the Bloomington standard cornmeal medium supplemented with $\pm$10% coconut oil for high-fat, or $\pm$ 10% psyllium husk for high-fiber (Liao, 2020) (Lambeau, 2017). Tumor progression was indirectly measured by lifespan, and every other week by fecal depositions and fluorescence microscopy of GFP-labeled Apc-Ras clone cells. It was anticipated that high-fat diets would be correlated with a shorter lifespan, fewer fecal depositions, and more tumors compared to high-fiber diets (Cheng et al., 2020) (Martorell et al., 2014). Preliminary data suggests that flies on high-fat diets may have shorter lifespans and more fecal depositions. Fluorescence microscopy of midguts suggests that flies on high-fat diets present differently, and may have more tumors; for example, a high-fat fly had approximately 18 tumors, while a high-fiber fly had approximately 4 (n=1 for each). This preliminary data is promising and supports additional study, in order to elucidate causes for rising EOCRC rates, and contribute evidence related to dietary intervention in CRC patients.

Staples High School

Teacher: Amy Parent

Project # 7

Bose, Arnav

<u>Optimizing Extraction of Chitin From Crustacean Shells</u>

Completed Project, Physical Science

Chitin is one of the most abundant naturally occurring polymers on planet earth, being present in crab and shrimp shells, butterfly wings, beetle's armor, and even in fungi. To match its overwhelming abundance, Chitin has uses in countless different industries, whether it be as a food thickening agent, a soil fertilizer, or even used to create a biodegradable, plastic like substance. The goal of this experiment is to determine the best conditions for extracting Chitin from raw materials, while still maintaining a good quality product. The raw material of choice was shrimp shells that have been washed and crushed prior to the procedure. Shrimp shells were chosen due to having a high Chitin content while also being relatively convenient to access, and the procedure is meant to be able to be reasonably replicated on a much larger scale. The preferred method of extraction is a chemical method, using 1 M treatments of Hydrochloric Acid and Sodium Hydroxide. The variation in the experiment is the temperature of the HCl treatments, being performed at 65oC, 75oC, 90oC, and 100oC over four different trial runs of the procedure, with the temperatures being kept constant via an incubator. Once the four procedures have concluded, the purity of the four Chitin products will be determined using a mass spectrometer, testing against the hypothesis that between the temperatures of 65 and 100 degrees Celsius, as the temperature of the HCl treatment increases, so will the purity of the final product.

Ridgefield High School

Teacher: Ryan Gleason

Project # 8

Buchesky, Alexia

Surgical Approaches for the Treatment of Cervical Spondylolisthesis: Current Evidence on Complications and Patient Outcomes

Completed Project, Health & Medical

Cervical Spondylolisthesis (CS) is the slippage of one vertebra over another in the neck due to instability. It can lead to cervical myelopathy and radiculopathy, both of which may cause nerve pain and neurological symptoms. Although less common than lumbar spondylolisthesis, CS is still present, and there is limited evidence on its surgical treatment and patient outcomes. The aim of this study is to develop a better understanding of the incidence, severity, and surgical treatments of CS to determine the percent improvement after surgery. PubMed and Clinical Trials databases were used to find publications of 485 papers, and were then transferred to the portal Rayyan to conduct the three stages of elimination: title level, abstract level, and full-text level. The publications were narrowed down to six papers and the data was organized into three tables: demographics, radiological report, and patient reported outcomes. Additionally, the quality of each paper was assessed using the MINORs checklist and bias was calculated when applicable. It was observed that there was no standard definition of treatment of CS. In addition, we found variability in what clinical measures were used to follow patients and determine if they improved.

Darien High School

Teacher: Guy Pratt

Project # 9

Bulsara, Akshay

Characterizing the Changes to the Optic Nerve Vasculature Following Optic Nerve Crush Injury in vivo

Completed Project, Health & Medical

Characterizing Vascular Changes in the Optic Nerve Following Optic Nerve Crush Injury in vivo Optic nerve crush (ONC) injury, a model of central nervous system (CNS) trauma, disrupts blood vessel integrity and delays neo-angiogenesis, impairing neuronal recovery. This study aimed to characterize temporal changes in optic nerve vasculature following ONC injury in vivo to establish a baseline for evaluating regenerative therapies. It was hypothesized that ONC would damage vasculature at the injury site, inducing inflammation and delaying neo-angiogenesis, resulting in reduced blood vessel density at early post-injury timepoints. Using mice as a model, blood vessels were labeled with Sulforhodamine-B, and tissues were collected at 3, 5, and 14 days post-injury. Blood vessel end branches were visualized and quantified using ImageJ software, and comparisons were made with uninjured controls. Results revealed a significant reduction in vascular density at days 3 and 5 post-injury, with recovery observed by day 14. Statistical analysis (ANOVA, $p < 0.05$) confirmed the temporal trend of vascular disruption and subsequent delayed neo-angiogenesis. These findings align with previous research suggesting inflammation, edema, and blood-nerve barrier disruption as contributors to delayed vascular repair. The study provides foundational knowledge into vascular dynamics post-ONC injury, emphasizing the need for interventions to enhance angiogenesis and support neuronal regeneration. Future research will investigate inflammatory mechanisms and explore advanced imaging quantification methods such as utilizing AI and machine learning. These findings could inform therapeutic strategies for CNS trauma and neurodegenerative diseases.

Amity High School

Teacher: Sarah Reeves

Project # 10

Callagy, Ella & **Nemec, Charly**

Movement: The Ideal Dosage of Vibration to Reduce Pain and Improve the Quality of Life in Patients

Completed Project, Teams (Completed Project)

Pain relief is a critical area of medical research, particularly exploring non-invasive, non-pharmaceutical methods. This study investigates the potential of vibration therapy as a tool for pain management, inspired by findings in vibroacoustic and motion therapy research. Prior studies have highlighted the benefits of physical movement in reducing symptoms associated with chronic conditions like Parkinson's disease, fibromyalgia, and depression. Incorporating vibration and synchronized activities with music has shown promise in amplifying pain-relief effects. Building on this foundation, our research explores whether vibration therapy can reduce pain responses to a cold stimulus. To test this hypothesis, participants immersed their arms in an ice bath while being exposed to vibrations applied to the arm muscles. Key metrics included heart rate variability, pain rankings, and duration of ice bath tolerance. A control group completed the ice bath without vibration for comparison. Results indicated that participants in the experimental group experienced more consistent heart rates, fewer pain-related spikes, and improved endurance compared to the control group. These findings suggest that vibration therapy can mitigate pain by promoting physiological stability, potentially shifting focus away from the pain stimulus. This study provides a stepping stone toward developing vibration as a clinically prescribed pain-relief method, offering a non-pharmaceutical alternative for individuals suffering from chronic pain. Future research could explore integrating music with vibration therapy to enhance its efficacy further.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 11

Cannon, Emma

<u>Determining the Amount of Pollution and Spat in Water by Using Oysters</u>

Completed Project, Environmental

In Long Beach Island Bay, new oyster growers are using chemicals to grow oysters rather than doing it naturally. By doing so, the bay is becoming increasingly more polluted and and now it is harder for spat to grow naturally. Spat helps the environment because when they spawn into shells, they filter water and provide stable ecosystems in the bay. By creating shelter for small fish, crabs, and other organisms, oysters and their growth is essential to ensure safety and the presence of clean water in the bay. As the oyster population increases in size and density the filtration rate increases. The same goes for population size. If there is a larger oyster population, there will be larger populations of several other organisms. Oysters also accumulate nitrogen in their tissues and remove it via bio deposit burial and denitrification. When oysters feed, they remove nitrogen and phosphorus. This study lasted for a total of two months, exploring how much spat growth would happen. In this the water quality was also analyzed. By placing bags of shells into water and checking them once a week. The water quality was able to be determined by observing the number of spat on shells and the number of organisms in the bag. If there were more organisms, then that meant that the water was cleaner, as the animals survived. This experiment determined that spat is able to grow in the bay and that there are areas of the bay that are cleaner than others.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 12

Chang, Chloe

Enhancing Nighttime Measurement Precision in an Aerosol Optical Depth Monitor Using LED Technology

Completed Project, Environmental

Fine particulate matter (aerosols) is a major contributor to adverse health effects, environmental degradation, and climate change. While current methods for measuring aerosols include satellite-based estimations and ground-level monitoring, a significant limitation exists in the inability of low-cost AOD sensors to measure particulate matter at night due to reliance on solar energy. Aerosol Optical Depth (AOD), a dimensionless measure of aerosol concentration (values ranging from 0–1), is crucial for understanding air quality, climate impacts, and ecological health. This project proposes a novel solution by integrating LED technology into low-cost AOD monitors, replacing solar-powered components with a stable, cost-effective LED light source capable of operating continuously, including during nighttime. LEDs with narrow wavelengths offer consistent and precise illumination, allowing for accurate AOD measurements irrespective of time. The experimental model modifies the Aerosol Mass and Optical Depth (AMOD) sampler to include an LED light fitted inside the central aperture. Calibration is achieved using a modified Beer-Lambert law (-log(final value/initial value)), with trials involving varying concentrations of aerosol particles. Key measurements include mass absorptivity, aerosol concentration, and background gas optical depth, ensuring that the AOD calculations reflect aerosol contributions accurately. Data analysis involves linear regression to correlate AOD with particle concentrations, ensuring precision and reproducibility. This enhanced system provides a continuous, reliable, and affordable method to monitor aerosols, offering valuable insights into air quality and supporting the development of improved environmental management systems.

Amity High School

Teacher: Sarah Reeves

Project # 13

Chen, Jordan

Evaluating AlphaFold-Multimer's Predictive Performance on Novel Protein-Protein Interactions by comparing Alpha Fold Generated Structures and Experimentally Resolved Protein Structures

Completed Project, Health & Medical

Protein-protein interactions (PPIs) are crucial for understanding protein complex functions. While experimental methods like x-ray crystallography and cryo-electron microscopy are effective, they are costly and time-intensive. AlphaFold addresses these challenges, excelling in single-protein predictions but showing limitations in PPI modeling. AlphaFold-Multimer achieves a 70% success rate for heteromeric interfaces using a 0.23 DockQ cutoff, though this threshold is debated. This project investigates heterodimers AlphaFold-Multimer struggles to model, aiming to identify conformations to improve PPI prediction.The hypothesis is if heterodimers are different enough from those in AlphaFold-Multimer's original training set or MSA database, then the models generated will have significantly lower DockQ score. The independent variable is training set inclusion, and the dependent variable is the maximum DockQ score per heterodimer. A Python algorithm filtered heterodimers with <20% sequence similarity from the Protein Data Bank (PDB). Structures predicted by AlphaFold-Multimer were evaluated using DockQ scores and ipTM metrics. Results showed variability in prediction quality, with 7 of 11 heterodimers scoring below the 0.8 high-quality DockQ cutoff and 1 scoring below 0.2, indicating failure. The hypothesis was partially supported, though the underlying causes remain unclear. A low correlation (R^2 = 0.542) between DockQ and ipTM scores suggests AlphaFold-Multimer's internal metrics are unreliable for novel proteins. These findings highlight the need for further development of AlphaFold-Multimer and future research to identify structural or sequence features in PPIs with poor MaxDockQ scores to improve prediction accuracy.

Amity High School

Teacher: Sarah Reeves

Project # 14

Chen, Rebecca

Determining the Geographical Correlation Between Per- and Polyfluoroalkyl Substances (PFAS) and Alzheimer's Disease (AD) Across Five U.S. Regions

Completed Project, Health & Medical

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals found in several industrial applications that are known for their bioaccumulative and nondegradable properties. These harmful substances are being considered as one of the causes of Alzheimer's Disease as a result of their access to the brain via transmission through the blood-brain barrier. Inconsistencies among several studies make it difficult to assess the severity of PFAS neurotoxicity. The purpose of this project was to determine the geographical correlation between Per- and Polyfluoroalkyl Substances (PFAS) and Alzheimer's Disease (AD) across five U.S. regions. If there is a high prevalence of PFAS in all five regions, then there will also be a high prevalence of AD, because there is already a known connection between PFAS and AD, so this pattern should stay true across all U.S. regions. The Independent variable in this experiment was the PFAS prevalence and the dependent variable was AD prevalence in each region. PFAS prevalence data were collected from the EWG and AD prevalence data were collected from the CDC. All data analysis was done by the experimenter while the mentor provided guidance throughout the experiment. Values of PFAS/AD prevalence were grouped by region and inserted into Excel for analysis. Results thus far suggest the highest PFAS/AD correlation in the Northeast region and the lowest correlation in the Midwest region. This research will provide more insight on the geographical correlation between PFAS/AD and can lead to further investigation on the regional differences.

Amity High School

Teacher: Sarah Reeves

Project # 15

Cox, Lydia

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

Completed Project, Environmental

Using Sunscreen as a way to distribute Beneficial Microorganisms for Corals (BMCs). Beneficial Microorganisms have been shown to help strengthen corals against the effects of coral bleaching. When corals are exposed to long periods of heat stress or other stressful conditions it disrupts the relationship between the coral host and its endosymbiotic zooxanthellae. This then leads to the loss of a coral's coloration and the coral becomes weaker, and potentially leads to death. To test the concept of a BMC enriched sunscreen, serial dilution was done with E.Coli. Different variables were introduced into the growth environment of the E.Coli including Zinc-oxide and glycerol. After looking at the growth of the bacteria it was found that the E.Coli grew well with glycerol. The results from the Zinc-oxide and E.Coli plates showed inconclusive; there was bacteria growth but there were no clear colonies making the data inconclusive. Going forward new data collection will be performed using the actual BMC compound or Bacillus Lehensis depending on availability. The bacteria being used will be microencapsulated in protein to protect it from the Zinc Oxide. Then Serial Dilution using water glycerol and zinc oxide will be performed, plated then the colony forming units will be counted.

Newtown High School

Teacher: Timothy DeJulio

Project # 16

Dodge, Kevala

Analyzing Weight-loss Related Subreddits to Determine the Effect of Semaglutide Use on Nightmares

Completed Project, Health & Medical

Semaglutide is a medication used for glycemic control and as a weight loss method. Data can be taken from semaglutide users within text based social media platforms such as Reddit, especially subreddit groups, convenient when researching specific groups. This project aimed to determine if semaglutide related subreddits have a higher association with nightmares than weight loss related subreddits. It was hypothesized that semaglutide subreddits would have a greater association with nightmares than weight loss subreddits post non weight loss subreddit removal. Also, post subreddit removal, results would show a larger count of nightmare related posts in group 1 (related to semaglutide) than 0 (unrelated to semaglutide). Data was collected from The Pushshift Reddit Dataset and imported into LIWC which analyzed the relation of posts to nightmares. Results were sorted by related to nightmares or unrelated to nightmares in Excel. In JASP, the non weight loss related subreddits were removed. Results showed when non weight loss related subreddits were removed there was a greater correlation between group 1 and nightmares. Indicated by a p-value of 0.003, supporting the hypothesis that post non weight loss subreddit removal, group 1 would have a higher relation to nightmares than group 0. Also, group 0 had a ratio of nightmare related posts to non nightmare posts of 174:154205 and the ratio of group 1 was 64:34697, indicating group 1 had more nightmare posts than group 0 in comparison to total. Concluding there is a significant correlation between semaglutide subreddit groups and nightmares.

Amity High School

Teacher: Sarah Reeves

Project # 17

du Pont, Sophie

Evaluating the Impact of Community-Based Mental Health Events on Stress and Emotional Well-Being: A Survey-Based Study

Completed Project, Behavioral

Mental health challenges, including rising stress levels and emotional distress, have become increasingly prevalent, and community-based initiatives may offer a new, accessible approach. This study evaluates the psychological impact of "Nights of Hope," a series of mental health events launched by the founders of Here For You in Fairfield, Connecticut. These events aim to reduce stigma, foster connection, and support well-being through storytelling and dialogue. Surveys were administered to participants before the event, immediately after, and one week later. Quantitative findings showed significant reductions in stress and anxiety immediately following the event, with average stress levels decreasing from 7.2 to 4.1 on a 0–10 scale. Feelings of loneliness dropped from 5.4 to 2.8, and over 85% of participants reported an increased sense of community. However, follow-up surveys (n=12) indicated partial regression toward baseline stress levels one week later. Qualitative responses highlighted themes of inspiration, comfort, and validation, with many participants noting the event provided a safe space for open discussions about mental health. Limitations, including a small sample size and self-selection bias, suggest caution in generalizing or trusting results. Nonetheless, the findings show the immediate emotional benefits of community-based mental health events. Future research should examine the long-term effects of such initiatives, explore their impact on diverse populations, and assess how personal storytelling influences both participants and panelists. This study adds to the growing evidence that community-driven mental health initiatives can play a vital role in reducing stress, improving emotional well-being, and fostering social connection.

Darien High School

Teacher: Guy Pratt

Project # 18

Fan, Janet

Determining the Correlation between Physicians' Perspective on Cannabis Legalization and Physician Comfort Discussing Cannabis Use with Youth Patients

Completed Project, Behavioral

In 2021, recreational cannabis use was legalized in Connecticut. While some studies suggest that recreational cannabis legalization has no impact on adolescent substance use, others show that adolescent cannabis use increases post-legalization. Early onset, heavy cannabis abuse while the brain is still developing is strongly correlated with decreased cognition, damage to brain structure, and lower IQ. Physicians, as primary healthcare providers in a youth's life, are crucial to identifying and treating youth cannabis abuse. This project will seek to identify if there is a correlation between a physician's personal opinion about recreational cannabis legalization and how comfortable physicians feel approaching the subject of cannabis abuse with their youth (child and adolescent) patients. The hypothesis is that if physicians have negative personal beliefs, they will feel more comfortable talking about cannabis abuse with their patients. The independent variable is participants' personal beliefs about legalization of cannabis and the dependent variable will be physicians' comfort towards approaching the topic of cannabis use with patients. Students examined participants' answers to two specific questions, "I think the legalization of cannabis is a step in the right direction" and "I feel comfortable discussing the risks of cannabis use especially in children or adolescents." Student used a correlation matrix to identify if there is a statistically significant correlation between participants' numerical answers to the IV and DV questions. This study will provide more information about the current state of physicians' comfort surrounding discussing recreational cannabis misuse with their youth patients, and potential correlating factors.

Amity High School

Teacher: Sarah Reeves

Project # 19

Finn, Maggie

Determining the Effect of Water Stress on Tomato Growth and Pollen Viability

Completed Project, Environmental

Beets and radishes are among the most commonly produced and consumed vegetables, but their production is affected by rising temperatures. Increased temperatures both limit the growth and pollination of these vegetables. This study determined the effects of the biofertilizer, specifically spirulina powder, on these plants. Plants were grown in planting trays with regular soil for approximately six weeks, which allowed for the counting of their leaves and other measurements. The plants were sprayed with spirulina daily, and the effects were assessed. This solution was created by mixing spirulina powder with water and placing it in a spray bottle. Half of the radish and beets were sprayed with the spirulina solution, serving as the independent variable, while the other half was not, serving as the control group. All plants were compared over several months under artificial grow lights. The independent variable is the radish and beets sprayed with the spirulina solution, the dependent variable is the growth and performance of the plants, and the control group is the plants not sprayed with spirulina solution. This experiment compared the heights of the plants, specifically the ones sprayed with spirulina, and those that were not. Additionally, the experiment counted the number of leaves and measured the plant's biomass. To conclude, the experiment aimed to determine the effects of the spirulina solution on the radish and beets under difficult conditions where the temperatures are high with artificial and natural light.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 20

Foley, Nora

The Effect of Positive Thinking and Mindset Techniques on High School Athletes

Completed Project, Behavioral

>>>>> ABSTRACT NOT AVAILABLE <<<<<

Ridgefield High School

Teacher: Ryan Gleason

Project # 21

Frantz, Tyler

Developing an NLP to determine the likelihood of developing post-traumatic epilepsy following traumatic brain injury

Completed Project, Health & Medical

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Amity High School

Teacher: Sarah Reeves

Project # 22

Fullerton, Anna

Polluting Paradise; Waste on Cape Cod Beaches

Completed Project, Environmental

Plastic pollution poses a growing threat to coastal ecosystems, particularly in areas like Cape Cod. Plastic waste disrupts ecosystems and endangers marine life. With tourism central to Cape Cod's economy, addressing beach pollution is essential to maintaining environmental health and economic vitality. This research aimed to identify the largest contributors to coastal pollution, focusing on the public, harbor boats and houseboats, and items washed ashore. Data was collected from three beaches within a one-mile radius: a private beach, a yacht club beach on a harbor, and a public beach all in Woods Hole. Using a measuring wheel, each beach was divided into ten sections, and two sections were randomly selected for trash collection. Data was recorded between 6 pm and 8 pm, with observations and photos of unusual items noted. Results showed that the yacht club harbor beach had significantly more trash than the public and private beaches. This suggests that harbor activity, rather than public beachgoers, may be a greater source of pollution. It also highlights the positive impact of community efforts to maintain clean public beaches. These findings point to the need for targeted interventions in harbor areas to reduce pollution. Future research should investigate specific sources of harbor-related pollution, such as boat waste or commercial activity, and explore strategies for mitigation. Enhancing waste management and raising public awareness may further support efforts to protect coastal ecosystems.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 23

Gleason, Calista & **Speicher, Emma**

The Affect of Invasive English Ivy on Native Wild Ginger Plants

Completed Project, Teams (Completed Project)

English Ivy (Hedera helix) is an invasive species that threatens native plants like Wild Ginger (Asarum canadense). This study examines how English Ivy affects Wild Ginger's growth and survival. English Ivy spreads quickly, forming dense mats that block sunlight and compete for nutrients. As a result, Wild Ginger struggles to establish, leading to reduced biodiversity. To analyze this impact, we observed Wild Ginger in areas with and without English Ivy. Findings suggest that Wild Ginger populations are significantly smaller in ivy-dominated areas. This highlights the need for invasive species management to protect native plants. Future research could explore effective removal methods. Protecting native plants like Wild Ginger is crucial for maintaining healthy ecosystems.

Fairfield Warde Highschool

Teacher: Ryan Gleason

Project # 24

Grace, Beatrice

In silico Design of a Drug to Bind to the Prion Protein for the Treatment of Prion Disease

Completed Project, Health & Medical

The conversion of PrPc to PrPsc in prion diseases is responsible for the progression and transmission of the diseases; this process is dependent on protein-protein interactions between prion proteins centered around the n1 region of the proteins. A protein binder will be designed for the purpose of preventing these interactions, and ultimately decreasing the rate at which the diseases progress. Prion diseases (TSEs) are a group of rapidly progressing neurodegenerative diseases currently with no cures nor effective treatment, and which claim the lives of thousands each year. The binder will be designed in silico with Bindcraft, a novel protein design software developed by Martin Pacesa et alia.

Newtown High School

Teacher: Timothy DeJulio

Project # 25

Hayashi, Parker

LungSCOPE: A Multimodal Machine Learning-Based Framework for Overall Survival Prediction in Non-Small Cell Lung Cancer

Completed Project, Physical Science

According to the National Cancer Institute, nearly 700,000 people die of cancer in the United States each year. Almost 20% of these deaths come as a result of non-small cell lung cancer (NSCLC), making it the most deadly form of the disease and creating the need for lung-specific therapeutic solutions. When treating an NSCLC patient, an accurate overall survival prediction is imperative for determining the optimal therapeutic strategy. Currently, physicians typically significantly overestimate overall survival. To solve this issue, predictive machine learning has been heavily developed in recent years. However, traditional approaches have typically only utilized unimodal data sources, limiting their ability to predict survival accurately. Furthermore, the few multimodal NSCLC-specific models which exist have mostly utilized deep learning, a promising yet computationally expensive method that has been shown to underperform alternative methods such as gradient boosting in genomic studies. In this project, a novel comprehensive eXtreme Gradient Boosting (XGBoost)-based multimodal machine learning framework for overall survival prediction in NSCLC, LungSCOPE was created. By utilizing 27 clinical features and 9 genomic biomarkers, an XGBoost model was trained and optimized to predict 12, 36, and 60 month overall survival. LungSCOPE achieved an area under receiver operating curve (AUROC) of 0.78, 0.83, and 0.84 at 12, 36, and 60 months respectively, outperforming all previous similar state-of-the-art models. This framework displays immense potential for providing physicians with accurate overall survival, allowing them to determine the optimal personalized treatment for their patients, greatly improving the quality of their lives.

King School

Teacher: Victoria Schulman

Project # 26

Hebbar, Rohan

Creating a Low-Cost, Smartphone-Enabled Particulate Matter Sensor to Detect and Measure Concentrations of Particulate Matter in the Air

Completed Project, Environmental

Particulate Matter (PM) is a commonly found atmospheric pollutant which negatively impacts human and environmental health when exposed. PM significantly impacts environmental health by polluting ambient air as well as disrupting ecosystem health. Current air quality sensors which detect PM concentrations in the air are expensive primarily due to complex electronic components and specialty software. The objective of this project was to create a smartphone-enabled, low-cost PM sensor that will allow users to detect and measure PM in the air with ease. The criteria for this project were that the sensor must successfully detect and collect PM as well as cost less than 40 dollars in total. The constraints included the time available to construct and test the sensor, as well as the limited amount of PLA filament available to build the sensor. The proposed solution was to design and 3D-print the sensor components using Tinkercad. This included a cyclone filter to increase the amount of PM entering the sensor. An aquatic pump was utilized to draw PM into two collection pans within the sensor. Subsequently, a smartphone-based microscope examined the PM in the pans after the collection period. The data from this experiment indicated that the sensor successfully collected more PM with the cyclone compared to without the cyclone, demonstrating that it was successful. The implications of this project will allow people to efficiently test air quality in their respective region. Future studies may further research smartphone-based air quality sensors as well as implementing a PM analyzing application.

Amity High School

Teacher: Lindsay McCarthy

Project # 27

Hoag, Nate

Carbon Fiber Composite Connecting Rods for Enhanced Strength and Efficiency

Completed Project, Physical Science

Abstract This study's goal is to find the effectiveness of Carbon Fiber Connecting rods in an internal combustion engine. To start, a 3d replica was designed on a CAD software to perfectly replicate a connecting rod from the AMC 150 cubic liter engine. This 3d replica was then turned into a mold and 3d printed by an Ender 5 3d printer. Once the mold was printed it was then prepped for the molding process by being cleaned and sprayed with non-stick oil. Chopped carbon fiber was then added to West Systems 2 part epoxy to create a chopped carbon slurry which was then poured into the 3d printed mold. For the curing process a 4000 ml beaker was filled and placed on top of the mold to ensure constant pressure during the drying and hardening process. The mold was then broken open to reveal the forged carbon fiber part. So far I have broken the carbon fiber connecting rod out of its mold. With the carbon fiber connecting rod fully casted my next steps will be to test the connecting rod in many different simulated scenarios. These simulations will include tensile testing, shear testing, fatigue testing, and friction testing. These series of tests will demonstrate the strength of the connecting rod and ensure its stability and safety before I am able to install it in the engine. While I don't have any current data I am hoping to start the testing of this connecting rod within the next few weeks.

Newtown High School

Teacher: Timothy DeJulio

Project # 28

Huber, Elena

Evaluating the Antifungal Potential of Citronella and Cassia Essential Oils at Different Concentrations Against the Mycelia Growth of Bipolaris sorokiniana

Completed Project, Environmental

The study investigates the antifungal properties of citronella (Cymbopogon nardus) and Cassia (Cinnamomum cassia) essential oils (EOs) against the mycelial growth of Bipolaris sorokiniana, a pathogenic fungus responsible for spot blotch disease in wheat. This disease significantly impacts crop yields, particularly in warmer climates. The experiment aimed to evaluate the inhibitory effects of citronella and cassia EOs at three concentrations (0.01%, 0.1%, and 1%) in vitro. The findings revealed that cassia EO at 0.1% was the most effective in inhibiting fungal growth, demonstrating comparable efficacy to the higher 1% concentration. This suggests that 0.1% cassia EO is a more efficient option, reducing costs and potential cytotoxicity while maintaining antifungal activity. The superior performance of cassia EO is attributed to its high cinnamaldehyde content, which disrupts fungal cell walls and inhibits reproduction. Citronella EO, containing compounds such as citronellal and geraniol, also showed antifungal activity but was less effective compared to cassia EO. These results underscore cassia EO's potential as an eco-friendly alternative to chemical fungicides, addressing the increasing demand for sustainable agricultural practices. However, the study's in vitro nature presents limitations, as results may not fully translate to in vivo agricultural applications. Future research should focus on testing cassia EO on plants to evaluate its cytotoxicity and efficacy under real-world conditions. This work contributes to the development of natural fungicides that are both effective and safe, promoting healthier crop management practices.

Amity High School

Teacher: Sarah Reeves

Project # 29

Kaoroptham, Anaya

<u>Investigating the correlation between external factors of homicide cases and homicide clearance rates.</u>

Completed Project, Physical Science

Homicide clearance rates have been steadily declining over the past several decades, prompting a need to better understand the factors influencing case solvability. The purpose of this project is to investigate how external factors impact homicide clearance rates. The hypothesis was that an increase in external factors would complicate decision-making and subsequently lower clearance rates. The independent variables in this study were various external factors, including resource allocation, community relations with law enforcement, technology, public perception, training and professional development, and collaboration between different agencies. The dependent variable was the homicide clearance rate, as influenced by these external factors. Twenty experienced homicide detectives (10+ years) from the New Haven Police Department participated in structured interviews, where their responses were categorized based on external factors. ANOVA analysis was used to determine significant differences between these factors. Results indicated that as external factors such as community relations, resource allocation, and collaboration between agencies became more involved in a case, clearance rates increased, contradicting the hypothesis. Notably, training and professional development had the highest correlation coefficient (0.97983), suggesting it is a key factor in solving homicide cases. Public perception, however, had the lowest correlation (0.65863) and was not found to be a significant factor in homicide solvability. These findings suggest that enhancing community engagement, resource allocation, and inter-agency collaboration can improve homicide clearance rates. The research has the potential to help law enforcement agencies optimize resources and refine investigative practices to address the decline in homicide clearance rates.

Amity High School

Teacher: Sarah Reeves

Project # 30

Keating, Riley

Age-Related Serotonin Degradation and Alzheimer's Disease Pathology

Completed Project, Health & Medical

Serotonin, 5-HT, is a neurotransmitter that regulates mood, memory, and behavior. Tryptophan, an amino acid that produces serotonin, has been supported in previous studies to decline in quantity with age. As a result, a decline of serotonin is predicted due to less tryptophan availability. It is predicted that with age, the density of serotonergic neurons and the amount of serotonin present in the brain will progressively decline, potentially contributing to cognitive impairment. When there is a decrease of serotonin in the brain, the functions that serotonin regulates are predicted to decline as well. Due to this, cognitive decline is predicted to be a result of serotonin degradation. Similarly, Alzheimer's Disease causes the decline in memory, mood, and behavior and could also be affected by serotonin degradation. For this study, brain images of mice (age groups of 6M, 12M, & 18M) were obtained by Dr. Boltcreed for a separate study. Images were collected, and the Dorsal CA1 of the hippocampus was used to collect the optical density of serotonergic neurons through analysis of all images on ImageJ. The following regions of the hippocampus were calibrated individually to determine degradation: Stratum Oriens, Stratum Pyramidale, Stratum Radiatum, Stratum Lacunosum Moleculare, and Stratum Moleculare. Once analyzed, the images supported a significant decrease in serotonergic neurons from the 6M to 18M age groups, but no significant difference from 6M to 12M. This decrease of serotonin pathways seen with age can be linked to a decrease in memory, often seen in Alzheimer's disease, supporting the hypothesis.

Darien High School

Teacher: Guy Pratt

Project # 31

Keehlwetter, Lily

Association Between Food Insecurity and Mortality Outcomes Among Cancer Survivors in the United States

Completed Project, Health & Medical

Cancer diagnoses present significant challenges, including physical, emotional, and financial burdens, which are often exacerbated by food insecurity (FI). FI, defined as uncertain access to adequate nutrition due to income, employment, location, and other factors, may adversely affect cancer outcomes, particularly mortality rates. This study examines the association between FI and mortality among U.S. adults with a history of cancer, aiming to highlight disparities and inform public health strategies. Using data from the 2011-2018 National Health Interview Survey (NHIS), FI was assessed with the 10-item USDA Food Security Survey Module, and mortality outcomes were accessed through NHIS-linked death records. Hazard ratios for mortality were calculated, adjusting for sociodemographic variables, to uncover key risk factors contributing to FI-related disparities. This study analyzed 18,574 cancer survivors, revealing 11% that experienced FI, with the most affected being younger, female, non-Hispanic Black or Hispanic, lower-income, and uninsured individuals. FI was associated with increased risks of all-cause and CVD-specific mortality, but not cancer-specific mortality. Comparisons with individuals without cancer showed differences in FI prevalence and mortality risks, emphasizing the vulnerability of cancer survivors with FI. The findings of this research seek to inform policy interventions and public health strategies aimed at reducing FI, ultimately improving survival rates and quality of life for cancer patients across the United States.

Darien High School

Teacher: Janet Keeler

Project # 32

Kelly, bridget

The Effects of Chloramine in Hair Strands

Completed Project, Physical Science

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Ridgefield High School

Teacher: Patrick Hughes

Project # 33

Kholmanskikh, Maria

A Novel Method to Assess Rho GTPase Activity

Completed Project, Health & Medical

Small Rho GTPases are proteins that act as molecular on/off switches. Extracellular signals or intrinsic cellular programs promote GTP loading of Rho GTPases, activating them. In this state, they bind to and activate downstream effector molecules. When Rho GTPases hydrolyze GTP to GDP, they become inactive and cannot transduce signals. Rho GTPases regulate essential processes like cell division, motility, shape, and phagocytosis, primarily targeting the cytoskeleton. Dysregulation of Rho GTPases is linked to diseases such as immune disorders, cardiovascular disease, neurodegeneration, and cancer. Accurate assessment of Rho GTPase activity is crucial for understanding biological processes, disease, pathophysiology, and developing therapeutics. Current methods to evaluate Rho GTPase activity include pull-down assay, bio complementation assay (BCA), and fluorescence resonance energy transfer (FRET) assay. Pull-down assays measure endogenous Rho GTPases but lack cellular resolution and are semi-quantitative. BCA and FRET measure activity in individual cells quantitatively but rely on exogenous sensor molecules. All three methods cannot monitor Rho-GTP interaction with specific effectors, despite evidence that only a fraction are activated at any time. We devised a novel method to monitor Rho GTPase activity using proximity ligation assay (PLA). PLA combines the advantages of pull-down assays (measuring endogenous molecules) with those of FRET and BCA (subcellular resolution and quantification). PLA also enables monitoring Rho-GTP interaction with specific binding partners. We optimized fixation conditions for anti-RhoA and anti-RhoC antibodies, showing specificity using shRNA. We observed a significant increase in PLA signal under conditions promoting Rho-GTP interaction with ROCK1, validating PLA's utility in monitoring Rho GTPase activity.

Darien High School

Teacher: David Lewis

Project # 34

Laryea-Adjei, Sowa

Making a Real-Time Water Quality Monitor

Completed Project, Physical Science

Water contamination is a critical global issue, with around 2.2 billion people lacking access to safe and clean drinking water sources. Contamination from bacteria like Escherichia coli (E. coli) and Salmonella shows significant health risks, like gastrointestinal and urinary tract infections, and even death from cholera if untreated. Contrary to popular belief, this issue is not only prevalent in underdeveloped countries, but also in 40 percent of rivers and 46 percent of lakes here in the United States. Despite the importance of regular water quality testing, high-accuracy equipment remains prohibitively expensive, particularly in lower-income regions. To address this issue, a compact, Arduino-powered water quality testing device was developed to measure parameters such as pH, Oxidation-Reduction Potential (ORP), Electrical Conductivity (EC), Total Dissolved Solids (TDS), and turbidity. The device takes the readings of the sensors and gives a result stating if the water is of good quality or not. The device aims to offer an affordable and portable solution for water quality monitoring. Both the circuit and 3D prototype of the device were designed using Tinkercad. Then I soldered a circuit with the necessary proponents and used foam cores to make the physical prototype. After comparing the readings of the device with a store-product water quality tester, the prototype still needs more modifications on some sensors in order to truly serve its purpose. This project has the potential to improve water monitoring practices, especially in resource-limited regions, by providing a user-friendly tool for regular water quality assessments.

King School

Teacher: Victoria Schulman

Project # 35

Li, Emily

Application of R Shiny to Monitor Intercurrent Events in Clinical Trials

Completed Project, Health & Medical

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Newtown High School

Teacher: Timothy DeJulio

Project # 36

Liu, Phydena & **Zhang, Lauren**

Using Machine Learning and Regression Models to Predict Atherosclerosis in Humans Considering Gene Expression, Sex, and Age as Factors

Completed Project, Teams (Completed Project)

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Avon High School

Teacher: David Lewis

Project # 37

Lonergan, Isabella

Risk Factors Contributing to Knee Osteoarthritis in Women

Completed Project, Health & Medical

Knee osteoarthritis (OA) is a very common condition and affects millions of people today. It is when the knee degrades as the cartilage wears down causing bone to bone contact. When the cartilage in this area wears down there is less space between the bones and eventually they begin to rub together. Rubbing of the cartilage can cause arthritis and result in cartilage loss. Some of the risk factors include age, genetics, previous joint injuries and gender. More women than men develop knee osteoarthritis and while multiple factors have been studied the exact reasons remain unclear due to varying data. Gait biomechanics is a factor that has been studied by researchers however it is still in debate as there is varying data. This study aimed to analyze existing research from journal articles to determine if gait is a significant factor that relates to the higher prevalence of knee OA in women. This research is critical as this can help doctors treat patients like going to physical therapy to correct their gait movement patterns. Early treatment could prevent or slow the progression of knee OA and can reduce pain. Jstor and google scholar were selected to find journal articles on knee OA and gait biomechanics to determine why women are more likely to develop knee OA more than men. It is predicted that the differences in gait between males and females is one of the main factors that contributes to the higher prevalence of Knee Osteoarthritis in females.

Darien High School

Teacher: Christine Leventhal

Project # 38

Louizos, Zachary

Production of Efficient Solar Fuels Using Noncovalent Pi-stacked Organic Framework

Completed Project, Environmental

In 2025, the need for efficient solar power has never been greater. With the issue of combating climate change being at the forefront of science research, the issue of producing renewable and sustainable energy is critical. In the race for the most sustainable energy source, photoreactions that produce efficient fuel sources have emerged as being among the best ways to reverse climate change and create a better global carbon footprint. The geometry and properties of organic framework, specifically that of noncovalent pi-stacked organic framework, plays a major role in the potential stoppage of climate change, as it has the ability to be integrated into systems that output large amounts of the hydrogen and oxygen gas. We optimize this method by testing various solutions containing our framework by way of running photoreactions. Platinum is loaded into the solution containing our organic, and deposits throughout the geometric structure of the porous PiOF. Our net solution is then able to undergo photocatalysis when placed in appropriate conditions of pressure and temperature. We use a 280 Watt Xenon lamp in order to facilitate our photoreaction in our batch reactor. Aiming to create a stable mechanism for the production of hydrogen and oxygen gas by way of water splitting oxidation reduction reactions, KI is used in order to create a level of reversibility within the reaction at hand. This creates an exponential longevity for the PiOF solution than if left only in a non-reversible reaction chamber. Finally, we aim to protect the organics within our solution by conducting efficient methods of photo-atomic layer deposition on our samples of PiOF. The generation of hydrogen gas and oxygen gas over the longest period of reaction suggests a highly efficient photocatalytic system. The magnitude of this breakthrough is massive in the field of solar energy, and will highly contribute to creating a more sustainable future.

King School

Teacher: Victoria Schulman

Project # 39

Lu, Nicholas

Modeling Breast Cancer Invasion Using Active Brownian Dynamics

Completed Project, Physical Science

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Amity High School

Teacher: Sarah Reeves

Project # 40

Maltese, Dillon

Voice-Controlled Robotic Arm for Assisting Complex Surgical Tasks

Completed Project, Physical Science

In the U.S., approximately 250,000 people die from medical errors annually, with over 4,000 due to surgical errors. To reduce this, labs are integrating augmented reality (AR) into operating rooms. However, AR headsets can overwhelm surgeons already managing multiple tasks. To address this, I developed a voice-controlled robotic arm designed to act as an additional hand, reducing multitasking and lowering surgical risks. The arm was designed and 3D printed using hard plastic and powered by Nema23 stepper motors with gearboxes for precise movement control. Initial tests on motion control and stability have been promising, with ongoing adjustments to improve fine motor skills for the hand and wrist. The prototype successfully moves in all directions in 3D space, offering more range of motion than a human arm. Current development focuses on enhancing dexterity for delicate tasks, making it suitable for operating room use. Feedback from surgeons has been positive, with the prototype showing potential for real-world application. This project fits into the broader effort to reduce surgical errors and improve patient outcomes by providing precise and reliable robotic assistance. With continued progress in fine motor control, the arm could revolutionize surgery, allowing surgeons to operate with greater accuracy and fewer complications. This innovative approach not only addresses a critical issue in modern healthcare but also paves the way for further advancements in robotic surgical assistance, improving safety and patient care across a wide range of procedures.

King School

Teacher: Victoria Schulman

Project # 41

Mannan, Zuhayr

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

Completed Project, Physical Science

Biofuel is fuel harvested from an organic source, which is known as biomass, a group that includes fungi and algae, and is typically produced using specialized bioreactors. Two common types of bioreactors, which are classified as vessels that allow biomasses to grow and be harvested in, stirred tank and membrane bioreactors, mix biomass and filter fuel, respectively. However, these systems are financially inefficient due to their reliance on single-organism production and low yields. This project designs a hybrid bioreactor that combines features of stirred tank and membrane bioreactors to produce biofuel using Trichoderma harzianum, Trichoderma viride fungi, and Arthrospira platensis algae. The bioreactor is engineered to allow high-speed water flow without damaging internal components like impellers or filters. It incorporates durable and specialized materials: stainless steel end caps for stability, borosilicate glass for flexibility and transparency in the main tank, carbon fiber tubing for strength and low-density impellers, and a porous polyvinylidene membrane for effective fuel filtration. After assembly with precut materials, the bioreactor is sterilized via steam induction, filled with filtered water, and filled with biomass powders. Over six weeks, the biomass grows and is harvested, with fuel yield measured and compared to hand-extracted biofuel (264 grams). Success is determined by the structural integrity of the bioreactor, the functionality of its membrane filter, and fuel yield compared to the previous yields. If effective, this hybrid design could significantly enhance biofuel production efficiency, making biofuel an economically viable alternative or additive to fossil fuels, with promising implications for sustainable energy.

Amity High School

Teacher: Sarah Reeves

Project # 42

Marin, Eve

Investigating the Effect of Temperature on the time of Degradation of TMA CAA
Polyampholyte Hydrogels

Completed Project, Physical Science

Polyampholyte hydrogels are being developed to serve as synthetic tissues for medical applications. It has been suggested that the hydrogels degrade at increased rates in low pH levels similarly in low pH levels, yet the effect of temperature on the speed of degradation has not yet been tested.The purpose of this study is to determine the effect of different temperatures on the degradation of polyampholyte hydrogels to ensure degradation happens properly and timely at all temperatures a human may experience. It was hypothesized that at a lower temperature, the polyampholyte hydrogels will degrade faster. The independent variable is the temperature the gels kept at. The dependent variable is the weight and length of the gel after 9 days in the solution. Hydrogels were sourced from Dr. Matthew Berndards. A high pH and a low pH liquid was created using water, vinegar and baking soda. The gels were individually placed into the liquids and then 3 groups were formed each containing a gel in high pH conditions and a gel in low pH conditions. One group was placed under elevated temperatures, one group under room temperature and one group under low temperature. The gels placed in the elevated temperature conditions were suggested to degrade faster. This is likely due to the fact that the process of gel degradation is an endothermic process. This understanding of how the gel breaks down helps further understanding about the gel as a whole and advance towards possible implementation into humans.

Amity High School

Teacher: Sarah Reeves

Project # 43

Marti, Nicholas & **McDonald, Isabel**

Ambiguous Images and Personalities

Completed Project, Teams (Completed Project)

Our experiment was intended to show how different people with different personality types perceive "double", or ambiguous, images differently. We sent a google form to the student body of King's Upper School, and polled their responses in organized data sets based on the three general social personality types: introverts, extroverts, and ambiverts. After 114 total responses, we found that introverts most often saw the same image as the majority vote, while extroverts had very extreme, or polar, answers in every direction. Meanwhile, ambiverts usually showed a clear representation of the middle ground, almost perfectly mirroring the total graph in each poll. Because of this, we concluded that introverts are likely to take the least controversial side, while extroverts are confident to go against the majority, even making more impulsive decisions at times. Finally, ambiverts are the most indecisive because many of them do not fit into a clear social norm.

King School

Teacher: Victoria Schulman

Project # 44

Matyszkowicz, Adrian

Analyzing GW170817-like Events and Effects on The Uncertainty of Hubble's Constant

Completed Project, Physical Science

Cosmology, the study of the universe's origin, structure, and evolution, often involves determining the Hubble constant (H0), which describes the rate of cosmic expansion. This study estimates H0 using gravitational wave (GW) data from mock observations of GW170817-like events. GW170817 was the first confirmed binary neutron star (BNS) merger observed by the LIGO and Virgo detectors. Binary neutron stars are significant as their mergers emit both gravitational waves and electromagnetic counterparts, enabling independent distance measurements crucial for cosmology. LIGO (Laser Interferometer Gravitational-Wave Observatory) and Virgo are ground-based observatories that detect distortions in spacetime caused by passing GWs. This study analyzes how increasing the number of mock observations reduces uncertainty in H0 estimates. Mode estimation and sampling simulations were used to synthesize data and determine the number of events required to match the uncertainties of the Planck satellite (1~km/s/Mpc) and the SH0ES (Supernovae and H0for the Equation of State) project (0.5~km/s/Mpc). Results indicate that 60 mock GW170817-like events reduce the standard deviation of H0 to approximately 1~km/s/Mpc. These findings demonstrate that combining multiple GW observations significantly narrows the distribution of H0 estimates. This highlights the potential of gravitational waves to enhance precision in cosmological measurements and deepen the understanding of the universe's expansion.

Darien High School

Teacher: David Lewis

Project # 45

Meier, Makayla

Addressing Burnout Within The Medical Field: Causes, Effects, and Management Strategies

Completed Project, Health & Medical

This project is hoping to combine a holographic projector with an Ai therapist app to make a hologram that can be a therapist. This project is important to the development of AI relationships with humans. If an AI therapist appears three dimensional, then people may have more of a connection to it. This project also helps with the creation of holograms which could, in the future, be another form of entertainment, communication and many more possibilities.

Newtown High School

Teacher: Timothy DeJulio

Project # 46

Meyers, Emma

Correlation Between Depth and Transplantation Success Among 3 Coral Species

Completed Project, Environmental

Coral reefs, essential for biodiversity and economic value, face significant threats leading to degradation and weakening of reefs. Coral transplantation has emerged as a potential strategy for damaged reefs, but its effectiveness varies based on species and environmental conditions, and specifics are not fully known. This study investigates the impact of the depth factor on coral health and growth during transplantation, measured by the area of live coral coverage (cm). Over 100 coral fragments from three species - Diploastrea heliopora, Favia abdita, and Pachsyseris rugosa - were transplanted at varying depths in the ocean - 6 meters, 9 meters, and 12 meters. Data was collected over a month-long period to asses coral growth rates. It was found that 2 of the species grew better in deeper waters and the other grew better in shallower conditions. The statistical analysis of the data will be conducted by performing a two-way ANOVA. This experiment aims to identify optimal conditions for successful coral transplantation and contribute to understanding coral resilience in changing marine environments. By examining the responses of different coral species to varying depths, this research aims to inform effective conservation strategies and improve overall coral reef restoration efforts. Results from this study will provide valuable information into species-specific transplantation success rates and guide future coral reef preservation initiatives in the face of ongoing environmental challenges.

Darien High School

Teacher: Guy Pratt

Project # 47

Moore, Bridget

DI Number of Athletic Trainers and Related Factors

Completed Project, Health & Medical

Catastrophic injuries and fatalities in collegiate athletes, though rare, have implications for the athletes, sports teams, and the athletic community. These incidents, which include severe head trauma, spinal cord injuries, and sudden cardiac arrest, can result in permanent disability, psychological trauma, and death. In Division I athletics, where competition is intense it impacts athletes both physically and mentally. This study examines the relationship between the number of athletic trainers and institutional factors—such as the number of student-athletes, undergraduate population, graduation rate, and student-to-faculty ratio—across the top five NCAA Division I conferences: Atlantic Coast Conference, Big Ten Conference, Big 12 Conference, Pacific-12 Conference, and Southeastern Conference versus the bottom five NCAA Division I conferences: Southwestern Athletic Conference, Southland Conference, Ohio Valley Conference, Big Sky Conference, and Colonial Athletic Association. Results indicate a significant correlation between Division I Conference and the number of athletic trainers suggesting that the institutional factors have an impact.

Darien High School

Teacher: Janet Keeler

Project # 48

Nardi, Sophia

The Effect of Chronic Versus Need-Based Stimulant Use on Sensitivity to Natural Reward in Drosophila Melanogaster

Completed Project, Behavioral

This study investigates the impact of chronic versus need-based stimulant exposure on sensitivity to natural reward in Drosophila melanogaster, focusing on reproductive and foraging behavior. The hypothesis posits that chronic caffeine exposure reduces sensitivity to natural rewards compared to need-based or random exposure due to diminished dopamine production. Three experimental groups were established: a control group with no caffeine exposure, a need-based group receiving caffeine biweekly, and a chronic use group receiving daily caffeine. All treatments began at the larval stage and continued for 25 days, after which caffeine was discontinued for the experimental groups. Behavioral changes, including reproductive success and foraging activity, were monitored and analyzed using infrared video footage and statistical comparison to the control group. Preliminary implications suggest that chronic stimulant use may lead to lasting alterations in reward sensitivity, providing insights into potential long-term effects of stimulant medication. These findings could inform parental decision-making regarding ADHD stimulant prescriptions, particularly in children with developing prefrontal cortices, where dopamine pathways are critical. Further analysis will elucidate the relationship between stimulant exposure and vulnerability to dopamine-related dysfunction, contributing to broader discussions on the risks and benefits of stimulant medications.

Ridgefield High School

Teacher: Ryan Gleason

Project # 49

Nomani, Noor

Beta-Blockers Effectively Decrease Insulin-Induced Tachycardia: Potential Combination Therapy for Diabetics with Cardiovascular Disease

Completed Project, Health & Medical

A key factor contributing to cardiovascular disease (CVD) in diabetics is dysregulated heart rate, often triggered by hyperglycemia or insulin use. Synthetic insulin, essential for managing diabetes, can release catecholamines like norepinephrine, causing tachycardia (Christensen, 1983). Managing this cardiostimulatory effect without compromising glycemic control is vital (McGill, 2009). Beta-blockers, which block catecholamine effects, are commonly used for heart rate regulation. Identifying the best beta-blocker for diabetics to counteract insulin-induced tachycardia without interfering with glucose regulation is crucial. Three beta-blockers—Labetalol, Metoprolol, and Propranolol—were analyzed. Daphnia, whose heart rhythm regulation shares similarities with humans, were used for experimentation. After drug administration, their heart rates were recorded over 24 hours and compared. Propranolol emerged as the most effective, closely matching the control heart rate without drugs while maintaining better living conditions. Labetalol, although statistically similar, caused significant weakness and high mortality. Metoprolol's effects were closer to the insulin group than the control. Propranolol demonstrated superior quantitative and qualitative outcomes, making it the most promising option for reducing CVD risk in diabetics.

King School

Teacher: Victoria Schulman

Project # 50

Patel, Aakarsh

Projections of Critical Global Warming Thresholds in Connecticut Using Data Analytics

Completed Project, Environmental

In today's world climate change is a major threat that affects us in various ways, such as rising temperatures, extreme weather events, rising sea levels, and greenhouse gas emissions. Therefore, this research hopes to create a model that is able to predict these changes up to 2050 under different scenarios. In order to create the model I used historical data and applied regression analysis and scenario analysis using Google Collab and Python libraries. The models will be evaluated based on the Mean Squared Error and R^2 error. MSE measures the average squared difference between predicted and actual values, indicating the model's accuracy, while R^2 shows how well the model's predictions explain the variability of the actual data. After I analyzed the results and provided recommendations for policymakers and how to improve the sustainability of Connecticut, this research not only aims to contribute to the scientific understanding of climate change impacts at a regional level but also seeks to raise awareness and inspire proactive measures within the state. By highlighting the potential future scenarios and their implications, the study hopes to drive informed decision-making and foster a more sustainable future for Connecticut.

Ridgefield High School

Teacher: Ryan Gleason

Project # 51

Petrizzo, Allison

PFAS Detection in Athletic Uniforms

Completed Project, Environmental

Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals that are added to textiles to provide physical properties such as water repellency and stain resistance. In this study, a total of 24 athletic uniforms from the New York and Connecticut areas and University of Notre Dame athletes were analyzed for the presence of PFAS. Firstly, the samples underwent PIGE analysis to determine the presence of fluorine. Secondly, LCMS was used to determine the types of PFAS which were present in the uniforms. Results from PIGE determined that no uniforms contained very high levels of PFAS but some showed indications of PFAS. These results suggest that more tests must be completed to determine the overall presence of PFAS in athletic uniforms. An increase in widespread regulation is needed in the United States to ban PFAS use in textiles to prevent direct PFAS exposure.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 52

Prince, Lucas

Comparing Patient Quality of Life in the First 12 Months Post-Op of Bone Regrowth and Metal Implant Surgeries

Completed Project, Health & Medical

Sarcomas, a type of tumor, can develop in both hard and soft tissues of the body due to uncontrolled cancerous cell growth. When sarcomas affect bones, standard treatment involves a combination of chemotherapy and surgical intervention to excise the tumor. Two primary surgical approaches are employed in such cases: natural bone regrowth and metal implant surgery. It is generally assumed that metal implants offer a faster recovery compared to the natural bone regrowth method. This study challenges the prevailing assumption by investigating whether there is a significant difference in the quality of life and recovery rates between patients undergoing the two surgical methods within the first twelve months following surgery. It was predicted that there would be no statistical difference in the recovery of the two groups. Lab and on-site physical performance test data were collected from MSKCC 2018-2025 (ongoing) and analyzed in 2024/2025 using the coding language R for data organization and visualization. It was found that when looking at mineral concentrations in the bloodstream and performance on physical fitness and ability tests for range of motion and percent weight bearing on the affected limb, two signs of recovery and quality of life of patients, there was no statistical difference between patients who had undergone the two different surgery methods. Focusing on the initial twelve-month postoperative period is particularly relevant for patients with less favorable cancer treatment outcomes, as it may guide their decision toward a surgical option that optimizes short-term quality of life.

Darien High School

Teacher: Christine Leventhal

Project # 53

Quadri, Meher

Determining the Effects of Daily Inclusion of Two Eggs in a DASH Diet on Endothelial Function, Cardio-Metabolic Risk Factors, and Diet Quality of Patients with Type 2 Diabetes.

Completed Project, Health & Medical

This study evaluated the impact of daily egg consumption within the Dietary Approach to Stop Hypertension (DASH) diet on cardio-metabolic risk factors in adults with hyperlipidemia. In a randomized, controlled, single-blind, crossover trial, 45 adults (mean age 59.5 years; 35 women, 10 men) were assigned to follow either the DASH diet with two eggs daily or the DASH diet without eggs for 8 weeks, with an 8-week washout period between treatments. Participants received dietitian guidance to maintain an isocaloric intake. Primary outcomes included LDL cholesterol and endothelial function, while secondary outcomes measured insulin sensitivity, lipid profiles, blood pressure, C-reactive protein, and dietary intake. The results showed no significant differences in endothelial function or LDL cholesterol between the DASH diet with eggs and without eggs. However, egg inclusion increased choline intake and reduced carbohydrate intake. These findings indicate that incorporating eggs into the DASH diet provides nutritional benefits without adversely affecting cardio-metabolic health in adults with hyperlipidemia. This highlights the importance of dietary patterns tailored to support cardiovascular health.

Amity High School

Teacher: Sarah Reeves

Project # 54

Reinhoefer Ribeiro, Bruno

An Effective Water Treatment Method: Adsorption of Ni(II) Ions in Water Using DNA-Wrapped Carbon Nanotubes

Completed Project, Physical Science

As of 2024, 1 in 4 people globally lack access to safe drinking water. According to the UN, in 2021 over 40% of 75,000 bodies of water in 89 countries were found to be severely polluted. As a result, it is imperative to develop efficient, sustainable, and cost-effective solutions for wastewater treatment. Current water treatment methods such as ultrafiltration or ion exchange are costly and high-maintenance. Recently, adsorption of chemical pollutants in water has earned much attention because of its low cost, high efficiency, and fast reaction time over a variety of environmental conditions. Adsorption is the chemical or physical adherence of a smaller molecule onto the surface of a larger adsorbent. Herein, carbon nanotubes (CNTs), carbon ring arrays rolled into tube-like structures at the nanoscale, were wrapped with single-stranded DNA and used as adsorbents. CNTs have noteworthy properties such as high thermal stability, tensile strength, and surface area, making them versatile adsorbents. DNA wrapping resolves two major challenges CNTs face: insolubility and aggregation among CNTs, which can greatly hinder efficacy. We aimed to establish DNA-wrapped CNTs as competent adsorbents. Concentration of nickel-II ions in aqueous solution was measured before and after CNT incorporation to determine adsorption effectiveness. It was found that 1.2×10^{-5} μmols CNTs adsorbed 53 μmols Ni^{2+}. This establishes DNA-wrapped CNTs as effective adsorbents, particularly of toxic metal ions in water. Given these findings, this approach has the potential to treat large bodies of metal-contaminated water if scaled up on a commercial level.

King School

Teacher: Victoria Schulman

Project # 55

Roth, Cooper

Force needed from an object to fly at a reative speed

Completed Project, Physical Science

The aviation industry is a major contributor to global carbon emissions, with aircraft responsible for approximately one billion tonnes of carbon dioxide annually. As the need for sustainable aviation solutions grows, understanding the energy requirements of aircraft is essential for advancing renewable energy alternatives. This study aims to develop a universally applicable formula for determining the force required to sustain an aircraft's speed, with the potential to replace fossil fuels with renewable energy sources. Currently, the Lift formula, a key component of aerodynamics, calculates the lift generated by an aircraft but does not directly address the energy or force required for flight. This experiment used a remote-controlled (RC) plane to simulate aircraft flight dynamics. The mph was determined by timing the speed at which the RC plane would fly 50 yards A throttle-to-speed ratio was calculated to investigate the relationship between speed and power output. By analyzing these data, the study seeks to establish a formula that can predict the force, measured in newtons, necessary for an aircraft to maintain a specific velocity based on its weight, wing area, and other relevant factors. The findings of this research may provide critical insights for optimizing aircraft energy consumption and contribute to efforts to reduce carbon emissions in aviation.

King School

Teacher: Victoria Schulman

Project # 56

Santin, Matteo

Assessing the Efficacy of Datopotamab Deruxtecan by Testing the Viability of Endometrial Endometrioid Cancer Cell Lines After Exposure to Scalar Concentrations of the Antibody-drug Conjugate

Completed Project, Health & Medical

Endometrial endometrioid cancer (EEC) is the most prevalent gynecologic cancer in the United States with about 66,000 cases in 2023. TROP2 expression is found in over 80% of endometrial cancers. The development of novel and effective targeted therapies remains an unmet medical need. This research project evaluated the preclinical activity of datopotamab deruxtecan (Dato-Dxd), a novel TROP2 targeting antibody drug conjugate (ADC) in EEC cell lines with variable TROP2 expression. A total of 10 EEC cell lines were evaluated by flow cytometry (FACS) for the surface expression of TROP2 using the antibody Datopotamab. End(k)265 was selected as 3+ TROP2 expressor while end(k)34 was selected as a negative TROP2 expressor. In vitro cell viability with Dato-DXd was assessed using flow-cytometry based assays against these two primary cell lines. Out of 10 cell lines tested, 30% showed 3+ expression of TROP2 while 70% demonstrated a negligible (i.e. 0) expression. Dato-Dxd was significantly more potent in inducing cell death than control ADC in TROP2 3+ expressor cell line end(k)265. Specifically, mean IC50 value for Dato-Dxd was 8.83µg/ml and T-test results demonstrated that there was significance in P value compared to the ADC control (P = 0.0022). In contrast, the representative TROP2 non-expressing cell line end(k)34 did not demonstrate significant cell death with either Dato-Dxd or control ADC (P = 0.2401). Dato-DXd shows promising preclinical activity against TROP2 overexpressing endometrial endometrioid cancers. This preclinical data shows in vitro efficacy of Dato-Dxd and further experiments evaluating in vivo activity of the drug in mouse models harboring EEC overexpressing TROP2 will be necessary to determine drug efficacy and its potential toxicity before being administered to patients. If additional in vitro experiments and the in vivo data confirm the efficacy of Dato-Dxd, this project could support the use of Dato-Dxd in clinical trials where EEC patients overexpressing TROP2 could receive a new and effective treatment.

Amity High School

Teacher: Sarah Reeves

Project # 57

Scanlon, Madeline

Assessing the Public's Awareness and Susceptibility to Cyber Attacks

Completed Project, Behavioral

In 2023, the Internet Crime Complaint Center reported over 21,000 Business Email Compromises with losses over $2.9 Billion. Even today, phishing stands as the most frequent method of cybercrime, with over 3.4 million baiting emails sent daily (Jumpcloud). Recent advancements in AI, such as ChatGPT, have enabled the creation of more sophisticated phishing emails and sites at unprecedented speeds (Jumpcloud). On average, worldwide, it is suggested that it takes more than 49 days to identify a ransomware attack (National University). Despite the increasing efforts for awareness against cyber crimes, many individuals fall victim frequently to cyber attacks. This research investigates public awareness of phishing attacks and examines the ability to identify these threats across various demographic factors, including age, race, education, and technology use. Through the use of a survey, this project explored how trust in technology and phishing awareness interact to inform vulnerabilities and guide strategies for mitigating cyber risks. It was discovered that there are no clear patterns of differences across demographic groups, indicating a consistent, universal vulnerability to phishing attempts. These findings emphasize that susceptibility to cyber attacks are not confined to any specific group but rather a widespread challenge that calls for immediate attention. Addressing this universal vulnerability can drive the development of more effective cybersecurity practices and awareness education, ultimately reducing the impacts of cyber phishing and improving digital safety.

King School

Teacher: Victoria Schulman

Project # 58

Shrivastav, Armaan

Visualizing Dropwindsonde Data of Small-Scale Features in Three Dimensions to Document the Role of These Features on Tropical Cyclone Intensity Change

Completed Project, Physical Science

Small, fast-moving structures in tropical cyclone (TC) eyewalls have been observed. These small-scale features (SSF) may mix high-entropy air from the eye to the eyewall, increasing TC intensity. The purpose of this project was to visualize dropwindsonde data of SSF in the eyewalls of intense tropical cyclones to understand their role in intensity changes. The hypothesis was that higher measurement of the characteristic of the SSF would correlate with rapid TC intensification due to energy exchange. The independent variable was dropwindsonde data sets showing theta-e, radial velocity (RD), and vertical velocity (VV) of SSF. The dependent variable was TC intensity change, measured by comparing SSF atmospheric values to find evidence of eye-eyewall mixing that intensifies the TC. The dropwindsonde data of rapidly intensifying Category 4 and 5 TCs was organized in Excel, with missing values removed. Using Plotly, variations in theta-e, RD, and VV over the dropwindsonde's trajectory were visualized in 3d. Wind-speed maxima were identified in any potential vortex. Results showed that as altitude increased, RD became positive, indicating eye-eyewall mixing, VV varied (up to 10 m/s), and theta-e increased (up to 6K), indicating high energy at wind-speed maxima. The presence of high-energy jets indicated SSF and outward energy transfer supported eye-eyewall mixing, reinforcing the hypothesis that higher SSF characteristics contribute to TC intensification. This project can lead to improved TC models and forecasts by identifying SFF, enhancing understanding of intensification, and enabling better warnings to reduce TC impacts on communities.

Amity High School

Teacher: Lindsay McCarthy

Project # 59

Shrivastav, Aryan

Developing a Machine-Learning Driven Wearable Vest for Early Diagnosis and Management of Chronic Obstructive Pulmonary Disease through Vitals Analysis

Completed Project, Health & Medical

Chronic Obstructive Pulmonary Disease (COPD) is a progressive lung disease characterized by breathing difficulties and poor airflow, affecting millions globally. Current detection methods, like spirometry and imaging, are often expensive, invasive, and inaccessible in low-resource settings. While non-invasive methods exist, they lack affordability and comprehensive monitoring, highlighting the need for a more accessible and effective solution to manage this debilitating disease. The purpose of this project was to develop a cost-effective, non-invasive wearable vest that uses machine learning to detect and manage COPD early through vitals monitoring. Models were trained on health datasets using binary classification algorithms such as Random Forest, XGBoost, and Logistic Regression. The vest was constructed with embedded sensors, circuits, and microcontroller-based integration to analyze data for real-time assessment. Among the machine learning models tested, Random Forest achieved the highest accuracy (100%), outperforming XGBoost (98%), Voting Classifier (97%), LightGBM (96%), and Logistic Regression (91%). Sensor-based vitals monitoring showed high accuracy across most metrics: heart rate (0.6 bpm MAE), respiratory rate (0.4 bpm MAE), and SpO_2 (0.8% MAE), though temperature measurements were less precise (7.0 °C MAE). The vest demonstrated reliable vitals tracking consistent with established studies on sensor-based health monitoring. The findings confirmed that the wearable vest could effectively monitor vitals and support COPD diagnosis, validating the hypothesis. Future research should explore diverse datasets, optimize sensor placement, and test the vest in real-world settings. This innovation has the potential to enhance remote health monitoring and improve COPD management, especially in resource-constrained regions.

Amity High School

Teacher: Lindsay McCarthy

Project # 60

Slocum, Ann

The Effect of Gender, Age, and Costoclavicular Symmetry or Asymmetry on the Costoclavical Interval for Neurogenic Thoracic Outlet Syndrome (nTOS) Patients

Completed Project, Health & Medical

Thoracic Outlet Syndrome (TOS) is a condition when there is compression in the thoracic outlet. Neurogenic TOS (nTOS) occurs when the brachial plexus nerve is compressed. The costoclavical interval, one of three passages that lead to the thoracic outlet, is also where compression occurs. nTOS is often misdiagnosed, leading to delay in proper treatment. This experiment aims to identify factors that affect the development of nTOS to help proper diagnosis by using MRI images. This is the first time MRI data has been used to examine the costoclavical interval and its relationship to nTOS. If women develop nTOS more frequently than men, then females will have a smaller costoclavical interval, as nTOS patients have a compressed costoclavical interval. Previous studies have shown that nTOS patients are predominantly ages 20-40. Examining the age of the patient at diagnosis may demonstrate that over time the costoclavical interval will widen as the ribs and shoulder girdle will change. Furthermore, previous studies have examined the costoclavical interval of the affected arm, but have not inspected this interval bilaterally. If nTOS narrows the costoclavical interval, then the affected costoclavical interval of nTOS patients is likely narrower than the unaffected costoclavical interval. Deidentified MRI data of nTOS patients was used to create correlation tests, one sample t-tests, and two sample t-tests. It was found that females have a statistically smaller costoclavical interval, the interval widens with age, and the affected side is narrower than the unaffected.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 61

Smith, James

<u>Molecular Signaling Differences in Systemic and Discoid Lupus Erythematosus</u>

Completed Project, Health & Medical

Systemic Lupus Erythematosus (SLE) and Discoid Lupus Erythematosus (DLE) are lupus subtypes with distinctive disease manifestations and genetic profiles. This study aims to investigate the differential expression of interferon alpha/beta signaling in B cells of SLE and DLE patients. We hypothesize that SLE will have an increase in alpha/beta signaling compared to DLE due to SLE's pathogenesis. This hypothesis was investigated by analyzing clinical single-cell RNA sequencing (scRNAseq) data. In lupus, B cells are hyperactive and create autoantibodies that attack the body's own cells. Due to B cells' known role in lupus, they were chosen as the target cell type for this study. The B cell populations for each patient were computationally isolated and analyzed for differential gene expression. Gene Set Enrichment Analysis (GSEA) revealed that, in SLE, there is a statistically significant increase in the expression of interferon-alpha/beta signaling compared to DLE. This increase concurs with the systemic, multi-organ tenacity of SLE compared to the localized skin lesions created by DLE. These findings support interferon-alpha/beta signaling as a potential therapeutic drug target for SLE and support the need for further research in the signaling pathways of DLE.

Darien High School

Teacher: David Lewis

Project # 62

Stannard, Charlotte

Investigating the Correlation Between BRCA Co-expressed Genes and Survival Rate in High Grade Serous Ovarian Cancer Patients

Completed Project, Health & Medical

Ovarian cancer is the leading cause of death among gynecologic malignancies in the United States. Screening methods are lacking, and early detection of this disease is difficult, leading to approximately 70% of cases diagnosed at advanced stages. BRCA1 and BRCA2, two important genes implicated in ovarian cancer, produce proteins to repair damaged DNA. When these genes are mutated, genetic stability is impacted, increasing the likelihood of ovarian cancer. This project identified genes co-expressed with BRCA1 and BRCA2 and investigated correlation with survival. The student identified BRCA1 and BRCA2 correlated genes from 4 databases and cross-analyzed to find the most frequently appearing genes. A cohort of ovarian cancer patients was created to quantify expression levels of these genes. Python code was written to extract expression levels for identified co-expression genes and corresponding survival status. A regression analysis was performed creating a model to analyze correlated BRCA1 and BRCA2 co-expression genes in relation to survival status. The model accurately predicted if a patient would be dead 85.31% of the time and if a patient would be alive 37.11% of the time and in total if the patient would be dead or alive 65.83% of the time. This model can be used to input gene expression levels of patients newly diagnosed with ovarian cancer to predict the probability of death or survival and inform clinicians when evaluating therapeutic options.

Amity High School

Teacher: Lindsay McCarthy

Project # 63

Thorburn, Grant

<u>Predicting Salt Levels in Connecticut Freshwater Streams</u>

Completed Project, Environmental

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Ridgefield High School

Teacher: Ryan Gleason

Project # 64

Tian, Sarina

Investigating the Relationship Between Diabetic Kidney Disease and Kidney Cancer Using RNA Sequencing Analysis

Completed Project, Health & Medical

Diabetic kidney disease (DKD) is a significant complication of diabetes that damages the kidneys and increases the risk of kidney cancer. However, the genetic mechanisms linking DKD to kidney cancer remain poorly understood. This study utilizes RNA sequencing to analyze gene expression patterns in DKD patients and healthy controls, aiming to identify genes shared between DKD and kidney cancer. Comparing RNA sequencing data will pinpoint differentially expressed genes that may play a role in the progression from DKD to kidney cancer. Identified genes will be visualized through volcano plots to highlight significant expression differences. Understanding these shared genetic pathways could contribute to earlier detection methods, improve diagnostic tools, and ultimately enhance patient outcomes by mitigating the risks of kidney cancer in DKD patients

Amity High School

Teacher: Sarah Reeves

Project # 65

Travaglini, Catherine

Caffeine's Effect on Plant Growth

Completed Project, Environmental

Caffeine's Effect on Plant Growth Catherine Travaglini Ridgefield High School, Ridgefield, Connecticut Euan Hunter, Ridgefield High School, Sponsor This project investigates the effect of caffeine on the growth and lifespan of Lima bean plants. The study aims to determine the maximum and minimum threshold concentrations of caffeine that influence these traits in the plants. Lima bean seeds were exposed to 0%, .5%, 1%, and 2% (in mg) of caffeine, and their growth was measured over three weeks (16-21 days). The collection of data included recording the height, number of leaves on the plants, color, and overall stability. The anticipated results will show the optimal results in these categories in the 1% mg of caffeine, whereas the other levels will either have zero effect on the plant or will exceed the maximum threshold and harm the lima bean lifespan. The implications should demonstrate the effect caffeine has on other organisms outside of human testing and will reveal where/what the maximum threshold of caffeine is before the plants experience harm. This study is expected to contribute to both environmental and agricultural methods and can affect how caffeine is disposed of, as well as the methods that can be used to benefit plant health.

Ridgefield High School

Teacher: Ryan Gleason

Project # 66

Valji, Allison

Confirming TESS exoplanet candidates and searching for multi-planetary systems using transit photometry and timing variations

Completed Project, Physical Science

Determining the habitability of exoplanets, which are planets outside the Solar System, and studying multi-planetary star systems have long been the goals of many astronomers, but first exoplanets must be discovered. The Transiting Exoplanet Survey Satellite (TESS) is a space telescope that searches for exoplanets using the transit method, or the indirect observation of exoplanets via the change in brightness of the star when the planet passes in front. Transit observations can be displayed graphically on a light curve, or brightness over time graph. Once a transit is detected by TESS, the planet is considered to be an exoplanet candidate, but some candidates can turn out to be false positives rather than planets. This study used the Phillips 24" Telescope at the Mt. Lemmon SkyCenter Observatory to perform follow-up transit observations, and then used the open-source software AstroImageJ to create light curves. The existence of exoplanets in the TOI-1858, TOI-1832, and TOI-3856 systems was confirmed. Possible transit timing variations were found in the TOI-1832 system, and a larger unknown object was found in the TOI-3856 system, indicating the potential existence of two multi-planetary systems. Also, the planetary radii of the targets were determined. Confirming candidates, and finding new planets through transit timing variations, allows astronomers to create a list of confirmed exoplanets which can be used to conduct follow-up studies to investigate planetary compositions and orbital architectures of multi-planetary systems. Studying star systems and exoplanets like these gives researchers insight into how our own solar system is different from others.

Darien High School

Teacher: Christine Leventhal

Project # 67

Veeder, Samantha

Host Immune Response Post-QUAD Molecularly Targeted Treatment Promotes Tumor Regression in Dogs with Naturally Occurring Glioblastoma

Completed Project, Health & Medical

Glioblastomas (GBM) are aggressive brain tumors in both humans and canines, presenting significant therapeutic challenges due to the blood-brain barrier (BBB), an immunosuppressive tumor microenvironment, and tumor cell heterogeneity. We have developed a novel QUAD therapeutic strategy that simultaneously targets four tumor-associated receptors with a single agent, showing direct tumor cytotoxicity in animal models of GBM. Additionally, QUAD treatment may initiate tumor immunogenic cell death (ICD) through the release of damage-associated molecular patterns (DAMPs) like high mobility group box 1 (HMGB1), triggering immune responses. We hypothesized that QUAD treatment would upregulate HMGB1 expression and activate ICD pathways, which would be associated with tumor reduction and improved survival in canine GBM. To test this, six dogs with naturally occurring GBM were treated with QUAD via direct intratumoral delivery. Blood samples were analyzed for HMGB1 expression using ELISA, and tumor mRNA expression was profiled with an 800-gene immuno-oncology platform. Dogs were followed for up to one year with clinical assessments and brain MRI scans.Preliminary results indicate that 66% of dogs survived at least 7 days post-treatment, while 33% passed after this period. Tumor reduction was observed, demonstrating the potential efficacy of the QUAD approach. This innovative strategy bypasses the BBB, targets multiple tumor receptors to address heterogeneity, and stimulates an adaptive immune response. Further investigation into the immune response triggered by QUAD could enhance patient outcomes, particularly when combined with other immunotherapies.

Darien High School

Teacher: Guy Pratt

Project # 68

Vohra, Roopshi

How nutritive versus non-nutritive sweeteners affect sleep quantity in drosophila melanogaster.

Completed Project, Health & Medical

Artificial sweeteners, widely used as low-calorie sugar substitutes, have become increasingly prevalent in modern diets over recent decades. While they are often associated with weight management benefits, their potential physiological effects remain underexplored. Sleep, a critical physiological process for maintaining metabolic homeostasis, cognitive function, and overall health, has not been widely studied in relation to artificial sweetener consumption. This study investigates the impact of nutritive (sucrose) and non-nutritive (sucralose, aspartame) sweeteners on sleep quantity in Drosophila melanogaster, a well-established model organism for sleep research. The hypothesis posits that artificial sweeteners may disrupt sleep patterns. The groups exposed to artificial sweeteners (sucralose, aspartame) will exhibit the most significant deviations in sleep quantity compared to the control group. Using a liquid food media system infused with 5% sweetener solutions, flies were divided into control and experimental groups. Sleep activity was quantified across three intervals (Days 1, 3, and 5) using infrared cameras to record 24-hour activity, with sleep operationally defined as periods of inactivity lasting five or more minutes. Preliminary findings suggest that artificial sweeteners alter sleep duration compared to the control group, highlighting potential physiological trade-offs associated with their consumption. These results may hint at a possible role of artificial sweeteners in disrupting the gut microbiome, a factor that warrants further investigation to better understand how dietary choices influence essential processes like sleep and overall health.

Ridgefield High School

Teacher: Patrick Hughes

Project # 69

Viswanathan, Shreya

Discovering Pathogenic Gene Variants in Individuals with a Family History of Recessive Muscular Dystrophy Using Associative Analyses

Completed Project, Health & Medical

Despite advancements in genetic diagnostics, many patients with rare diseases like muscular dystrophy remain undiagnosed, hindering timely treatment. This study aimed to determine whether data analysis methods could identify genes associated with undiagnosed muscular dystrophy (MD) cases. By analyzing genetic datasets, patients with uncertain diagnostic classifications were isolated through a stepwise filtering process, excluding known carriers and individuals diagnosed with dominant, recessive, or X-linked forms of MD. Pivot charts and associative analyses revealed five key genes—PLEC, RYR1, AMPD1, SYNE1, and SYNE2—as the most frequently associated with undiagnosed MD cases. Notably, RYR1 was the most prevalent in both dominant and recessive forms of the disease, while DMD was the most frequent in X-linked recessive MD. The study highlighted PLEC as the top gene associated with undiagnosed patients, with many variants of uncertain significance (VUS), underscoring its complex pathogenicity. Variants within PLEC shared consistent features, including alignment to reference sequence NM_000445.4, occurrence within the coding sequence, and position-specific point mutations. These findings suggest that undiagnosed MD may involve diverse genetic etiology, necessitating advanced sequencing and bioinformatics tools to capture and interpret such diversity effectively. This study emphasizes the importance of including PLEC in diagnostic panels and conducting further functional and clinical studies to clarify its role in undiagnosed MD. The results could improve genotype-phenotype correlations, leading to better predictions of disease progression and personalized treatment strategies for affected individuals.

Amity High School

Teacher: Lindsay McCarthy

Project # 70

Wang, Teresa

Investigating the Genotoxicity of MSG in Drosophila Melanogaster

Completed Project, Health & Medical

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Weston High School

Teacher: Stacey Greenberg

Project # 71

Wang, Leon

Treating APOE4-induced TGFβ-mediated Perivascular Fibrosis-driven Blood-Brain Barrier Dysregulation, Cerebral Amyloid Angiopathy, and Alzheimer's Disease with Pulmonary Fibrosis Drugs

Completed Project, Health & Medical

Alzheimer's disease (AD) is a debilitating form of dementia and affects 416 million patients worldwide. Estimates show that by 2060, 13.8 million people will die from Alzheimer's Disease each year without the development of effective treatments. Novel treatments for Alzheimer's disease are required to address the urgent medical need for AD treatments and improve the prognosis of millions of patients worldwide. The most common genetic risk factor for AD is the APOE4 gene, with homozygous carriers of the APOE4 gene being up to twelve times as likely to develop AD as their APOE3/3 counterparts. Among AD patients, more than 90% of AD patients suffer from cerebral amyloid angiopathy (CAA), which dysregulates the blood-brain barrier (BBB) and causes acute neurodegenerative symptoms associated with AD. Additionally, BBB is dysregulated via mural cell fibrogenesis. Thus, we established the relationship between TGFβ-mediated perivascular fibrosis and vascular amyloidosis in APOE4 iPSC-derived mural cells and utilized FDA-approved idiopathic pulmonary fibrosis (IPF) drugs, nintedanib and pirfenidone, to rescue BBB dysregulation and fibrogenesis and assess their applications in treating CAA. Here, we report that these two IPF drugs reduced fibrotic biomarkers in mural cells, suggesting that these drugs could prevent BBB dysregulation and potentially act as an upstream inhibitor of CAA. This opens up a promising new direction for treating CAA and APOE4-induced AD, which could help millions of AD patients and families worldwide.

King School

Teacher: Victoria Schulman

Project # 72

Weiss, Brian

Evaluating Market Efficiency Through Deep Learning: A Performative Analysis of LSTM Neural Networks, Actor-Critic Reinforcement Learning Models, and Technical Indicators

Completed Project, Physical Science

Stock market inefficiencies provide opportunities for traders to achieve returns above market averages. However, these inefficiencies are quickly exploited, making their identification and practical application challenging. Previous studies have utilized Long Short-Term Memory (LSTM) neural networks for stock price prediction, yet they often face two critical limitations: reliance on normalization methods that incorporate future data, rendering them unsuitable for real-world trading, and a focus on prediction accuracy without addressing how these predictions translate into actionable trading strategies. This study addresses these limitations through a two-step approach. First, it employs a rolling normalization technique that relies solely on historical data, ensuring real-world applicability. Second, it integrates predictive modeling with a trading framework to bridge the gap between theoretical predictions and practical decision-making. Additionally, the research explores the comparative effectiveness of conventional and unconventional technical indicators to assess their ability to identify market inefficiencies. Using EUR/USD data at 5-minute and 15-minute intervals from 2019-2024, the study develops a dual-model system comprising an LSTM-based predictor and a Deep Q-Network reinforcement learning agent. The choice of 5-minute and 15-minute time frames test the hypothesis that shorter intervals are more effective at uncovering transient market inefficiencies than longer intervals. Preliminary results indicate that unconventional indicators outperform conventional ones in identifying market inefficiencies. Furthermore, these timeframes show the potential advantages for exploiting these inefficiencies. By combining technical indicator analysis with actionable trading strategies, this research advances the practical applications of artificial intelligence in finance, providing valuable insights for both academic research and professional trading practices.

Joel Barlow High School

Teacher: Paul Testa

Project # 73

Weng, Mingze (Steven)

<u>Using Seed Trait Analysis to Determine Suitability for Lumbricus terrestris Earthworm-Driven Suppression of Common Weeds in the United States</u>

Completed Project, Environmental

Earthworms, such as Lumbricus terrestris, play a role in weed management by consuming seeds based on traits like oil content, size, shape, and hardness. This study hypothesized that Lumbricus terrestris in U.S. soils would preferentially consume weed seeds that were high in oil content, small, spherical, and soft, aligning with feeding preferences observed in other regions. However, limited research exists on this topic. To test this hypothesis, the study analyzed seeds of 10 common U.S. weeds: Taraxacum officinale (dandelion), Digitaria sanguinalis (crabgrass), Trifolium repens (white clover), Plantago major (plantain), Stellaria media (chickweed), Portulaca oleracea (purslane), Chenopodium album (lambsquarters), Cyperus esculentus (yellow nutsedge), Setaria faberi (giant foxtail), and Glechoma hederacea (creeping charlie). Seed traits were scored using data from three databases (Seed Information Database, TRY Plant Database, USDA ARS National Plant Germplasm System) and evaluated through a Pugh matrix. Oil content was weighted highest, followed by size, shape, and hardness. The results showed that Taraxacum officinale had the highest score due to its high oil content, which is a key factor for seed predation. All other weed species had similar, lower scores. The hypothesis was not supported, because only Taraxacum officinale exhibited traits strongly aligning with Lumbricus terrestris preferences. Although the study estimated the likelihood of seed consumption, it did not include direct feeding data. It concluded that Taraxacum officinale was the most susceptible species to seed predation, but further research on actual consumption rates was recommended.

Amity High School

Teacher: Sarah Reeves

Project # 74

Wright, Elayna

Synthetic Turf Field's Effect on Water Feature

Completed Project, Environmental

Synthetic turf fields are made up of rubber often sourced from tires found on cars. These Tires are known to contain various chemicals and toxins, such as arsenic, cadmium, lead, and nickel. These chemicals pose a high health risk to the environment. This has not been sufficiently studied with water bodies. This research aims to investigate the effect of synthetic turf fields, Especially the one located at Tiger Hollow Stadium at Ridgefield High School. This field has a water runoff behind it, known as the Titicus River. The study is conducted in two phases. The first is an in-lab experiment. Turf samples are collected from the field and left undisturbed in distilled water for 4 weeks. After the 4 weeks, the water samples are tested for any presence of toxins. The second experiment takes place near the Titigcus River. Water samples are pulled upstream, and the distances of the water pull are measured. The results of this study will prove that Synthetic turf fields affect the environment around them.

Ridgefield High School

Teacher: Patrick Hughes

Project # 75

Yurkovsky, Elijah

The Effects of Moisture Levels on Polystyrene Consumption in Tenebrio Molitor

Completed Project, Environmental

The Effects of Moisture Levels on Polystyrene Consumption in Tenebrio Molitor. The irresponsible disposal of mass-manufactured plastic has caused widespread environmental damage, including soil degradation, marine life toxicity, and contamination of groundwater. While recycling efforts are essential, they remain insufficient as most plastics are non-biodegradable. Tenebrio Molitor larvae have demonstrated the ability to degrade polystyrene, presenting a potential natural solution to plastic waste. This study investigates how varying levels of water availability influence the rate of polystyrene consumption and degradation in T. Molitor larvae. Six groups of larvae were provided with different amounts of water (0, 0.5, 1, 1.5, 2, and 2.5 mL) along with 15 grams of polystyrene foam. Water was added every four days, and polystyrene consumption and degradation were monitored for 12 days. The final masses of remaining polystyrene after 12 days were compared to assess the effect of moisture levels. Results showed that larvae with moderate water levels (1-2.5 mL) consumed more polystyrene than those in the 0 mL group, which also had significant larval mortality. Experimental data suggests that moisture levels influence the degradation efficiency of T. Molitor, with moderate water availability promoting higher plastic consumption. Specifically, the group given 2.5 mL of water consumed 3 times more polystyrene than the group given 0 mL.

Ridgefield High School

Teacher: Patrick Hughes

Project # 76

Wong, Sage

Developing an HIPAA-Compliant Application Using Localized Large Language Models to Identify and Replace Stigmatizing Language in Clinical Notes

Completed Project, Health & Medical

Clinical notes can include stigmatizing language, such as words like "addict" or "abuser". Currently, there exists no solution for both identifying and replacing such language in clinical notes. Online tools like ChatGPT violate HIPAA regulations since sensitive health data is transferred over the internet. The purpose of this project is to develop a HIPAA-compliant application using localized large language models to identify and replace stigmatizing language in synthetic clinical notes. The criteria was that the model would have an F1 score of at least 95% on correctly identifying and replacing synthetic clinical notes. The constraints were that it encrypted the data to comply with HIPAA and only used local LLMs. The student generated medical information using Synthea, which was used for prompting. The student generated 20 notes containing stigmatizing language. The mentor reviewed the notes and helped the student to modify the program to output more realistic notes. The student generated 50 notes for a dataset to test the application. Local LLMs were prompt engineered to identify and replace stigmatizing language in the dataset. The student programmed in Python to create a local application. The student did all the programming while the mentor helped make the notes more realistic. For identifying stigmatizing language, the Phi-4 model achieved the highest F1-score of 80%. Research has shown that patients with stigmatizing language written about them were two times more likely to have received diagnostic errors. By ensuring that patients are described respectfully, this application can promote equity in healthcare delivery.

Amity High School

Teacher: Sarah Reeves

Project # 77

Vivanco, Lucia

Understanding the effect of nutrient additives on the growth and performance of the seaweeds Saccharina latissima and Gracilaria mammillaris

Completed Project, Environmental

Saccharina latissima and Gracilaria mammillaris are ecologically important primary producers that provide essential nutrients to surrounding ocean ecosystems. Specifically, S. latisisma provides habitat, protection, and structure for abundant marine life, impressively ranging along 25% of Earth's coastlines. Macroalgae has recently gained popularity as a potential renewable and cost-effective source of biofuel, feedstock for agriculture, and biomanufacturing material, providing additional interest for efficient cultivation techniques. However, due to anthropogenic changes such as increased water temperatures and ocean acidification, these algae are predicted to experience higher mortality rates, eventually leading to cascading and catastrophic impacts in surrounding ecosystems. Here, we show the effect of various nutrient additives, namely vitamin C in the form of L-ascorbic acid, zinc gluconate, and manganese gluconate, on the growth rates and photosynthetic efficiency of algae. The statistical analysis did not reveal any significant differences between experimental groups during a 4-week controlled growth experiment; however, the additives were successful in mitigating mortality under heat stress. Vitamin C benefited both species' photosynthetic efficiency under thermal stress, implying a general ability to function as an antioxidant, while the manganese and zinc treatment only benefited G. mammillaris. These additives likely facilitated growth through increasing pathogen resistance and functioning as a redox buffer. These results demonstrate the potential for nutrient additives as a possible method of mitigating the effects of rising ocean temperatures on kelp in the era of climate change.

King School

Teacher: Victoria Schulman

Project # 78

Stoltenberg, Ian

Developing a Computational Model to Study the Feasibility and Effectiveness of the Conversion of Hydrogen Fuel into Ammonia for Transport

Completed Project, Physical Science

The purpose of this project is to develop a computational model to study the feasibility and effectiveness of the conversion of hydrogen fuel into ammonia for transport in order to apply it to existing methods of hydrogen transportation. Hydrogen has recently been becoming a more popular source of fuel in an effort to switch to more environmentally friendly energy sources and reduce carbon emissions. However, hydrogen is a challenging substance to store and transport because of its unique properties. It has a very high volumetric energy density, meaning that a lot of hydrogen only contains a relatively small amount of energy. Additionally, for hydrogen to be stored as a liquid, it must be kept at the right temperature and pressure to stop it from vaporizing. To combat these issues, researchers have proposed transforming hydrogen into ammonia (chemical formula NH_3), which requires less energy to store and transport. This project aimed to study the exact costs associated with transporting and storing hydrogen and ammonia through a computational model and determine the best method to transport hydrogen for use as fuel. Thorough research was conducted to find data regarding the properties of each substance and conditions for its transport, and this data was used to create a Python model that could output total costs. It was found that hydrogen was significantly cheaper to transport than ammonia, but more research with more pinpointed values needs to be conducted to determine this for certain.

Amity High School

Teacher: Sarah Reeves

Project # 79

Zhang, Ziyan

The Effect of Climate Change on the Flowering Time of the Heath Family

Completed Project, Environmental

Climate change has significantly influenced plant phenology, particularly flowering time, affecting ecosystem dynamics. The purpose of this study is to examine how temperature variations from 1840 to 2024 have impacted the flowering dates of five Heath family species in Connecticut. This research hypothesized that increased spring temperatures would lead to earlier flowering. Historical flowering records were obtained from the Global Biodiversity Information Facility (GBIF) and the University of Connecticut's database, while temperature data were sourced from the National Center for Environmental Information (NCEI). Linear regression analyses assessed correlations between temperature fluctuations and flowering shifts. The results showed a general trend of earlier flowering, though statistical significance varied by species and month. Pink Azalea exhibited the strongest correlation with rising temperatures, while Sheep Laurel showed no significant changes. These findings suggest that temperature influences flowering phenology, but additional environmental factors may also play a role. Understanding species-specific responses to climate change is crucial for conservation, as shifts in flowering time can disrupt plant-pollinator interactions. Future research should explore a broader range of plant families and consider other environmental variables, such as precipitation and soil conditions, to improve predictive models of climate change impacts on plant phenology.

Amity High School

Teacher: Sarah Reeves

Project # 80

Abraham, Jacob

Neuromedin U Inhibits Counterregulatory Hormonal Responses to Recurrent Insulin-Induced Hypoglycemia

Research Proposal, Health Research Proposal

Hypoglycemia-associated autonomic failure is a major challenge for achieving tight glycemic control in type 1 diabetic patients with frequent hypoglycemia. This study examines how neuromedin U (NMU), a neuropeptide that limits insulin production under nutrient restriction in Drosophila, may suppress counterregulatory hormone release during recurrent hypoglycemia (RH). It focuses on whether insulin-induced hypoglycemia increases adrenal NMU expression and serum levels in a rat model. Blocking NMU receptors with the antagonist [D-Pro6]-NMU8, both in the VMH and peripherally, is expected to restore HPA axis activity, increase epinephrine and other hormonal releases, and normalize glucagon production under clamped hypoglycemia. The study assesses if serum NMU increases more in tightly controlled patients with lower HbA1c. These findings aim to show how NMU, as part of a conserved feedback system, influences glucose regulation and hormone responses during hypoglycemia.

Darien High School

Teacher: Guy Pratt

Project # 81

Accinelli, Stella & **Accinelli, Leighton**

Early Recognition and Prevention of Melanoma

Research Proposal, Teams (Research Proposal)

This research is based upon the aim to improve cases of melanoma worldwide, through easy access to medical advice, with just the use of a mobile app. An app will be created and programmed to be able to identify any concerning parts of the user's skin with the use of the smartphone's camera. This will be done with the collection of data and images which display melanoma as well as skin imperfections with a melanoma-like appearance; a model will then be built that has the ability to organize and differentiate between melanoma characteristics and other potential reasonings for the skin abnormality. This model will be trained and tested, ensuring the most accurate results possible. Then, the created model will be programmed into an app which has the ability to scan skin concerns with a smartphone camera and provide treatment suggestions to the user.

Ridgefield High School

Teacher: Ryan Gleason

Project # 82

Albrecht, Rachael

Utensil Solutions for Tremor Assistance and Neurological Disorders (USTAND)

Research Proposal, Physical Science Research Proposal

Tremors are a common side effect of neurological disorders such as Parkinson's Disease and Multiple System Atrophy (MSA), which significantly disrupts daily tasks like eating. The goal of this project is to design a utensil that reduces the strain associated with tremors, allowing those impacted by tremors to rely less on caregivers. The primary research question is: How can a utensil design effectively aid an individual with a neurological disorder in eating and handling food more successfully? The expected outcome is a prototype of a utensil that reduces food spillage caused by tremors by at least 25% compared to regular utensils. The project involves creating a utensil made entirely with food safe materials by incorporating an ergonomic grip and weight-balancing system, and will result in a design that will improve usability and stability. The procedure includes designing CAD models then 3D printing prototypes with food-safe filament. To test the utensil, a machine such as an earthquake table will simulate tremors, and will be evaluated by usability, spillage, and grip comfort. Due to the fact that MSA tremors involve more cerebellar dysfunction than Parkinson's, these tremors can be categorized as postural tremors. However, Parkinson's tremors are resting tremors, which is caused by dopaminergic degeneration in the basal ganglia. The final design will improve comfort, accessibility, and efficiency, ultimately reducing food spillage and strain during use. Future applications include a versatile grip that can attach to various utensils for universal accessibility.

Newtown High School

Teacher: Timothy DeJulio

Project # 83

Anderson, Anya

ACTN3 and Athletic Potential: Genetic Insights into Human Performance and Evolutionary Parallels with Monkeys

Research Proposal, Behavioral Research Proposal

Athletic performance is influenced by genetic factors, with the ACTN3 gene playing a key role in muscle function and athletic ability. This study investigated the relationship between ACTN3 polymorphisms and athletic tendencies in humans while exploring potential evolutionary parallels in rhesus monkeys. Saliva samples from human participants and DNA from rhesus monkeys were analyzed using polymerase chain reaction (PCR), gel electrophoresis, and restriction enzyme digestion to identify ACTN3 genotypes. The results showed that individuals with high athletic abilities predominantly exhibited the CC genotype, while middle-level athletes had a mix of CT and TT genotypes. Participants with the lowest athletic abilities displayed diverse genotypes (CC, CT, and TT), suggesting that factors beyond ACTN3 may influence performance. Analysis of rhesus monkey DNA was inconclusive, highlighting the need for further research. These findings underscore the importance of ACTN3 polymorphisms in human athleticism and raise intriguing questions about their evolutionary significance.

King School

Teacher: Victoria Schulman

Project # 84

Avidon, Abigail

The Effects of Different Levels of Acidity

Research Proposal, Environmental Research Proposal

Algae is necessary for many organisms to live, but as the acidity of rain increases and CO_2 levels in the atmosphere continue to rise, the question of how algae will be affected must be raised. If algae, specifically cyanobacteria, begins to form as harmful algae blooms, then the food chain and environment would be disrupted. Although algae is beneficial for the environment, if it grows too much and becomes an algae bloom, it will be very harmful. There will be four flasks, as flasks will be better for air circulation, filled with water, each with a different pH – 6.0, 6.5, 7.0, and 7.9. A growth medium will also be added into each flask. To change the pH of the water, a weak acid will be used. A sample of Anabaena cyanobacteria will be placed in each container and left for five days. To study how the Anabaena reacted, a spectrophotometer will be used to analyze absorbance and transmission. A study from University of Michigan found that as water pH got more basic, the sample of algae had a decrease in chlorophyll levels. Therefore, the hypothesis is that the cyanobacteria would grow immensely as acidity increases and eventually become an algae bloom. The need for understanding how algae will react as acidity in rain and CO_2 levels increase is key for protecting organisms and environments.

Joel Barlow High School

Teacher: Paul Testa

Project # 85

Research Proposal,

STUDENT RETRACTED FROM PARTICIPATION

Teacher:

Project # 86

Baranidharan, Ananyasri

The Substitution of 1-Azahomocubane with Phosphorus and Arsenic

Research Proposal, Physical Science Research Proposal

This research proposal investigates the synthesis and structural properties of phosphorus and arsenic-substituted 1-azahomocubane variation, which can help stabilize other variations of cubane, and explore potential pharmaceutical applications of drugs with phosphorus and arsenic-containing structures. The proposal focuses on substituting the nitrogen bridgehead atom in 1-azahomocubane using nucleophilic substitution reactions with solutions like PCl_3 and $AsBr_3$, followed by high-pressure synthesis under 1000 atm and temperatures of 200–300°C to stabilize the cage structure. Analytical techniques, including NMR spectroscopy, X-ray crystallography, and gas chromatography, can confirm the successful synthesis and purity of the products, while density function theory calculations can provide details about bond lengths, bond angles, and strain energies. Substitution results in significant bond angle distortions (310°–320° for phosphorus and 320°–330° for arsenic) and strain energy reductions compared to nitrogen-based azahomocubane. Phosphorus variations can have higher stability, stronger P–C bonds, and yields of 85–90%, while arsenic derivatives can show greater bond angle distortions, weaker As–C bonds, and slightly lower yields (70–80%) due to side reactions. So, the phosphorus-substituted azahomocubane is predicted to have better stability and reduced strain energy compared to the nitrogen-based molecule, while the arsenic-substituted azahomocubane is likely to be less stable.

Darien High School

Teacher: Janet Keeler

Project # 87

Blackwell, Haley

Hearing Loss's Correlation to Anxiety

Research Proposal, Behavioral Research Proposal

Hearing loss can often result in symptoms of anxiety or an anxiety disorder; this begs the question: what is hearing loss's correlation to anxiety? Anxiety left untreated can take a toll on one's daily life, causing distress and discomfort. Also, aspects of hearing loss management can relate to anxiety, as people develop anxiety around equipment and audiological appointments. Two Google forms (surveys) will be designed: one geared towards adults and one children. These surveys will address questions about hearing loss, anxiety, environmental factors, and life situations. These surveys will be sent using Facebook to adults with hearing loss and parents of children with hearing loss. On Facebook, different groups will be joined that are all related to hearing loss to get the pool of participants for this survey. Then, following receiving data (survey answers), the data will be analyzed. I hope to find that there is a positive correlation between hearing loss and anxiety (conforms with my initial hypothesis). If my hypothesis is correct, the results of this study would match the results of previous research done, examined in the background research. I also want to look into if the degree of hearing loss affects anxiety, which I believe it will, and I expect there to be a positive correlation. This study will shed light on an area that isn't commonly researched. For the next steps of my research, I would like to look into specific components contributing to the overall correlation between hearing loss and anxiety.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 88

Bozzuto, Ian

Analysis of Various Approval-Based Committee Rules Under Real-World US Block Plurality Election Data

Research Proposal, Behavioral Research Proposal

Currently, research is being conducted into Multiwinner Approval Voting, where the ballot allows voters to choose as many candidates as they like, and multiple candidates win. Many competing methods to choose winning candidates have been developed and analyzed, but one main issue when analyzing these methods is the lack of real-world use. One avenue to research its dynamics in real-world situations could be Block Plurality or "Plurality At-Large" voting. Block Plurality's ballot is very similar to an Approval Voting ballot, but with a restriction on the total number of candidates allowed to be approved. While it is no longer used for US Congressional elections, this system is still very common in US Municipalities. The goal of this research would be to conduct a similar analysis to "Utilitarian Welfare and Representation Guarantees of Approval-Based Multiwinner Rules" by Lackner and Skowron but with data from this kind of ballot format, as opposed to using randomly-decided "approval cutoffs" on preferential ballot data. The ballot data would need to be acquired in the form of a Cast Vote Record (CVR), which would provide more information than election results alone. This data would be more reflective of how people would vote under these methods in the real world compared to the data in the original study. We hypothesize similar results to the original paper for this study.

Darien High School

Teacher: David Lewis

Project # 89

Brandon, James

<u>Neural Network Synthesizer for Real-Time Audio-to-MIDI Conversion</u>

Research Proposal, Behavioral Research Proposal

This study presents a Neural Network Synthesizer designed for real-time audio-to-MIDI conversion, enabling latency-free translation of acoustic audio signals into MIDI representations. Traditional audio-to-MIDI systems often struggle with latency and accuracy, particularly when handling polyphonic or non-standard inputs. My system will leverage a deep neural network architecture to overcome these limitations, incorporating both temporal and spectral features for enhanced audio signal processing. The system utilizes a convolutional-recurrent neural network (CRNN), which derives layers for feature extraction (amplitude, frequency, wavelength) and recurrent layers for temporal pattern recognition. This hybrid design ensures robust performance across diverse audio inputs, including instruments, vocals, and environmental sounds. The Preprocessing steps include short-time Fourier transform (STFT) and mel-spectrogram analysis, feeding the model with rich acoustic data. The network outputs MIDI note events, including pitch, velocity, and duration, with low latency, suitable for live applications. Designed with scalability in mind, the synthesizer is lightweight and deployable on consumer-grade hardware, making it accessible for musicians, producers, and interactive media developers. This innovation represents a significant step forward in real-time audio processing, bridging the gap between acoustic performance and digital music production.

Darien High School

Teacher: Christine Leventhal

Project # 90

Buchesky, Anastasia

<u>Veterans and Dogs</u>

Research Proposal, Behavioral Research Proposal

>>>>>   ABSTRACT NOT AVAILABLE   <<<<<

Darien High School

Teacher: Janet Keeler

Project # 91

Burchetta, Sutton & **Newman, Finley**

Using Hydromoths to Analyze Effects of Noise Pollution on Marine Life in Long Island Sound and the Bahamas

Research Proposal, Teams (Research Proposal)

Marine anthropogenic noise pollution can be very harmful to aquatic animals. We decided to research noise pollution in marine biomes because it is a not well-known issue but very important as it may lead to many physical and mental implications to marine life. Our research focuses on listening to the different noises that have effects on marine life and how it may cause animals to change their behavior. We are planning to use our hydromoths to analyze the noise made by marine animals in times where boats are active versus not active. This will help show the effect on the animals behaviors and activity. The recordings collected will show us the changes of behaviors in the several locations we test in. For our experiment, we are hoping to find results and a correlation between boat noise or anthropogenic noise and how marine animals respond to it. Other researchers have found connections between these two things, as usually the marine animals are less active when there is more human noise. It is important to see whether this also affects animals in our testing sites to see if there is any way to limit noise pollution. For future research, we hope to be able to further understand marine noise pollution and its effects by comprehending the data we receive. This will allow us to acknowledge the dangerous effects of marine noise pollution on our environment, and hopefully will eventually lead to noise pollution limits in our testing areas.

Sacred Heart Greenwich

Teacher: Joyce Reed

Project # 92

Burns, Claire

Ocean Acidification Effect on Great White Sharks Movement

Research Proposal, Environmental Research Proposal

Great White Sharks are warm blooded which means they need to stay at their own comfortable regulated temperature. Due to climate change throughout the decades this has caused Great White Sharks to change their habitats ascribed to climate change. Climate Change has been causing not just our worlds on land to change but our oceans, which benefits human life most of all. Climate Change causes temperature increase, a sea level rise, and an increased amount of acidification. The Great White Sharks change in movement has been at a rapid increase for many years as climate change makes the oceans acidity worse and worse. As this continues to happen warmer waters attract Great Whites north which can have disastrous consequences for a whole ecosystem. This exemplifies how the ongoing acidification of the ocean, driven by climate change, could lead to significant shifts in the movement patterns of Great White Sharks as ocean temperatures continue to rise.

Ridgefield High School

Teacher: Patrick Hughes

Project # 93

Buser, Hannah

The Differences in the Structure of Prefrontal Cortex in patients with ADHD-Schizophrenia and Schizophrenia-ADHD

Research Proposal, Behavioral Research Proposal

ADHD and Schizophrenia are two psychiatric disorders that are known for coinciding with each other. More people are being diagnosed ADHD meaning that more people are more likely to develop Schizophrenia and vice versa. These two disorders overlap in the same area of the brain, the prefrontal cortex. Which the aim of the current study will be to see if the two different groups, ADHD-Schizophrenia and Schizophrenia-ADHD, have differences in the prefrontal cortex structure. People with ADHD-Schizophrenia should undergo greater changes in the structure of the prefrontal cortex compared to the Schizophrenia-ADHD group. This is because Schizophrenia is known for changing the brain structure, especially the prefrontal cortex, and at the same time ADHD does the same but not at such a high severity like Schizophrenia. Using 3 groups of people(healthy, ADHD-Schizophrenia, and Schizophrenia-ADHD), we can use Structural MRI's to be able to show the differences in structure between the three groups as well as using the Wisconsin Card Sorting Test to determine which affected group has higher cognitive function and which is able to problem solve better. Based off of the results, we will notice that people with ADHD-Schizophrenia, their prefrontal cortex is more affected compared to the other group, meaning less volume in that area of the brain. As well as, ADHD-Schizophrenia group will struggle more with their cognitive function and problem-solving since Schizophrenia leaves a bigger impact on the brain than ADHD does.

Darien High School

Teacher: Janet Keeler

Project # 94

Byrne, Erin

Human Detection Accuracy of A.I. Generated Faces Over Continuous Exposure

Research Proposal, Health Research Proposal

Artificial intelligence-generated audio, images, and video synthesis (known as deep fakes) that were previously exclusive to advanced special effects technology, are becoming increasingly accessible every day. Recent studies indicate that A.I. faces are now not only indistinguishable from human faces, but in some cases perceived as more realistic, a phenomenon termed as hyperrealism. General Adversarial Networks (GANs) are popular deep learning architectures that pit two artificial neural networks—a generator and discriminator—against each other. Starting with random pixels, these generators iteratively learn to create artificial faces until they are indistinguishable from the human ones of their training image data set. This study aims to determine whether human participants can distinguish GAN A.I. faces from real human faces. Additionally, participants will participate in multiple trials with new stimuli to observe if their scores improve after being presented with their results from the previous trial. Given the increasing abundance of A.I. content, this topic is more relevant than ever. Results will imply if humans will continue to be misled by deep fake face images, or if they have the potential to learn to differentiate between today's state of the art A.I. and genuine human faces. The outcomes will provide insights into the dangerous potential of deepfake technology, the uncanny valley phenomenon, and what humans themselves define as "human" features.

Ridgefield High School

Teacher: Ryan Gleason

Project # 95

Chan, Claire

CCL2 Inhibition of Fetal Microchimeric Cell Proliferation in Rheumatoid Arthritis

Research Proposal, Health Research Proposal

Rheumatoid arthritis (RA) is an inflammatory condition of the joints that affects more than 20 million people worldwide, for which women are 3 times more likely to have the disease. Research has shown that RA may be linked to women via fetal cell microchimerism (FCM), the transfer of fetal microchimeric cells (FMCs) between mother and child through the placenta. Previous studies having shown that FMCs carrying the DERAA human leukocyte antigen (HLA) gene increases maternal risk of RA by 17-fold. FMCs have also been shown to migrate to sites of injury to participate in inflammatory processes via C-C chemokine ligand 2 (CCL2), however, its effects on inflammation as a result of FMC cell proliferation in RA remain to be elucidated. In this experiment, female TNF-α mice will be crossbred with male NOG/HLA-DR4 eGFP+ mice. The fetal eGFP+ microchimeric mice and nulliparous female TNF-α mice will then each have half of their respective groups receive anti-CCL2 bindarit injections orally via gastric gavage. Inflammation levels in the mice will be analyzed using ultrasounds measuring synovial thickness over 14 days. CCL2 is expected to alleviate inflammatory RA symptoms specifically for mothers with DERAA+ FMCs. This study may provide insight into RA progression and provide a new manner for treatment of the disease.

Darien High School

Teacher: David Lewis

Project # 96

Cheng, Kendra

Generating Biofuels from Local Connecticut Microalgae Platymonas subcordiformis Using Bicarbonate, a More Efficient Carbon Source

Research Proposal, Environmental Research Proposal

Widespread reliance on fossil fuels has led to high levels of CO2 released and absorbed by oceans, leading to ocean acidification (Doney et al., 2009). Biofuels, derived from lipids of living matter, offer a sustainable alternative to fossil fuels and if optimized release fewer CO2 molecules (Tomar et al., 2023). Microalgae, as biofuel sources, are 10-50 times more efficient at carbon sequestering than terrestrial plants (Onyeaka et al., 2021). The use of bicarbonate to increase efficiency and use of local microalgae as biofuel sources must be explored to help reduce atmospheric CO2 and ultimately ocean acidification. Optimizing microalgae growth through bicarbonate poses a more efficient carbon delivery method than atmospheric CO2 culturing conditions, which is costly and inefficient due to CO2 outgassing (Ughetti et al., 2023). Platymonas subcordiformis, a microalgae local to New Haven, Connecticut, will be evaluated using NaHCO3 in a closed photobioreactor. This will allow the calculation of net CO2 output from outgassing and algal respiration to explore bicarbonate recycling and test for net negative fuel production. Results will be quantified through microalgal growth from spectroscopy, pH changes, carbon capture from titration, biomass and lipid content from gravimetric analysis, and biofuel production via gas chromatograph. Given P. subcordiformis's ability to resist alkaline environments, it is predicted higher NaHCO3 concentrations will increase growth, lipid production, and carbon recycling potential (UTEX, n.d.) (Pekkoh et al., 2023). If verified, a local microalgae will be proven as a sustainable solution to reduce dependence on fossil fuels and decrease ocean acidification.

Staples High School

Teacher: Amy Parent

Project # 97

Cho, Yu-Min & **Kotula, Olivia**

<u>Use of Machine Learning Algorithms to Predict Exoplanet Habitability</u>

Research Proposal, Teams (Research Proposal)

Telescopes including Hubble and JWST have contributed to discovering over 5,800 extrasolar planets, yet only 63 are confirmed as habitable, or having temperature, atmospheric, and surface water conditions potentially supporting life. While past studies have used deep learning classifiers to identify the existence of exoplanets using the transit method, the same techniques remain unproven for discerning planets' properties. Artificial intelligence, in other instances, was capable of detecting atmospheres and liquid water on exoplanetary surfaces. A novel approach to the issue rests on using simulated atmospheric spectra to train a machine learning model, using real spectra recorded by JWST to test the model's validity. NIRSpec data of the exoplanets K2-18b and LHS 1140b from the MAST Archive was reduced procedurally through all six stages of the Eureka! data analysis pipeline. A Python Jupyter notebook was used to host both the model and the data. ExoTR, an exoplanet modeling software, aided in constructing spectra for the two planets, while the unidimensional General Circulation Model constructed the simulated spectra using a range of parameters. The interface provided by the Keras sequential API allowed for a regression analysis to be applied using the given criteria, generating a predicted habitability score (HBS) ranging from 0-100%. Once the model reached >95% accuracy in classifying simulated habitable and barren spectra, it was deployed on real data, including the two habitable candidates as well as four barren planets. Continuing to employ AI in processing astronomical datasets may yield viable research targets and hasten the pace of future discoveries.

Joel Barlow High School

Teacher: Paul Testa

Project # 98

Coughlin, Carolan

Impacts of water movement on growth rates of kelp (Laminaria digitata)

Research Proposal, Environmental Research Proposal

Understanding the factors that play into kelp growth is important for the industry and the lives of millions of people the industry supports. In this study, kelp grown in areas with more available sunlight would show higher growth rates. The independent variable would be the amount of available sunlight while the dependent variable would be the growth of the stipe, the stem-like feature in kelp. Stipe length would be measured using the hole punch method, where a hole is punched in the stipe of the kelp once a month, and the distance between holes is the mesure rounded to the nearest tenth. It is expected that a positive relationship will be observed, where an increase in available light will lead to an increase in stipe growth. Implications for this study include improvements to the tactics and methods of the kelp industry and kelp farms. This increase in productivity of kelp farms will greatly improve the environment. As kelp receives pollutants from the water as it grows, as well as its possible use for biofuel, and building materials like a translucent leather like material.

Darien High School

Teacher: Christine Leventhal

Project # 99

Cruson, Daniel

Potential Effects of Infrasound on Mouse Nasal Fibroblasts

Research Proposal, Physical Science Research Proposal

This is a proposal for a project that could be done for this idea. It will be done over the span of a month by playing sound at different infrasonic frequencies and durations. These frequencies will be between 15 hz to -5hz and the durations will be 30 minutes, One hour, and one day. Then the cells will be check daily over the span of a month too see the amount and they will hae 5 trials, Then the energy from the cell will be seen through the method of ATP Cell viability assays.

Newtown High School

Teacher: Timothy DeJulio

Project # 100

Csaszar, Clare

The Future of Architecture: Sustainable Living

Research Proposal, Environmental Research Proposal

This research project aims to transform an existing home into a net-zero energy house by integrating solar power, passive house principles, and green spaces. The goal is to make the house more environmentally friendly and reduce its carbon footprint. The study explores how to combine these sustainability measures effectively, the best methods for retrofitting a house, and the potential role of AI and new technologies. The project will begin with an energy audit of the house to identify current energy consumption and inefficiencies. Solar panels will be installed to produce energy, and the house will be retrofitted with better insulation, airtightness, and energy-efficient windows and doors. Additionally, green spaces like green roofs and vertical gardens will be added to improve the house's microclimate. Data will be collected throughout the project to assess the impact of these changes on energy consumption and production. The expected outcome is a significant reduction in the house's reliance on traditional energy sources, moving it toward net-zero energy status. This project aims to provide a practical example of sustainable architecture, inspiring future homes to adopt eco-friendly designs and contributing to global efforts to combat climate change.

Newtown High School

Teacher: Timothy DeJulio

Project # 101

Curry, Campbell

Analyzing Occupational Therapy Opportunities for Parkinson's Disease Patients in the United States

Research Proposal, Behavioral Research Proposal

Parkinson's disease (PD) is a motor brain disease with no cure or one treatment option that can simultaneously treat its wide plethora of symptoms. Occupational therapy can help people to be able to continue to do the things they love because it focuses on a person's occupation. A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis survey will be sent to occupational therapists in the US who work with PD patients. This is important to the Parkinson's population because once the strengths, weaknesses, opportunities, and threats are found awareness of the benefits of occupational therapy can be spread effectively by knowing these aspects. Key information is expected to be found from this survey that could be used to advertise occupational therapy's strengths for making an impact on a person with Parkinson's disease's life. It is expected that the results given will be similar to those of the SWOT analysis in Israel; "Occupational therapy for people with Parkinson's disease in Israel: A SWOT analysis" written by Avital Cavaglion, Michal Duvdevani, Na'ama Siegelman, Rachel Kizony, and Galit Yogev-Seligmann. If the results are similar then it will be known how to target a large population of people with Parkinson's disease because they therefore would have similar approaches and conceptions towards using occupational therapy. The study should yield significant information that can make an impact on how the Parkinson's community is treating their symptoms.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 102

Dean, Caitlin & **Broughton, Lily**

Assessing Nitrate and Phosphate Pollution in Blind Brook, NY

Research Proposal, Teams (Research Proposal)

Our research focuses on the issue of nitrate and phosphate pollution, which contributes to the deterioration of water quality and negatively impacts aquatic life and surrounding ecosystems. We aim to address this problem by testing water quality in local areas to identify which regions are more prone to pollution and the driving factors. If left unresolved, this pollution could pose a serious threat to future generations. To investigate nitrate and phosphate contamination, we have been collecting water samples from Blind Brook in New York and testing for nitrate, phosphate, dissolved oxygen, atmospheric pressure, turbidity, and pH levels on a weekly basis. By consistently collecting and analyzing this data, we are tracking trends in the brook's water quality, which helps us identify the root causes of nitrate and phosphate pollution in nearby bodies of water. We found that the Blind Brook had lower levels of nitrate and phosphate pollution compared to predicted levels. The results of all tests stayed consistent throughout our testing period. This means that Blind Brook is in a low-concentration pollution area. Upstream sites tested for higher levels of pollution than the downstream sites. Using the Blind Brook as a standard, our research will help with other efforts to reduce pollution in natural water sources. Next, we will continue to collect data, analyze trends in data, and develop potential solutions based on results. These steps are essential so we can collect ample samples and have reliable results to make valid conclusions about potential solutions to this pollution problem.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 103

Dobin-Smith, Jonathan

Mitigating CO2 emissions Via bio concrete by Improving Alkalinity resistance in Cupriavidus necator through Gradient Domestication

Research Proposal, Environmental Research Proposal

Climate change is one of the most pressing issues of our time, and one major contributor to this issue is the manufacturing of industrial materials. Concrete production contributes approximately 8% of global CO_2 emissions, and requires urgent sustainable alternatives. One alternative is bio concrete, which utilizes microbially induced calcium carbonate precipitation (MICP), to both self-heal and sequester carbon dioxide. This study focuses on enhancing the bacterium Cupriavidus necator for improved functionality in the high alkalinity of concrete (pH 10–13). Building on Xu's (2024) gradient domestication technique for improving microbial alkalinity resistance and Zhu's (2019) optimized nutrient media for calcium carbonate precipitation, the study employs a combination of these methodologies to increase the bacterium's calcium carbonate pathway effectiveness at pH 13. This study also involves rigorous strength testing of the bioconcrete to ensure that the enhanced MICP process not only supports sustainability goals but also meets the mechanical performance standards required for construction applications. Optimized strains are expected to achieve greater calcium carbonate precipitation, enhancing the self-healing capacity and carbon sequestering ability of the bioconcrete, while also being able to maintain standard construction compressive and tensile strength. By integrating this modified bacterial system into concrete production, this research seeks to reduce industrial CO_2 emissions and advance the development of sustainable infrastructure materials.

Staples High School

Teacher: Amy Parent

Project # 104

Elias, Campbell

The Measure of Local Senescence at the Sight of ACL Tear Before and After Surgery

Research Proposal, Health Research Proposal

Cellular senescence happens to cells after a traumatic injury such as an anterior cruciate ligament (ACL) tear. Senescence promotes both the release of pro-inflammatory factors (SASP) and post-traumatic osteoarthritis (PTOA). While scientists have measured senescence pre-surgery, limited research has been conducted to compare measurements pre and post-surgery. The objective of this study is to analyze local senescence in synovial fluid at the site of the ACL injury both pre and post-surgery to evaluate the effect surgery has on the measurement of senescence. I hypothesized that the number of senescent cells post-surgery would be less than that of senescent cells pre-surgery, which would determine if surgery would eliminate future complications such as PTOA.

Darien High School

Teacher: Janet Keeler

Project # 105

Fernandez, James

How Sleep Impacts Cognitive Function in Adolescents

Research Proposal, Behavioral Research Proposal

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 (muscle memory) and declarative (general) memory (Potkin, 2012). It can also lead to a risk for Alzheimer's Disease during the latter stages of life. Sleeping more or less than 7-8 hours a night consistently is considered insufficient sleep. Very few of these studies done have 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 a group of students come into a classroom and anonymously record on a post-it how many hours of sleep they got the night before and any abnormalities if any occurred. They will then all watch a 25 minute video and take exactly one page of notes before handing it in and going about their day. The notes will be run through "Transkribus" a handwriting interpretation software. How many errors the machine makes will be recorded to measure cognitive function. This will be compared to how much sleep the student got during the previous night. Allowing the correlation between the amount of sleep and neatness of the handwriting to be clearly seen through simple numbers, giving people an easier understanding of the importance of sleep.

Ridgefield High School

Teacher: Ryan Gleason

Project # 106

Figlar, Eva

The Effect of Polyphenols and Ascorbic Acid on Iron Absorption in Zophobas Morio

Research Proposal, Environmental Research Proposal

People around the world have started turning to bugs as a meal or nutritious snack. Bugs, especially mealworms, are a staple in many cultures, but can also be a quick source of iron and protein for people facing food insecurity. By experimenting with the diet of mealworms, I could maximize their iron content, making them a nutritious option for a meal.

Ridgefield High School

Teacher: Ryan Gleason

Project # 107

Foley, Charlotte

The Effect of Ultraviolet Light on the Growth of Yeast

Research Proposal, Health Research Proposal

UltraViolet light (UV light) is beneficial 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 possibly resulting in 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 put in various areas for 30 hours, as well as under multiple types of UV light. In terms of what would be put in the plates Agar plates would be put with Saccharomyces Cerevisiae and have a changed variable. After the UV light exposure, a spectrophotometer would be used to measure the optical density (OD) of each test set, and 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. Specifically looking to see if something is rutile and has anatase proteins. Finally, the tests would then be repeated to test the credibility of the data.

Ridgefield High School

Teacher: Ryan Gleason

Project # 108

Galotti, Alyssa & **Linn, Lucia**

Acne in Adolescents

Research Proposal, Teams (Research Proposal)

Our research question is "Does stress play a role in acne in adolescents?". Our expected outcome is to have a significant number of people that say their acne is related to stress. We expect that stress is not the only factor but that it does play a role in it. Based on our rationale, the studies we looked at also came up with similar results and conclusions. Participants will be asked to fill out a survey. We created a questionnaire and came up with the questions ourselves. It does not require permission because it does not require sensitive information or experiments. Our background research is important because it supports our research question. Some information we received from our research articles was that skin disorders is a physical reaction to stress. We want to focus in and look into adolescents. My participants will be found in the Sacred Heart community and nearby schools as well. They will be invited to participate by reaching out via email to see if they are interested in participating. For future research, I could broaden my participants to more than just Sacred Heart students.

Sacred Heart Greenwich

Teacher: Joyce Reed

Project # 109

Gillen, Mackenzie

The Correlation Between Mental Health and Celebrity Worship

Research Proposal, Behavioral Research Proposal

Celebrity worship has been increasingly linked to mental health issues such as anxiety, depression, and obsessive behaviors, with some studies suggesting that it may be a coping mechanism for individuals facing emotional distress. However, existing research leaves gaps in understanding the nuanced relationship between mental health and celebrity worship, especially in younger populations. This study aimed to explore the correlation between mental health indicators and celebrity worship among high school and college students. A survey was administered using three established instruments: the Celebrity Attitude Scale, the Depression Anxiety Stress Scale, and the Coping Self-Efficacy Scale. The survey sought to determine if celebrity worship could be a healthy coping strategy, contributing to personal inspiration and emotional resilience, or if it could lead to unhealthy behaviors when it dominates an individual's life. The results indicated a moderate positive correlation between celebrity worship and mental health struggles, particularly among those who exhibited signs of anxiety and depression. However, the findings also suggested that moderate engagement with celebrity culture could serve as a beneficial source of comfort and motivation, as long as it does not overshadow real-world interactions. This study's conclusions emphasize the need for a balanced approach to celebrity worship and the importance of self-awareness in using it as a coping mechanism. Future research should further investigate the potential therapeutic benefits and risks of celebrity worship in mental health contexts, and explore interventions for those whose obsession with celebrities becomes detrimental to their well-being.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 110

Golden, Jacob

Effect of weather patterns on bird range size

Research Proposal, Behavioral Research Proposal

The American woodcock (Scolopax minor), a migratory bird native to New England, relies on thawed, moist soils in early spring to access earthworms, its primary food source, during migration and breeding. With climate change causing earlier snowmelt and soil thaw, woodcocks may advance their migration timing, potentially misaligning with optimal conditions for food availability. This study will investigate shifts in woodcock migration using long-term tracking data and records of first sightings, coupled with soil temperature and thaw data from key stopover and breeding sites. Statistical analyses will correlate migration timing with climatic variables to assess trends and potential mismatches. We hypothesize that warming temperatures are driving woodcocks to arrive earlier in spring, which could jeopardize access to resources if soil conditions or food availability lag behind these shifts. By examining this phenomenon, the study will provide critical insights into how climate change impacts migratory behavior and habitat use. The findings may inform land management practices, such as maintaining habitats with diverse thawing conditions to support woodcock populations. These results will also contribute to broader efforts to understand and mitigate the effects of climate change on phenological relationships in migratory birds.

Darien High School

Teacher: Guy Pratt

Project # 111

Halvorsen, Sydney

Mepolizumab doses in patients with EGPA

Research Proposal, Health Research Proposal

Eosinophilic Granulomatosis with Polyangiitis (EGPA) is a rare disease where the immune system attacks blood vessels and causes inflammation in organs like the lungs. Prednisone, a powerful steroid, is typically used to treat EGPA, but long-term use can lead to serious side effects like weight gain and weakened bones. Recently, biologic treatments like mepolizumab have shown promise in targeting the root cause of the disease, reducing inflammation without many of the steroid-related side effects. This study aims to see if combining a lower dose of prednisone with mepolizumab is just as effective as the usual high-dose prednisone treatment. We'll split patients into two groups: one gets the regular treatment with prednisone, and the other receives a lower dose of prednisone along with mepolizumab. We'll track how many patients achieve remission, how long it takes, and the side effects experienced. We'll also look at relapse rates and how easily patients can reduce their steroid use. Our goal is to show that using less prednisone, combined with mepolizumab, can achieve similar results while reducing harmful side effects, ultimately improving the quality of life for patients with EGPA.

Darien High School

Teacher: Guy Pratt

Project # 112

Hanson, Avery

The Identification of Epigenetic Aging in Hutchinson-Gilford progeria syndrome

Research Proposal, Health Research Proposal

Hutchinson-Gilford Progeria syndrome (HGPS) is a rare genetic disorder characterized by premature aging with the average life expectancy being 13.4 years. This experiment will analyze fibroblasts samples from predominantly the Coriell Institute of HGPS patients, ages 1-20, compared to the healthy control group from young, middle, and old age. In doing so, this study will observe the signatures of HGPS and compare them to the blood samples in DNA repair-deficient progeroid syndromes revealing accelerated epigenetic aging, specifically Cockayne syndrome. HGPS is caused by a point mutation of the Lamin A protein. This mutation results in the deletion of nucleotides, developing an abnormal protein product called progerin that disrupts the nuclear envelope. In HGPS, progerin production affects Mesenchymal stem cells expressing the phenotype. By conducting this experiment, using RNA sequencing, Hi-C experiments, and principal component analysis it will be observed that there are great alterations in the epigenetics of HGPS patients seen in the chromatin structure, genomic instability, and DNA methylation. However, these epigenetic changes do not reveal accelerated epigenetic aging, but rather the HGPS premature aging phenotype. These findings suggest that the HGPS phenotype is caused by the accumulation of progerin from mutations in the Lamin A protein rather than epigenetic aging in DNA repair-deficient progeroid syndromes. The limitations of this experiment include the limited lifespan of HGPS patients where it's difficult to observe changes in epigenetic age because we can't investigate HGPS patients at an adult age, unlike DNA repair-deficient progeroid syndromes.

Darien High School

Teacher: Guy Pratt

Project # 113

Hardy, Madeleine

Evaluating the Efficacy of Psilocybin in The Treatment of Major Depressive Disorder in Comparison to Anxiety

Research Proposal, Health Research Proposal

In the United States alone over 21 million adults (8%) suffer from Major Depressive Disorder (MDD). When it comes to teens that percentage only skyrockets, turning into over 15% of teenagers in the United States that suffer from this disorder. Major Depressive Disorder is a mental health disorder characterized by prolonged periods of depressed mood [8,9]. Other debilitating symptoms include loss of interest in activities, changes in appetite, weight, and sleep, suicidal ideation, etc. all of which significantly impair daily functioning. Along with MDD, another increasingly prevalent disorder is Generalized Anxiety Disorder (GAD), affecting over 3.1% of the adult population [8]. Traditional treatments for both include SSRIs, SNRIs, Somatic Therapy, and behavioral therapy all primarily targeting neurotransmitter systems such as the 5-HT2A receptor [10]. Recent studies are starting to explore alternative therapies, particularly psilocybin. Psylocibin has piqued the interest of researchers due to its similar target of the 5-HT2A receptor leading to altered neural connectivity and enhanced emotional processing [1-7]. Psilocybin presents as a compelling alternative for MDD treatment, particularly for patients who are unresponsive to conventional therapy [1-7]. This study aims to compare how the efficacy of psilocybin for symptom reduction in patients with MDD varies compared to patients with anxiety using available literature. Psilocybin is predicted to suppress the symptoms of MDD more effectively than the symptoms of GAD.

Darien High School

Teacher: Christine Leventhal

Project # 114

Hari, Jay

Predicting 3-Dimensional ncRNA Structures with OpenFold using a Novel Approach of Structural Homology Transformation to Aid in Therapeutic Drug Synthesis Targeting ncRNA-based Cancers

Research Proposal, Physical Science Research Proposal

Noncoding RNAs(ncRNA) compose a majority of the genome and may be responsible for many cancers, which could be targeted for drug therapy if structures were available(Yan & Bu, 2021). Structures are often difficult to ascertain through Nuclear Magnetic Resonance(NMR) spectroscopy and X-Ray crystallography: computational methods have proven to be more efficient(Childs-Disney et al., 2022). Currently, RNA-folding programs are less accurate than their protein-folding counterparts(Feng et al., 2022). A transformer, in conjunction with the best protein-folding program OpenFold, could predict ncRNA structures through a novel mapping method. Using a dynamic homologous structure comparison mapping between nucleotides and amino acids, RNA sequences can be "transformed" into homologous protein sequences, allowing OpenFold to predict the structure. The accuracy of generated RNA folds(n=30) on the transformed OpenFold network will be compared to two RNA-folding algorithms, trRosettaRNA and DRFold. Accuracy is measured in Ängstroms, a microbiological measure of distance, for the Root-Mean Squared Difference and Template-Modeling Score between generated and experimentally-determined structures. The transformed OpenFold model will then evaluate CCAT2, an oncogenic ncRNA with unknown structure. It is hypothesized that the transformed OpenFold model will learn the intermolecular interactions between different monomers in context and use those to generate sequences which fold homologously in OpenFold(Ahdritz et al., 2022) and be superior to current RNA-folding algorithms. If so, a novel method of biomolecular folding harnessing current gold-standard technology will be created which could aid in docking analysis of oncogenic ncRNA molecules to produce drug therapies to combat cancers.

Staples High School

Teacher: Amy Parent

Project # 115

Hartnett, Madison

<u>Mortality of Manatees</u>

Research Proposal, Environmental Research Proposal

Manatees in Florida, with a potential lifespan of over 60 years, face increasing mortality primarily due to human-related activities. The leading cause of death is collisions with boats and barges, which peak during Florida's boating season from May to October. Despite protective measures such as speed zones and sanctuaries, these incidents persist, reflecting gaps in enforcement and effectiveness. Additionally, harmful algal blooms, specifically red tide events caused by the dinoflagellate Karenia brevis, produce brevetoxins that contribute to mass manatee mortalities and pose significant health risks to humans near affected shorelines. Seasonal trends indicate that natural mortality events are more frequent in winter months, likely due to environmental stressors. This research analyzed mortality trends, rehabilitation data, and the impact of conservation efforts to assess the primary threats to manatees and the effectiveness of current protective measures. Rehabilitation admissions from 1991–2017 show a steady increase, driven largely by watercraft collisions and environmental factors. These admissions offer valuable insights into population health and long-term survival trends, complementing data from carcass salvage programs. Findings highlight the urgency of addressing human-caused threats through enhanced conservation strategies. Improved enforcement of speed regulations, expansion of protected sanctuaries, and innovative monitoring technologies are essential for reducing manatee mortality. Further research is needed to assess the long-term effects of brevetoxin exposure and evaluate the effectiveness of current conservation efforts. These steps are critical for protecting Florida's manatee population, ensuring their survival, and maintaining the health of aquatic ecosystems.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 116

Herman, Eve

Combining Isoform-specific HDACi and Anthracyclines as a Targeted Therapy to Reactivate RUNX3 and Treat AML

Research Proposal, Health Research Proposal

Acute myeloid leukemia (AML) is a form of acute leukemia that is most common in adults, with a median diagnosis age of 70 years old. Because the 5-year survival rate of AML patients over 60 years old is less than 8%, new advanced drug therapies are needed. By testing HDACi in combination with an anthracycline drug using cell culture, this study aims to develop more effective therapeutic drug combinations for older AML patients. Most notably, the experiments that will be employed in this study include viability and caspase activity assays to determine cell survival, ATAC-seq to measure chromatin accessibility across the genome, and western blots to compare acetylation, apoptosis, and RUNX3 activation caused by the different drug regimens that will be tested. Past studies have shown that administering Decitabine before Vorinostat, a widely tested HDACi, in a sequential dose regimen decreases cell viability to a greater extent than either agent alone, even at low concentrations. Another study investigated the combination of Vorinostat with Idarubicin and Cytarabine, two anthracycline drugs, finding that histone acetylation was detected in 30% of the patients studied. This study hopes to determine if the combination of Vorinostat or ST80, an HDAC6 inhibitor, with Daunorubicin, another anthracycline drug, holds more promise to successfully treat AML by inducing acetylation. In the long run, the results of this study could help dictate the path for future AML therapies in order to increase the survival rates in older AML patients and potentially treat other types of leukemias and cancers.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 117

HIll, Sara

Lyme Disease and The Effect of Climate and Survival

Research Proposal, Health Research Proposal

here are many ways that Lyme Disease affects the way that people live their lives as well as their mental and physical health. Lyme disease can cause many complications all across the board when it comes to health, hurting a person's physical, cognitive, and emotional health causing many complications later on in the long journey of recovery from this terrible disease that affects so many people around the U.S. and many other places as well. Lyme disease causes many issues in the human body and can also create problems later in the process of healing. Some examples of this are PTLDS or post-treatment Lyme disease syndrome which is where patients experience multiple different reactions in their body from having had Lyme disease before. Lots of people experience PTLDS differently but most of the symptoms that are shown to be pretty common would be joint pain, headaches/migraines, as well as immune issues, etc. These issues that are brought upon past LD patients can be annoying and health-impacting for the person as well as their life later on. Temperature changes that fluctuate normally cause the likelihood of becoming infected with LD to be lessened.

Ridgefield High School

Teacher: Ryan Gleason

Project # 118

Hills, Addy

Probiotics for Neuropathic Pain: Investigating Gut Microbiota and Cytokine Modulation in Neuropathic Pain

Research Proposal, Health Research Proposal

Neuropathic pain is a chronic condition caused by somatosensory system damage, often disrupting sleep, emotions, and quality of life. Emerging evidence links gut microbiota to chronic pain and inflammation. This study will examine whether a probiotic containing Lactobacillus fermentum, known for its anti-inflammatory properties, can alter gut microbiota and cytokine levels in chronic pain patients. 40 participants will be divided into a probiotic group and a control group. After six weeks, stool samples will be collected and will undergo 16S rRNA sequencing, and blood samples will measure pro and anti-inflammatory cytokines (TNF-a, IL-1β, IL-10), through ELISA. The two groups will rate their pain using the Numeric Rating Scale (NRS) to assess self-reported pain reduction. The probiotic group is expected to show increased beneficial bacteria, reduced pro-inflammatory cytokines, elevated IL-10 (an anti-inflammatory cytokine), and lower pain ratings, supporting probiotics as a non-invasive chronic pain therapy.

Darien High School

Teacher: Christine Leventhal

Project # 119

Hoffman, James

Effect of OCTN-1 on Transdermal Movement of Ergothioneine

Research Proposal, Health Research Proposal

Ergothioneine (ERGO) is a derivative of the amino acid histidine that, while abundant in fungi and bacteria, is unable to be synthesized in animals and plants. However, in both preclinical and clinical studies on the effects of ERGO supplementation (typically through diet), ERGO has displayed remarkable antioxidant and anti-inflammatory effects that hold significant value in the search for new therapeutic agents to reduce the negative effects of oxidative stress on both the body and the brain, especially in relation to aging (ERGO supplementation has associated with reduced physical frailty in murine models, and lower blood levels of ERGO in humans over 60 is associated with rapid cognitive decline). Novel Organic Cation Transporter 1, or OCTN-1, is a cation transporter found throughout the human body that favors ERGO as a substrate, and is efficient at accumulating ERGO in cells and tissues suffering from oxidative and inflammatory damage (particular in the skin and in mitochondria). However, despite the prevalence of OCTN-1 and its therapeutic potential in relation to ERGO, the transporter remains poorly understood. This study will look into the potential to increase the absorption of ergothioneine in skin through increasing OCTN-1 expression, with the end goal of preventing oxidative damage.

Darien High School

Teacher: David Lewis

Project # 120

Jackson, Hope

Investigating the Reproductive Health of Bay Scallops: A Study on Physical Traits and Gonadal Development

Research Proposal, Environmental Research Proposal

This study investigates the effects of increasing water temperatures on the reproductive cycles of bay scallops (Argopecten irradians), specifically how temperature fluctuations influence gonadal development and spawning timing. Bay scallops were collected biweekly from Nantucket Harbor, and their gonads were carefully dissected for examination. The main objective of the research is to evaluate whether the rising ocean temperatures could be accelerating gonadal development, potentially leading to earlier and more frequent spawning events. I hypothesize that elevated temperatures will cause gonads to mature faster and alter reproductive cycles in ways that could disrupt population dynamics. Preliminary data suggest a correlation between warmer temperatures and faster gonadal development, though further analysis is needed to draw definitive conclusions. The findings of this study will ultimately provide valuable insights into the long-term impacts of climate change on bay scallop populations and their ecological and economic importance, especially to local fisheries.

Darien High School

Teacher: Christine Leventhal

Project # 121

Jalakas, Heili

Feasibility of Sampling the Ice Plumes at Enceladus for Biomarkers of Extraterrestrial Life

Research Proposal, Physical Science Research Proposal

This research proposes a modification to existing ice capture systems designed to collect ice samples from Enceledus' plumes. This study would primarily use the Cold Light Gas Gun, located at the University of Kent, to simulate the impact of ice on a metal sheet as a spacecraft flies through one of Enceledus' infamous plumes. The ice models would be doped with a fluorescent biomarker. This would be done in order to measure capture efficiency and determine if complex biological molecules preserved in the ice could potentially survive the impact. Current designs, often utilizing aluminum capture surfaces, may suffer from reduced efficiency in the extremely cold space environment. This proposal hypothesizes that increasing the temperature, specifically of aluminum capture surfaces, will significantly enhance sample collection in a potential fly-by of Enceladus plumes. Warmer surfaces are expected to improve capture efficiency by minimizing cracking and projectile rebound, increasing energy absorption, as well as potentially mitigating the risk of projectile penetration. Most importantly however, would be the potential increase in survivability of complex biological molecules, enhancing the overall mission of searching for life on Enceladus. While a slower spacecraft velocity may be necessary to accommodate warmer capture surfaces, the potential benefits in terms of sample integrity and capture efficiency may outweigh the need for more fuel in order to achieve that slower velocity. This study proposes to investigate the optimal temperature range for aluminum capture surfaces in order to optimize sample collection for future potential missions to Enceladus.

Darien High School

Teacher: Janet Keeler

Project # 122

Jara, Mateo

HydroDynamics: Analyzing Pot Design for Effective Water Distribution and its Effect on Plant Development and Wellbeing

Research Proposal, Environmental Research Proposal

On an individual basis, the average pot does not accommodate for the differences between plant species in the home, and oftentimes contributes to plant wilting and death. Contemporary pots allow for much of the water to lay at the top layer of soil, while much of the middle to lower layers to continue dry. Much of the roots are therefore left without water, diminishing the plant's growth rates. Many efforts have been made to find alternate methods of irrigation, but is based around the issues of large-scale irrigation of plants during imposing water deficits. This study focuses on proper water distribution of singular potted plants with specially designed pots to record their resulting overall plant development and wellbeing. In this experiment, a control group of pre-germinated 6 Basil (Ocimum basilicum) plants in store-bought pots will be compared to 6 plants in specialized pots with small tubes within the soil meant to distribute water evenly. With a total of 12 Ocimum basilicum plants, all will be compared by their speed of growth by measuring stalk and leaf growth on a weekly basis, the health of leaves based on their individual Chlorophyll Content Index, and the leaf production, measured in the amount of leaves produced, when, and how large they are on average. Overall, utilizing this research may foster a deeper understanding of the pot's influence on a plant's overall health and vitality, distributing water more effectively without the soil and reducing the frequency of deaths relating to household plants.

Joel Barlow High School

Teacher: Paul Testa

Project # 123

Kaoroptham, Anaya

Title Investigating the correlation between external factors of homicide cases and homicide clearance rates.

Research Proposal, Physical Science Research Proposal

>>>>>   ABSTRACT NOT AVAILABLE <<<<<

Amity High School

Teacher: Sarah Reeves

Project # 124

Kennedy, Ava

Determining the presence of Northern Long-eared bats in Weston, Connecticut using the Titley Chorus.

Research Proposal, Environmental Research Proposal

A study will be conducted to determine the presence of Northern Long-eared bats in Weston, Connecticut. This experiment will be done using the application of the Titley Chorus, an acoustic monitor system that takes in and records bat echolocation calls. White Nose Syndrome is slowly eliminating Northern Long-eared bats, along with other species of bats, and this experiment will show if, in areas with areas closer to human establishments, there may be a decrease of bat colonies in Weston, possibly increasing the spread of disease if they are moving to other colonies. This study will conclude that over time, humans could continue to drive Northern Long-eared bats away from their previous roost locations' original placements.

Weston High School

Teacher: Stacey Greenberg

Project # 125

Khan, Sameer

Identifying Amylase Reaction Rates to Improve Physical Health

Research Proposal, Health Research Proposal

When an individual decides to follow an exercise program, identifying the right exercises is vital towards maintaining one's physical health in order to allow the body to regenerate energy more efficiently via metabolism. This study evaluates how metabolic rates are impacted through various exercise performances. These performances may include a 500-meter run, lunges with 3 sets and 10 repetitions, and 500-meter biking amongst other activities. To begin experimenting, there is a standard rate of metabolism associated with the individual being experimented on. The saliva sample collected from this individual contains the amylase enzyme that is important for metabolic rates by breaking down starch into smaller sugar molecules. The saliva sample that includes amylase is mixed with a starch solution. The presence of sugar molecules can be noted by conducting an iodine test. An iodine test would involve placing a solution of iodine into the mixture and later obtaining a wavelength that corresponds to a specific color. Importantly, the blue color range wavelengths are supposed to no longer be present if broken down sugar molecules are detected. Chemical reaction signs including color change and temperature change, and possibly gas production will be noted in order to measure the reaction time. The same tests for metabolic rates versus time will again be conducted when saliva is collected after the individual performs the various assigned exercises. The exercise with the fastest amylase reaction rate corresponds to the most efficient metabolic rate.

Joel Barlow High School

Teacher: Paul Testa

Project # 126

Khan, Dua

<u>Social Determinants of Cardiovascular Disease of US Veterans</u>

Research Proposal, Health Research Proposal

Social Determinants of Health (SDoH) are defined by the World Health Organization (WHO) as the conditions in which people are born, grow, live, and age, and the wider set of forces and systems shaping the condition of daily life. Researchers have studied social determinants of health in regards to a plethora of diseases including cardiovascular disease (CVD). However, we do not have many studies about SDoH in regards to CVD specifically for veterans (over 15 million in the US). This study will be focusing on the impact of SDoH for CVD for the US veteran population.Data was extracted from utilizing data from the Department of Veterans Affairs Electronic Health Record (EHR). The data was limited to veterans with a diagnosis of CVD from years 2000 to 2019. SDoH measures like housing, income, education were included by the Area Deprivation Index (ADI) scores for every veteran. The analysis is currently under progress. Our hypothesis is that the exposure and severity of CVD is associated with SDoH and may vary by gender. Literature suggests that SDoH may impact health. Healthcare institutions can work towards the improvement of equity in diagnosis and treatment. This study may help inform the specific SDoH in context of CVD among US veterans.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 127

Knispel, William

The effects of sugar and oxygen immediately following head trauma on long-term risk of CTE

Research Proposal, Health Research Proposal

Chronic Traumatic Encephalopathy (CTE) has many causes but one of the most common is repeated head trauma from football. Increasingly, post-mortem analysis of the brains of NFL players has been found to contain high levels of tau protein, the hallmark of several neurodegenerative diseases. Even the brains of high school football players who died of other causes have been found to have unusually high levels of tau protein. These tau proteins can cause lasting side effects like memory loss, reduced appetite, change in personality, depression, anxiety, and eventually dementia or Alzheimer's Disease. There is currently no real way to diagnose CTE. In addition, there is no treatment for it. With thousands of football players in the NFL, tens of thousands in college, and millions in high school it is essential that until a treatment is found, there are ways to reduce the long-term potential of CTE immediately following head trauma. Oxygen and sugar are used as fuel by the brain. By consuming sugar and inhaling extra oxygen immediately after experiencing a hit to the head, the brain may react differently to the hit. CTE will be induced in drosophila using repeated blows from the Chen et Sun model. Immediately after the flies are hit on the head, different groups will receive various amounts of oxygen and sugar. Each group will have their movement, eating patterns, and fatality rates measured. It is expected that flies that receive treatment will recover faster and will have positive results in all measurements.

Ridgefield High School

Teacher: Patrick Hughes

Project # 128

Krenzer, Alexis

The Effect of the Nutritional Supplement, Curcumin, on Vulval induction to evaluate its role in Epidermal Growth Factor Driven Cancers

Research Proposal, Health Research Proposal

Cancer, a leading cause of death globally, will result in 30 million yearly deaths by 2040(National Cancer Institute, 2024). Many epithelial cancers stem from overactivation of the Epidermal Growth Factor Receptor (EGFR) signaling pathway(Liu, 2018). While there are therapeutics targeting the EGFR pathway, the impact of natural compounds on the diseases is less understood. Curcumin, a natural compound and antioxidant, is thought to downregulate EGFR expression in some cancer cells however studies are small(Zoi, 2021). Caenorhabditis elegans have a tyrosine receptor kinase, LET-23, that is closely related to the EGFR, making it a powerful whole organism model to study these cancers(Gauthier & Rocheleau 2017). Over stimulation of the LET-23 pathway results in a Multivulva(Muv) phenotype, a tumor-like symptom(Liu, 2018). To test curcumin's impact, Muv. let-60 (gf) C. elegans will be fed OP50 E. coli $\pm$curcumin $\pm$ controls (paraquat & N-acetyl cysteine) until adulthood; wild-type vs Muv phenotype will be scored. Additionally, ROS accumulation will be quantified using fluorescent dye, and the impact on downstream regulators will be measured using gel electrophoresis and western blots with monoclonal antibodies against these regulators to determine curcumin's mechanism of action(Liu, 2016). Curcumin is expected to down-regulate the LET-23 / EGFR signaling pathway and act as an antioxidant to reverse the Muv phenotype. If this proves to be true, it will support the use of natural compounds, like curcumin, in epithelial cancers.

Staples High School

Teacher: Amy Parent

Project # 129

Kwong, William

Can Curcumin, a natural antioxidant, protect against microplastic damage: studying its effects in Caenorhabditis elegans

Research Proposal, Environmental Research Proposal

Microplastic pollution is a significant issue due to increases in plastic production. Currently, there isn't a solution to combat problems caused by microplastics in the human body. In humans, microplastics are associated with inflammation, disease, and cancer, presumably due to oxidative stress. This study investigates the potential of curcumin, a natural antioxidant found in turmeric, to prevent and reverse oxidative stress caused by aged polystyrene microplastics in Caenorhabditis elegans. N2 strains of C. elegans will be utilized. Curcumin(25uM), dissolved in dimethyl sulfoxide(DMSO), will be used to prevent (co-treatment) and reverse (post-treatment) after aged polystyrene microplastics(1mg/ml) treatment. Lifespan and reproductive rates will be recorded. Reactive oxygen species(ROS), a type of free radical, will be measured using Dichlorohydrofluorescein Diacetate(DCFDA) and Chloromethyl-H2DCFDA assays. Fluorescence microscopy and spectrometry will be used to evaluate in vivo responses and quantitatively measure ROS, respectively. Co-administration during microplastic treatment is expected to protect against ROS increases and decrease in lifespan and reproduction. Post-administration of curcumin is expected to reverse ROS increases and negative impacts on lifespan and reproductive rate. This research could highlight the benefits of curcumin as a dietary supplement to counteract harmful effects of microplastics.

Staples High School

Teacher: Amy Parent

Project # 130

Lee, Milo & **Johnston, Nathan**

Hard-soft electroadhesion: a novel adhesive-free bonding mechanism for conductive and soft materials

Research Proposal, Teams (Research Proposal)

Electroadhesion, a process where conductive materials adhere to soft, aqueous substances under a low-voltage electric field, represents a promising avenue for technological innovation. Recent studies have shown that water within soft materials plays a key role in enabling this adhesion by promoting electrochemical reactions that bond surfaces. While much attention has been given to the materials themselves, little research has examined how variations in water content influence the effectiveness of electroadhesion.Water levels are critical because they directly impact the conductivity, flexibility, and bonding behavior of materials. By altering hydration levels, it may be possible to tune adhesion strength and control the bonding process. Tomatoes, with their high and adjustable water content, provide a unique model for studying this phenomenon due to their agricultural significance and uniform structure. Understanding the role of water content in electroadhesion could offer practical insights for applications in robotics, biomedicine, and manufacturing, where materials of varying hydration are frequently used.This study aims to investigate how water levels in tomatoes affect their electroadhesion properties. Using a drying oven, we will systematically reduce the water content in tomato samples and measure changes in adhesion strength, bonding time, and reversibility under a controlled electric field. By filling this gap in knowledge, our research seeks to uncover new ways to optimize electroadhesion for practical use and expand its applications. This work has the potential to inform future developments in fields requiring precise material bonding and adhesion technologies.

Joel Barlow High School

Teacher: Paul Testa

Project # 131

Li, Matthew

The effect of oleuropein on cytotoxicity and peroxiredoxin expression in cancerous cells

Research Proposal, Health Research Proposal

The anticancerous behaviors of the Olea europaea plant can be attributed to the two phenolic compounds oleuropein (OLE) and hydroxytyrosol (HT). This proposal aims to test both OLE and HT with a modified cancerous cell line MCF-7 in comparison to the normal mammary cell line MCF-10A. The modification made to the cell lines, both cancerous and normal, is the implication of a patient-derived xenograft (PDX) conditioned media to better simulate in vivo tumor microenvironments. In addition, time-lapse fluorescence microscopy will be used for a real-time visualization of the cellular response. The goal of this is to see the impact of OLE and HT on certain molecular pathways including Bax/Bcl-2, p53, peroxiredoxin (Prdx) expression, and reactive oxygen species (ROS) regulation. The predicted results of this testing are based on supportive literature and suggest that a cytotoxic response will be elicited from OLE and HT only in the MCF-7 cancerous cells with a minimal response to the MCF-10A normal cells.

Darien High School

Teacher: Christine Leventhal

Project # 132

Lombardo, Aubrey

Moral Value Differences in Veterans -Compared to Official Military Values, Civilians, and the VIA Character Values-

Research Proposal, Behavioral Research Proposal

While the US military has officially listed morals for each of its branches, it is not clear how well veterans represent these values, or how much the personal moral values of veterans differ from those of civilians. Researching this topic provides further understanding of the mindsets of veterans, which can aid in mental health services for them. This research will allow a clear view of how well veterans represent and align with the current US military. Furthermore, research that provides knowledge on the way humans fundamentally think and behave in various situations is important to many fields of science. My method first addresses gathering general information, such as race, and military involvement. This allows for observation on any patterns that may show up across groups. The survey then has a moral evaluation, where participants rank a set of morals. This is the core of the research, where personal moral values across veterans are examined. I would expect to find patterns of variance across different groups –gender, political party, etc.– it is hard to tell what is morally valued, and how those values will compare to official military values. Future research ideas include looking at what environmental values affect having a military career, and how service affects values. For the next step in my research, I plan to contact veterans' organizations in my area to see if they have veterans who would be willing to take my survey, which is confidential, and would be sent to them through email.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 133

Manglani, Krisha

The Effects of Caffeine on Fine Motor Movements

Research Proposal, Health Research Proposal

In this experiment, the effects of caffeine on fine motor movements will be examined using fruit flies as a model organism to provide information on the potential effects on humans. During the experiment, sixteen fruit flies will be split up into 4 groups and put in an enclosure for three days. Each group will receive a different level of caffeine intake before participating in the maze/challenge activity. After they complete the maze/challenge activity, their movements will be analyzed and mistakes will be recorded in order to determine at what periods of time they are performing fine motor movements. Their performance over time will also be noted in order to assess if constant caffeine consumption benefits or hinders their performance. It is expected that their navigation through the controlled setup will be more precise and have few errors when having a moderate intake of caffeine.

Ridgefield High School

Teacher: Patrick Hughes

Project # 134

Massey, Kate

Healthcare Equity in Adolescent Cancer Patients

Research Proposal, Health Research Proposal

Socioeconomic status (SES) has a big impact on healthcare access and outcomes for teens with cancer. This proposed study looks at how a family's income affects the time it takes to start treatment, access to specialists, and overall recovery. Data would be collected from hospital records, insurance information, and interviews with 30 teens from different income levels. The predicted results show that teens from higher-income families get faster care, better access to specialists, and better outcomes. In contrast, lower-income families face challenges like travel issues, high costs, and delays in treatment. These findings show the need for changes, like better insurance coverage, more local treatment options, and support for families, to make sure all teens with cancer have a fair chance at recovery.

Darien High School

Teacher: Christine Leventhal

Project # 135

Mathews, Morgan

<u>Melatonin Mislabeling</u>

Research Proposal, Health Research Proposal

Melatonin is not an FDA-regulated drug, resulting in the mislabeling of products, which causes dangerous health outcomes. These dangerous health outcomes, such as seizures, are the result of melatonin mislabeling, specifically regarding the quantities of the active ingredients within products. Supplements will be dissolved in methanol, and then use liquid chromatography to distinguish the amount of melatonin and serotonin within the supplements. This is a successful method of discovering content within products. Based on previous research by scientists, CBD was included in products, and melatonin quantities did not match labeled amounts. This shows that the products are mislabeled, which can result in serious outcomes. These products are available for anyone, showing how dangerous they can be. I plan to conduct my own experiment using liquid chromatography to discover the contents within Greenwich, Connecticut's top 10-selling melatonin products

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 136

McCartan, Madeline & **Whitbeck, Alexandra**

Exploring the Relationship Between Crowd Influence and Performance

Research Proposal, Teams (Research Proposal)

Choking under pressure is a common occurrence found among athletes, a confidence breakdown which can be caused by many factors. A moment of success and excelling under pressure can be just as common though, and also is derived from a certain subset of factors. This experiment will bring attention to the effect of crowd noise on athletic performance. This study will be focused on basketball games, so the data will be collected there. A sound meter device will record the intensity of the crowd noise, which collects the decibels of sound in a given space and time. Certain statistics from the game (shot and free throw percentage, and point differential) will also be noted. Finally, we will compare the success of the athletes with the intensity of the sound that was present while they competed. The expected results for this experiment are noticeable improvement in performance for the home team with louder crowd noise present. This research could help programs build a better environment for high school athletes to compete in, as well as being applied to professional athletes.

Ridgefield High School

Teacher: Patrick Hughes

Project # 137

McCauley, Lauren

Family Interpreters' Experiences in Medical Settings

Research Proposal, Behavioral Research Proposal

Due to the lack of professional support in health care, family members as interpreters are normalized, which increases the amount of miscommunication between the provider and the limited-English proficient (LEP) patient. It is important to find professional support for these individuals who experience emotional hardships while worrying about care for their family member. The plan is to send a Google form survey to Hispanic adults who act as family interpreters. This survey will include questions about access to professional interpreters, emotions experienced while interpreting, and areas for improvement. There have been many studies regarding adolescent brokering, but by doing this study, it will help the adults who face this issue. This survey will help improve support for the family interpreters.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 138

Mihopoulos, Luke

Optimized Spiro-MeOTAD with standard 2D/3D Perovskite Solar Cells for improved stability and efficiency

Research Proposal, Physical Science Research Proposal

Perovskite solar cells have been tested as an alternative to current silicon solar cells due to their simple structure and efficiency. They have made great strides in developing efficiency, but their stability has kept them from becoming widespread in the market. This project aims to test various forms of perovskite solar panels modified with polymer dipoles to find structures that have increased stability while maintaining their power conversion efficiency. In this project, several solar cells will contain different mol% of 2D perovskite on top of 3D perovskite. Further, each group will also be tested to determine the optimal oxidized Spiro-MeOTAD doping %. They will be tested for power conversion efficiency, thermal stability, and stability towards humidity. It is predicted that the higher mol% 2D perovskite will have better stability but worse PCE and that the mid-range mol% will have the best balance of efficiency and stability. Further, it is projected that the optimized Spiro-MeOTAD will decrease the rate of PCE degradation in all PSC groups. Regardless of this though, the experimentation will provide invaluable information on the application of additive-free Spiro-MeOTAD on non-2D PSCs.

Darien High School

Teacher: Janet Keeler

Project # 139

Mitev, Alina

<u>Effect of Interventions on Pro Climate Change Mitigation Behaviors</u>

Research Proposal, Behavioral Research Proposal

Interventions aimed at targeting different aspects of the Protection Motivation Theory model (PMT), in conjunction with commitment interventions aimed at targeting habit and other automotive cognitive processes, may be more effective in elicit climate change mitigation behavior in climate change acknowledgers than using the PMT by itself. In order to target the two segments of the PMT, the personal/collective threat appraisal (How does it impact me/us? How severely does it impact me/us?) and the personal/collective efficacy appraisal (What can we/I do about it? How much of a difference will this make? What is the collective population already doing about it, or is the collective population willing to take action?) I will use climate messaging, targeted education, and feedback interventions in the form of articles, videos, and online quizzes assessing total carbon footprint. Analyzing PMT through a collective lens is necessary as climate change is not just a personal threat, and does not just require personal action, but also requires collective action. I will use commitment interventions in the form of goal setting, tracking progress, and accountability to help target automatic cognitive processes (ex. Habit and self regulation). To measure the efficacy of interventions, I will compare the reduction in greenhouse gas emissions from the changes in behavior (ex. Reducing electricity use, using alternative forms of transportation, reduction in process food/meat consumption, etc.) from the PMT interventions, versus the commitment interventions.

Ridgefield High School

Teacher: Ryan Gleason

Project # 140

Mohr, Ava

Investigating the Impact of Timing and Duration of Skeletal Loading Interventions on Bone Density, Muscle Development, and Motor Function in Cerebral Palsy

Research Proposal, Health Research Proposal

This study investigates the effects of timing and duration of skeletal loading interventions on bone density, muscle development, and motor function in individuals with cerebral palsy (CP). Bone density is assessed using Quantitative Computed Tomography (QCT), Quantitative Ultrasound (QUS), and Radiographic Absorptiometry. Muscle development is analyzed through Magnetic Resonance Imaging (MRI) and Ultrasound Imaging. Motor function is evaluated using Electromyography (EMG) and Timed Up and Go (TUG) tests, which provide insights into neuromuscular coordination, mobility, and balance. Participants are divided into three groups: Early Childhood, Adolescence, and Adulthood. Interventions, including controlled resistance training and weight-bearing exercises, are implemented at varying intensities and durations tailored to each group. Bone density and muscle development are tracked using imaging techniques, while motor function is assessed through functional tests and muscle activation patterns. Skeletal loading interventions are performed at different developmental stages, with frequency and intensity adjusted for each group. Group 1 receives shorter, less intense interventions to promote bone development without overstressing the skeletal system, while Groups 2 and 3 undergo longer, more intense interventions. Participants are followed over periods of 3 months to 1 year with regular assessments. It is predicted that early, long-duration interventions will improve bone density, muscle strength, and motor function in individuals with CP, with greater benefits seen in adolescents and adults. The study aims to identify the optimal timing and duration of interventions for better rehabilitation strategies for CP.

Darien High School

Teacher: Guy Pratt

Project # 141

Morton, Kehara

Botox versus Galcanezumab treatment on the alleviation of Chronic Migraines

Research Proposal, Health Research Proposal

Chronic migraines (CM) are a neurological disorder that are defined as having a headache at least 15 times per month with 8 being migraines for at least 3 months. Migraines are accompanied with a variety of symptoms including: nausea, photophobia, phonophobia, and pain. There are many ways to alleviate migraines, but some are better than others. onabotulinumtoxinA (botox) is a purified protein that has been proven to alleviate migraines with administration to the forehead, temples, neck, back of the head, upper back, and bridge of the nose. It is taken by pain receptors in the muscle's nerves and deactivates those receptors. Galcanezumab, also proven to alleviate migraines, is a GCRP antibody that binds to CGRP to block the activation of trigeminal nerves which are responsible for the onset of migraines. A clinical trial consisting of a sample of patients aged 18-65 diagnosed with CM will be conducted. Three randomly determined groups will be studied over the course of 6 months. The first group will be administered 120 mg/month of galcanezumab following an initial 240 mg/month loading dose. The second group will be administered 31 botox injections of 5 units (for a total of 155 units). The third group will be administered a saline injection as placebo. The results of the study are predicted to support the hypothesis that botox is more effective in reducing migraine days in patients with CM. This study hopes to further understand the efficacy of certain treatments on alleviating chronic migraines.

Darien High School

Teacher: Christine Leventhal

Project # 142

Moss, Lola Moss

Incentivising Fungus (Fusarium oxysporum) to Quickly Degrade Plastic

Research Proposal, Environmental Research Proposal

Climate change is an urgent global issue, with rising emissions and environmental degradation threatening the planet's future. While nationwide bans and mandates, particularly targeting large oil companies, may be necessary to address the root causes of climate change, individual actions can also play a role in mitigating waste, such as reducing plastic consumption and increasing recycling efforts. Sustainability is a key factor in combating pollution and the broader climate crisis. One promising development in this area is the potential use of Fusarium oxysporum, a fungus that has been shown to degrade plastics. Specifically, Fusarium oxysporum breaks down polyethylene terephthalate (PET) plastic by cleaving the ester bonds, converting it into BHET (bis(hydroxyethyl) terephthalate), a more easily recyclable form of plastic. This degradation mechanism evolved as the fungus breaks down cutin, a waxy coating on apples, to access glucose for growth. Given this natural ability, I hypothesize that by bonding a metabolite to BHET, we could enhance the fungi's degradation process, speeding up the breakdown of plastic. This approach would focus on post-consumed PET, particularly BHET, which is more accessible for metabolic breakdown. Ideally, this could create a continuous cycle in which plastic is repeatedly broken down, metabolized, and broken down more while degrading other pieces of PET at the same time, promoting a more sustainable solution for plastic waste.

Weston High School

Teacher: Stacey Greenberg

Project # 143

Muccia, Grace

<u>Understanding The Effects of Music Usage On Caregivers of Alzheimer's Patients</u>

Research Proposal, Behavioral Research Proposal

Across the United States, approximately 7 million people are affected by Alzheimer's disease (AD), and patients are often angry, stressed, or confused, causing caregivers to experience high levels of stress. I am planning to determine whether music is beneficial to the patient and the caregivers' overall well-being because it can help caregivers receive the help they need mentally and contribute to their overall life quality. I plan to make a 3-section survey, which addresses consent, information on the patient and caregiver, and the usage of music and its effects. The participants in this study will be found by reaching out through email to local nursing homes and support groups that reside on social media platforms. All participants will have a link shared with them, which will lead them to an anonymous survey on Google forms with questions related to my topic. This survey will aid me, through data collection, to determine whether music is beneficial. It is expected that caregivers receive benefits from using music as a tool because the patients are calmed down and less agitated. Since the patients are less agitated, there is less stress placed upon the caregivers, allowing the caregivers to ease their mental state. This research is significant because caregivers around the world are affected mentally by their demanding jobs, and it is important to pay attention to their well-being. Considering I have created the survey, I anticipate the next step for my research to distribute the surveys and begin collecting data.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 144

Nehro, Stella

Stella Nehro - Scent change due to dichogamy leads to a shift in pollinators of Annonacea squamosa.

Research Proposal, Environmental Research Proposal

There is a well-established understanding of how certain factors such as color, petal shape, and size affect pollinator preference. However, olfactory cues present a large gap of this understanding. Although recent years have shown an increase in literature surrounding the role scent plays in pollination, much remains to be understood: particularly regarding how scent changes due to dichogamy affect pollinator preference. A tree that presents an opportunity to fill some of these gaps is A. squamosa, which produces dichogamous flowers that are 'sweet smelling' during their female stage and 'rotten smelling' during their male stage. Literature exists on the pollinators of A. squamosa, however no literature exists on how scent change affects pollinator preference. The goal of this study is to discover how scent change due to dichogamy affects the pollinator behavior in A. squamosa flowers. An Annonaceae tree would be selected for observation and the totality of its flowers would be monitored. Researchers would utilize cameras to monitor the flowers remotely and record visitation rates with the help of AI Model YOLO. About thirty hours after flowering, the male stage begins and a new cycle of data collection would begin. It is predicted that Annonaceae flowers will be pollinated by beetles during their male stage and by bees in their female stage. The results for this study are expected to provide valuable insights into the role of scent in pollination, and has the potential to contribute to advancements in agricultural biotechnology.

Darien High School

Teacher: David Lewis

Project # 145

Nehro, Marin

Stress levels in Adult Emergency Medical Technicians (EMTs) vs Youth EMTs

Research Proposal, Behavioral Research Proposal

Marin Nehro Darien High School Stress Levels in Adult Emergency Medical Technicians (EMTs) vs Youth EMTs Emergency Medical Technicians are under immense amounts of stress when at work. They perform at high levels of excellence for long shifts and often witness traumatic events. In the Darien Connecticut community, high school minors are able to obtain Emergency Medical Technician certificates and volunteer for twenty - four hour periods of time, multiple times per month. Darien EMS also employs adult volunteers who do the same work as the high schoolers. Adults and minors experience stress from various external factors, but when working the same job, minors may be more likely to display high levels of stress as compared to their adult counterparts. I will be using the ENGERWALL fitness tracker to monitor heart rate. This device is worn on the wrist and data (average heart rate) from the device is sent to a smartphone. I will simultaneously use an anonymized google form that does not collect name or email address from participants to receive a self reported rating of stress levels from a scale of 1-10. I will also be using google sheets to organize the collected data. Acknowledgements Dr. Kirsten Cherian, Clinical Assistant Professor at Stanford University Mrs. Janet Keeler, Darien High School Biology Dept.

Darien High School

Teacher: Janet Keeler

Project # 146

O'Malley, Eliza

The effect of high salinity on coral's acclimation to climate change

Research Proposal, Environmental Research Proposal

There are many ways that corals help the ecosystem, whether its for the environment, the land or the fisheries corals have a great impact. Corals dying have many problems on the world such as population decreases in fishes and the increase in coral bleaching. This research is important because it could change the way that corals can be biologically engineered to withstand the rising temperatures. Coral reefs are a part of fragile ecosystem that struggles due to coral bleaching. Coral bleaching occurs when water temperature increases due to climate change. This research is important because it highlights some of the work already done by marine biologists from places such as Northeastern and University of Miami. This would help with supporting reef recovery. This research is also important in creating awareness for funding. The proposed outcome is that after the two month period, the corals will be fully adapted

Ridgefield High School

Teacher: Ryan Gleason

Project # 147

Oshin, Lolade

Exploring Sialokinin as a Potential Nociceptive Modulator in Eisenia fetida while Investigating the Presence of NK1-Equivalent Receptors through Behavioral Assays

Research Proposal, Health Research Proposal

There are conflicting predictions about how Sialokinin's functions (vasodilation, modulation of macrophages, NK1R agonist) are carried out in invertebrates like Eisenia Fetida earthworms. This study aims to determine if Sialokinin, found in Aedes aegypti mosquitoes, positively or negatively impacts the pain experience of earthworms by conducting a behavioral assay of how Sialokinin, when applied topically, impacts the spontaneous mobility, movement sharpness, speed of movement, and extrusion of coelomic fluid of earthworms. This study will also test whether NK1-like receptors are present in earthworms, and how they influence the pain experience. Earthworms will be placed in petri dishes full of concentrated solutions (0.2% - 4.0%) of Lidocaine, Sialokinin, Substance P, and Saline to determine the non-lethal and viable concentrations. They will be applied topically, and observations will be collected based on the physical behaviors of the earthworms while being probed by forceps. Results of this study are predicted to portray that when Sialokinin is applied topically, the earthworm's physical behaviors will become more rigorous due to interactions with the NK1-like receptor. The earthworm's reaction to the Sialokinin solution will resemble that of Substance P, and higher concentrations will shorten the time needed to stop the spontaneous movement of the earthworms. Lethal concentrations of Sialokinin and Substance P are expected to be concentrations greater than 0.2%. The results of this study will provide insight into Sialokinin's potential role as a pain modulator and determine if Sialokinin negatively or positively affects nociception in earthworms.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 148

Osier, Gus

Fungal Bioacculuation and Conductivity

Research Proposal, Physical Science Research Proposal

The goal of this study is to explore the application of mycelium in electronics, attempting to augment their physicality using bioaccumulation of conductive and non-conductive metals, observing the effect they have on overall mycelial conductivity. The goal of this study is not to test and augment the health benefits of fungal samples, and no amount of fungal mass, enriched or not will be consumed during the course of the study. Experiments will be conducted by cultivating small samples of Pleurotus ostreatus (Oyster Mushroom) on agar, once the sample is of a suitable size the sample will be transplanted into a variety of enriched agar formulas, these formulas will be enriched with various low concentrations of metals including copper, aluminium, iron, lead, and silver. The samples will be routinely inspected as they consume the enriched agar, with the goal being bioaccumulation of high levels of the introduced metals. Once a suitable amount of agar has been consumed by the fungus, presuming its survival, the resulting metal enriched mycelium will then be tested for conductivity with a multi-meter setup. This experiment will deal with enriched agar, which I will manufacture using various metals in low concentrations in a powdered form. These metals will be mixed with the agar to provide a mineral dense food source for mycelium with the goal that the metals will be bioaccumulated within the hyphae and their conductive or nonconductive properties will be partly transferred.

Newtown High School

Teacher: Timothy DeJulio

Project # 149

Palla, Kartheek

Indigenous medicinal plants used to treat malaria

Research Proposal, Health Research Proposal

Indigenous medicinal plants hold immense potential as sustainable and accessible resources for healthcare. Rooted in centuries of traditional knowledge, these plants have been utilized by indigenous communities to treat various ailments, ranging from infections to chronic diseases. This research explores the pharmacological value of these plants, their bioactive compounds, and their role in addressing modern health challenges such as antibiotic resistance, mental health disorders, and chronic conditions. By examining traditional uses and applying modern scientific methods, this study highlights the potential of indigenous medicinal plants to contribute to global healthcare systems. A comprehensive review of literature reveals the ethnobotanical significance of these plants and their integration into drug development. Case studies from diverse regions, such as South America, Asia, and especially Africa, illustrate their widespread use and the wealth of knowledge passed down through generations. The findings underscore the importance of biodiversity conservation, as many medicinal plants face threats from environmental degradation and overharvesting. Moreover, the study investigates how traditional knowledge can inform sustainable healthcare practices, reducing reliance on synthetic drugs and addressing healthcare inequities in underserved populations. Collaborations between indigenous communities, scientists, and policymakers are crucial for ethical and effective integration of these plants into modern medicine. Indigenous medicinal plants represent a vital intersection of traditional wisdom and contemporary science, offering promising solutions for global health challenges while advocating for the preservation of cultural heritage and environmental sustainability. These findings underscore their significance as a cornerstone for advancing sustainable and inclusive healthcare systems.

Darien High School

Teacher: Janet Keeler

Project # 150

Pereira, Arianna

AI Prediction: Randomized Clinical Trial Enrollment

Research Proposal, Health Research Proposal

The successful recruitment of participants is a critical determinant of randomized clinical trial outcomes, yet many trials fail to meet enrollment targets, leading to delays, resource inefficiencies, and trial terminations. This study proposes the development of a machine learning (ML) model to predict clinical trial enrollment rates with 80-90% accuracy, leveraging key trial characteristics such as location, intervention type, condition studied, and more. Using data from ClinicalTrials.gov, a comprehensive dataset of past and ongoing trials was compiled. This study involves data preprocessing, feature selection, and the application of RStudio code to identify the most significant predictors of enrollment success. The methodology encompasses data cleaning, exploratory data analysis (EDA), feature engineering, model training, and evaluation, with metrics such as Mean Absolute Error (MAE) to assess model precision. Hyperparameter tuning and cross-validation ensures generalizable results. Key insights are derived from the relative importance of features in predicting enrollment, measured by the difference of predictions, offering actionable recommendations for improving recruitment strategies and, ultimately, saving the lives of those who can benefit from experiential treatment. Preliminary research highlights the urgent need for such innovation: only 31% of UK trials meet enrollment goals, and 25% of cancer trials fail to enroll sufficient participants [1]. The anticipated ML model aims to address these challenges by optimizing resource allocation, enhancing recruitment diversity, reducing trial failures, and accelerating the timeline for medical innovation. This work has the potential to transform clinical trial design and management, promoting more efficient and inclusive studies while advancing public health outcomes.

Joel Barlow High School

Teacher: Paul Testa

Project # 151

Pereyra, Asher

<u>The Effect of Temperature on Fossil Formation</u>

Research Proposal, Physical Science Research Proposal

Fossils are one of the most important tools in all of biology, as they give insight into the past of the Earth, and how organisms interacted or lived in their environments. By understanding the processes that create and form these fossils, it allows for more understanding of the ways that life on our planet changed. However, in nature, fossils are extremely rare, requiring very specific conditions which are not available in a large amount of areas, and takes hundreds to even thousands of years to form. However, in laboratory settings, it has been demonstrated that the artificial creation of fossils is very much possible, and experiments have been conducted that have been able to form these fossils in short periods of time, such as only a few days (Saitta et al. 2019). However, these short-term experiments generally need high grade equipment that can operate at very high temperatures of 200°+. This experiment aims to use lower grade equipment with lower temperatures to create comparable results, by extending the process over longer periods, of up to 1 month. It also aims to investigate the role that temperature plays in the formation of fossils, with multiple different groups at different temperatures. In this procedure, specimens are exposed to sediment and different temperatures to allow for the fossilization of those specimens. It is expected that those specimens which are exposed to the higher temperatures will be affected the most, and become the best preserved fossils, comparable to those of other experiments.

Ridgefield High School

Teacher: Ryan Gleason

Project # 152

Petrini, Jacob

Affect of Flagellum on photosynthesis rate

Research Proposal, Physical Science Research Proposal

The proposal is to genetically modify organisms to make them more proficient. Methods will use the CRISPR method to genetically modify Ceratium. These were chosen based on the flagellum and the photosynthesis. They will be inserted with the Shf1 mutated gene from another dinoflagellate Chaydomas. This shorter tail will make it more difficult to swim around then how it normally would be by using its tail. This in turn will affect how it collects its energy. It will no longer hunt and will have trouble staying afloat. The idea behind this is if the tail needs to be shorter and it can no longer to locomotive as effectively. They will have to turn more to photosynthesis to survive and it will be its main source of energy which will lead to more photosynthesis overall. With its ability to perform cell division it will allow it to pass on its genes quickly which will help humans by collecting CO_2 in areas of high carbon emissions like rivers in cities.

Newtown High School

Teacher: Timothy DeJulio

Project # 153

Platt, Taylor

Associations between sleep duration and multiple dimensions of cognitive functions among US adults

Research Proposal, Behavioral Research Proposal

Sleep is essential for optimal cognitive brain function but there is limited research on sleep duration's effect on various executive functioning domains including suppression of bias, working memory, and divergent thinking simultaneously. This study explores the relationship between sleep duration and cognitive performance. A sample of 100-250 United States adults will take a 20-minute survey following the Pittsburgh Sleep Quality Index after completing a series of cognitive tests. Cognitive performance will be evaluated through Stroop, London Tower, Digit Span, and Alternative Uses tests. Participants will be classified into groups of high sleep (>8 hours per night), average sleep (6-8 hours per night), and low sleep (<6 hours per night). It is predicted that the average sleep group will be associated with the highest cognitive performance, followed by the high sleep group and the low sleep group. These findings locate a general finding for sleep duration's effect on various cognitive factors which may inform public health promotion of optimal sleep to maintain cognitive health among adults.

Darien High School

Teacher: Guy Pratt

Project # 154

Rajangam, Tanvi

Chemical Detoxification as a Parameter of the Health of the New Creek Marsh

Research Proposal, Environmental Research Proposal

Coastal salt marshes are vital ecosystems that perform essential functions such as carbon sequestration, nutrient cycling, and water purification; however, these habitats are increasingly threatened by human activities and environmental degradation. This study examines the chemical filtration capacity of the New Creek Marsh in Westport, Connecticut, as a measure of marsh health and evaluates the potential impact of nearby transportation infrastructure on the marsh ecosystem. The marsh's health can be determined by employing chemical testing, phytoplankton analysis, and vegetation surveys. This research investigates nitrate and phosphate reduction, the presence of polycyclic aromatic hydrocarbons (PAHs), and soil organic carbon (SOC) dynamics across seven sampling sites within the marsh. Proposed findings suggest that nitrate and phosphate levels decrease from the marsh inlet to its mouth, though reductions are less than 60%, indicating a moderately healthy ecosystem with potential early-stage degradation, and SOC measurements should reveal an accumulation rate of around 80 g C/m^2/year, which is below the average for healthy marshes, around 110 g C/m^2/year, further supporting evidence of early-stage degradation for the marsh. Minimal levels of PAHs near the train station may indicate limited direct contamination from railway operations. This research highlights the marsh's role in chemical detoxification and its resilience despite moderate degradation. Findings underscore the importance of proactive conservation strategies to mitigate the cascading ecological impacts of marsh decline, particularly in urbanized coastal areas. The study also contributes to understanding how anthropogenic activities, such as railway operations, intersect with wetland ecosystems, informing sustainable management practices.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 155

Raskopf, Charles

PlaceholderName

Research Proposal, Physical Science Research Proposal

Due to global climate change, severe weather is becoming increasingly common. This is problematic for areas in the Southeast United States and Central America as hurricanes become increasingly common. Thus, there is a need for heightened disaster response capability. Georgia and North Carolina were assisted by the National Guard and their UAVs to respond to and get information from critical and inaccessible areas. It will be increasingly important to have access to this type of technology for rapid response in the future, as storm intensity is predicted to increase as well as their prevalence. From this issue, there are 2 potential solutions: increase budget and train workers in standard fire and police work to operate $10,000 drones, or develop cheaper solutions that require only BVLOS certification, a tutorial, and flight experience. The latter should not only improve the availability of UAVs for search-and-rescue due to lower initial cost, but be extremely capable as its long wingspan of 6ft should give great roll axis stability. Additionally, the ability to house almost anything that would be useful for aerial imaging sets this apart from other drone solutions as every part is fully adjustable in computer-assisted-design software, making it able to be modified for nearly any scenario. This would require a 3-d printer, ASA filament, FIbreglass, epoxy, carbon fiber tubes, two brushless motors and ESCs, a flight controller, transmitter, receiver, and remote camera system. The criteria for success is over one-and-a-half hour flight time, 750ft altitude imaging, and operation in 15mph wind.

Darien High School

Teacher: Guy Pratt

Project # 156

Raz Guzman, Carolina

The effects of increased systemic toxicities by anti-cancer compounds on the clearance rate of the G6 dendrimer.

Research Proposal, Health Research Proposal

Malignant gliomas make up 70% of brain cancer diagnoses and are aggressive, with an average survival rate of only 15-20 months, Current treatments, such as chemotherapy, radiation, and surgery are limited by systemic toxicities, accuracy, and the inability to cross the blood-brain barrier (BBB). Dendrimers, nanoscale macromolecules, offer a potential solution for targeted drug delivery to brain tumors, preventing off-target toxicities that unnecessarily harm patients. Specifically, Generation 6 (G6) PAMAM dendrimers (6.7nm in size) can cross the BBB and target Tumor-Associated Macrophages (TAMs), cells that promote tumor growth by manipulating the immune environment. This is a significant advancement, as previous treatments haven't been able to efficiently target TAMs. Previous studies using GL261 glioblastoma mouse models and 9L gliosarcoma rat models demonstrated G6 dendrimers' ability to accumulate at the tumor site (target it accurately, meaning it would able to effectively deliver medication), as confirmed by confocal imaging. The dendrimer's slower renal clearance (the circulation of the G6 out of the body via the kidney) compared to earlier generations was found beneficial, allowing prolonged circulation for sustained drug delivery. However, the effectiveness of G6 dendrimers in combination with Cisplatin, a chemotherapy drug known for causing kidney damage and immune toxicity, has yet to be tested. A future study combining G6 dendrimers with Cisplatin would help assess whether this system can effectively deliver chemotherapy while minimizing harmful side effects. Ultimately, G6 dendrimers have the potential to revolutionize brain cancer treatment by improving drug delivery, reducing toxicity, and enhancing patient outcomes in glioma therapy.

Darien High School

Teacher: David Lewis

Project # 157

Schroeder, Ivy

Enhancing Martian Biosignature Detection: A comparative study of Noachian Regoltih in Simulated Aqueous Environtments

Research Proposal, Physical Science Research Proposal

The Noachian era of Mars around 4 billion years ago, is thought to have been the prime era of surface water abundance, and thus habitability. To discover just what was going on during this period, a simulant of this time period can be replicated and exposed to similar Mars conditions. This comparative study aims to investigate the possible biosignature formation and preservation in Noachian regolith simulants compared to current mars simulants under simulated aqueous conditions to highlight the importance of accuracy. By incubating microbial communities in both stimulants, differences in microbial growth diversity, and metabolic activity will be assessed. This research will contribute valuable insights to astrobiological investigations on Mars, such as the Moon to Mars mission.

Darien High School

Teacher: Christine Leventhal

Project # 158

Schwartz, Ezra

High False Negative Results in Radiologists Detecting Glenoid Labral Tears: Comparing Deep Learning Approaches to Improve the Diagnostic Accuracy Through MRI

Research Proposal, Health Research Proposal

Shoulder glenoid labrum tears are common injuries (6% general population;35% athletes (Zughaib, 2017)). Undiagnosed injuries lead to chronic instability and pain. Magnetic resonance arthrograms(MRA) provide high sensitivity(88%) and specificity(93%) but are invasive, and costly. Magnetic resonance imaging(MRI) is less invasive but offers lower sensitivity(76%) and specificity(87%). This study will improve diagnostic accuracy of MRI detecting glenoid labrum tears using convolutional neural networks(CNNs) and transfer learning. UNets, used for transfer learning in a musculoskeletal classification network, will demonstrate a novel methodology gaining representations of features extracted from anatomically similar data. The study will test the accuracy of transfer learning, single(grouped) vs double(successive) vs single(non-grouped) for the encoder using hip MRIs(n=>1000;New HavenCT) and knee MRIs(n=1370;StanfordCA) to capture general structural patterns. Final models will classify healthy versus torn glenoid labrum using MRI scans confirmed by surgical operation reports, the diagnostic gold standard(n>300). All models will use PyTorch as the base library. Metrics such as sensitivity, specificity, and area under the curve(AUC) will evaluate the models' performance. This study builds on prior work, which achieved an 84.3% accuracy using transfer learning from brain MRI(Clymer,2019), and hypothesizes that anatomically relevant datasets will yield better results. Through the use of UNets this study aims to develop a CNN-based diagnostic tool that reduces false negatives, enhances early detection, and minimizes reliance on invasive and costly procedures.

Staples High School

Teacher: Amy Parent

Project # 159

Scutari, Vito

Comprehensive Assessment for Executive Dysfunction

Research Proposal, Physical Science Research Proposal

Each year, over one million people in the United States suffer from traumatic brain injury (TBI), with 230,000 requiring hospitalization and 50,000 ultimately dying. Of those hospitalized, 34% are discharged with TBI-related disabilities, contributing to the estimated 5.3 million Americans living with TBI-induced impairments today. These impairments severely impact patients' ability to perform everyday tasks. Additionally, TBI can affect anyone, from an average person to a professional athlete. Furthermore, traditional assessment methods for executive dysfunction are not only costly and time-consuming but also prone to human error due to their paper-and-pencil or verbal nature, limiting their effectiveness in frequent evaluations. This paper presents the Comprehensive Assessment for Executive Dysfunction (CAED), a mobile, tablet-based, gamified tool designed to overcome these challenges. By integrating gaming elements with clinical evaluation, CAED offers a more accurate, efficient, and patient-friendly approach to assessing executive dysfunction in TBI patients. CAED features realistic game scenarios that replicate daily activities. Player behavior, timing, and decisions within these scenarios are tracked and when analyzed, will provide insights into patients' cognitive function. Significant progress has already been made, specifically in its software architecture and visual design including basic systems and concept art. CAED has the potential to revolutionize neurological assessment and rehabilitation, offering a novel, technology-driven solution to improve care for individuals with TBI.

King School

Teacher: Victoria Schulman

Project # 160

Seymour, Ella

eDNA collection on connecticut rivers to test for the presence/absence of brook trout

Research Proposal, Environmental Research Proposal

This study investigates the relationship between trout population density, diversity, and the presence and complexity of in-stream structures, such as tree roots and boulder clusters. In-stream structures are known to enhance habitat diversity by creating refuge areas from predators, stabilizing sediment, and reducing flow velocity. These are all critical for survival growth and reproduction. By comparing populations across river segments with varying levels of in-stream structural complexity, we aim to determine whether more complex habitats support higher trout densities and greater genetic diversity. We hypothesize that river segments with greater complexity in terms of tree roots and boulder clusters will exhibit increased trout population density and diversity. This is due to the enhanced availability of refuge and feeding opportunities. Field surveys will be conducted to measure fish abundance, size distribution, and habitat complexity at multiple sites, while statistical analysis will be used to assess correlations between habitat features and trout populations. This research has implications for habitat restoration strategies, particularly in rivers impacted by human activity, where the reintroduction of in-stream structures may support the recovery and sustainability of trout populations.

Darien High School

Teacher: David Lewis

Project # 161

Sherman, Michael & **Kunar, Kaelen**

<u>Determining the Effects of PFAS on Sargassum Algae</u>

Research Proposal, Teams (Research Proposal)

With plastics being used more and more in everyday life, the presence of toxic substances in the natural environment is constantly increasing. With this increase comes uncertainty regarding the health of various life forms, like sargassum algae, which is typically fast-growing. This study explores the effects of PFAS (per-and-polyfluoroalkyl substances) on sargassum. PFAS, according to National Institute of Environmental Health Substances, are complex chemicals found in everyday products since the 1950s. A PubMed Central report details about the effects PFAS can have on plants like inducing "deleterious effects to the plant itself, such as altering the metabolomic profile in plant roots and leaves," indicating that PFAS could affect sargassum as well, which is important for it's provision of food, refuge, and breeding grounds for many marine animals. A ScienceDirect report then indicated that PFAS inhibited plant growth in concentrations including "64.40, 156.70, and 251.40 μM", giving some idea as to what concentrations to use. In this study, samples of sargassum will be given time to grow different concentrations of PFAS in water, which will be measured using a mass spectrometer. Then, measuring the growth in algal mass using a scale is the next step. This study expects the algae's mass growth to be inhibited more as the PFAS concentration increases. In the future, there could be a drastic change in algae prevalence if PFAS' presence in nature is not curtailed, negatively impacting all life and ecosystems dependent on the algae.

Joel Barlow High School

Teacher: Paul Testa

Project # 162

Sisca, Layla

The Efficacy of Temperature on Drosophila Melanogaster Sleep

Research Proposal, Behavioral Research Proposal

This experiment focuses on determining whether higher or lower temperatures are more beneficial for sleep quality. This will be evaluated using Drosophila melanogaster and then related back to humans, finding a solution for sleep disorders such as insomnia and difficulties maintaining sleep. The experiment includes two vials, each containing approximately 20 Drosophila melanogaster. One vial will be incubated at a temperature of 85°F, while the other will be incubated at 65°F. A control group at 75°F will also be included. Time-lapse cameras will record movement, and the data will determine which temperature fosters improved sleep. Findings will contribute to understanding whether colder or warmer environments enhance sleep quality.

Ridgefield High School

Teacher: Ryan Gleason

Project # 163

Slade, Amalia

The Psychology of Yondr Pouches and The Impact on Student Well-being

Research Proposal, Behavioral Research Proposal

Yondr pouches (magnetic 'phone jails') have become a new phenomenon introduced to schools across the country that limits students' cell phone usage while in school. Cell phones are an indispensable part of everyday life—especially to a teenager—and can have negative effects on student well-being. This study aims to support the scholarly hypothesis that yondr pouches are beneficial for student focus and well-being while also validating student emotions. To investigate this hypothesis, participants pooled from senior classes at St. Lukes and Greens Farms Academy responded to a survey adapted from the PERMA Workplace Survey and a Cellphone Addiction Measurement. The survey results supported that initially, students do better in school when not distracted by a cell phone but feel more stress and disconnection. Scores on the PERMA Workplace Survey improving on average by +1.2, seen in each question (post) for GFA students, indicate that psychological values, cognitive factors, and study habits influence learning motivation and academic success. Findings suggest a need to replicate this study to compare private vs public schools regarding cell phone usage.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 164

Smith, Emerson

How Neurospora Reacts to a Gradual Change in Environment

Research Proposal, Environmental Research Proposal

Pathogenic fungi are silent killers of the immune compromised and have been a long overlooked problem. As climate change has gradually seeped into our environment, it has also gradually effected forgotten about parts of the ecosystem. Never before have pathogenic fungi been able to survive in high temperatures, keeping the healthy and able-bodied free from the worry of fungi-related diseases. Until now that is. This research aims to test of Neurospora (a non-toxic, very commonly studied, and genetically similar to pathogenic fungi, fungus) will react to a gradual change in environment. This will be done by gradually increasing the severity opf a changing environment in five research groups of Neurospora. The experiment at hand is meant to mimic the effects of climate change on these dangerous pathogenic fungi, on a much smaller scale in a more controlled environment using a safe-to-handle fungus. Neurospora is also a very tolerant fungus that typically does not die in changing environment, so the goal is to observe the physical and microscopic changes that take place throughout the experiment. Fridges, heat incubators, and moisture chambers are all tools that will be used in a more lab-like setting in order to conduct the experiment that will take place over four to five months. This project will take place in five groups, a control group (68 degrees F, 50-60% on hygrometer), cold group (40 degrees F, 50-60% on hygrometer), a hot group (96 degrees F, 50-60% on hygrometer), dry group (20-30% on hygrometer), and a moist group (80-90% on the hygrometer).

Ridgefield High School

Teacher: Ryan Gleason

Project # 165

Steneken, Alivia

The Effect of Environmental Chemicals Found in Menstrual Products on Women's Reproductive Health.

Research Proposal, Health Research Proposal

Around 1.8 billion people menstruate each month (26% of the global population), this means that 1.8 billion people may be, unknowingly, exposing toxic chemicals to highly permeable skin. Chemicals absorbed vaginally bypass the liver and go directly into the circulatory system. These chemicals are detrimental to human health. Prolonged exposure can cause many complications such as polycystic ovary syndrome (PCOS), hormonal cancers, infertility, endometriosis, toxic shock syndrome (TSS), developmental issues in fetuses, and metabolic disorders such as obesity. This experiment aims to learn more about the dangers of environmental chemicals and raise awareness of the topic.

Ridgefield High School

Teacher: Ryan Gleason

Project # 166

Swearingen, Jeffrey

Generating Heat-Tolerant Copepods through Ingestion of Heat Tolerant Phytoplankton - Improving the Ability of Marine Fauna to Withstand Climate Change

Research Proposal, Environmental Research Proposal

Ocean temperatures are rising. Ensuring the survival of marine zooplankton is essential to maintaining the food chain. Previous evidence suggests that zooplankton can undergo heat acclimation through exposure to progressive heat environments; however there is limited evidence that the same can be accomplished through xenohormesis, an easier solution to implement. In the present study, copepods local to Long Island Sound, will be fed phytoplankton heat stressed at a variety of temperatures ranging from 20-30oC to generate psychological changes to produce heat-resistant copepods. The studies will use the principle of xenohormesis, adaptation to a stressful environment through response to chemical signals of other species that have been exposed to a similar environment. It is anticipated that the copepods grown at 20oC and fed phytoplankton grown at the highest level of heat stress (30oC), will be more heat resistant than the copepods in the control group, and the copepods grown at the same temperature but fed less heat stressed phytoplankton (20, 25oC, respectively). Additionally, it is believed that heat-stressed phytoplankton will have lower polyunsaturated fat (PUFA) levels and lipid peroxidation which is the proposed mechanism to protect the copepods. If proven, seeding local waters with heat resistant phytoplankton provides an easy solution to generate a population of heat resistant copepods, thereby protecting the marine food webs as water temperatures rise. This is critical given the fact that these organisms are the first trophic link of the food web.

Staples High School

Teacher: Amy Parent

Project # 167

Taleb, Eva

<u>The Effects of Nitrogen Runoff Pollution on the Competition Between terrestrial and aquatic Invasive and Native Plant Species in the Northeast.</u>

Research Proposal, Environmental Research Proposal

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 less harmful to invasive species than it is to native species. The purpose of the experiment is to investigate how nitrogen pollution affects native and invasive species differently on land and in water and compare plant growth as well. The species of plants studied will be local and tested in a lab-controlled 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 # 168

Taylor, Olivia

Purification of Cyanobacteria using UV-C light irradiation

Research Proposal, Environmental Research Proposal

Cyanobacteria is rapidly becoming an issue, detrimental to human and plant life. Phosphorus and Nitrogen runoffs from pesticides and excess CO2 emission in the atmosphere are the leading causes of these harmful blooms. Humans are enabling this algae to grow, while it deteriorates waterways rendering most water sources unusable. By exposing harmful cyanobacteria, such as Anabaena which is native to Connecticut, to UV-C light, the cells will cease to secrete harmful toxins and will decrease in size, ultimately killing the cell. By stopping these algae blooms from producing such toxins, it will further enhance water treatment methods for both plant and human life. The way this will be tested by having two samples of Anabaena cultured in BG-11 growth medium and their growth will be monitored using a spectrophotometer to identify the late logarithmic stage (OD750), which is ideal for UV-C irradiation. One sample will be kept in a dark room as a control, while the test sample will be irradiated with UV-C light for 10–30 minutes, with observations recorded at 5-minute intervals. The irradiated sample will then be transferred to a fresh BG-11 medium to assess regrowth, with cell density, size, and shape monitored over several days using microscopy and spectrophotometry. If the cell density of the test sample is lower, then the cells have died and the UV-C light worked. Upon completion of the experiment, it will further research into preventing these cyanobacteria blooms from spreading and will ultimately make freshwater safer and cleaner.

Joel Barlow High School

Teacher: Paul Testa

Project # 169

Tersigni-Bjugan, Ari

AI Hologram

Research Proposal, Physical Science Research Proposal

This project is hoping to combine a holographic projector with an Ai therapist app to make a hologram that can be a therapist. This project is important to the development of AI relationships with humans. If an AI therapist appears three dimensional, then people may have more of a connection to it. This project also helps with the creation of holograms which could, in the future, be another form of entertainment, communication and many more possibilities.

Newtown High School

Teacher: Timothy DeJulio

Project # 170

Tiedemann, Catherine

Consumer's Knowledge of Ultra-Processed Foods and Associated Health Risks

Research Proposal, Behavioral Research Proposal

Ultra-processed foods (UPFs) have become a major part of the worldwide diet, especially in developed countries like the United States. Not everyone has a solid understanding of the definition of these foods and how they can cause harm. I had cancer in middle school and I am extremely interested in processed foods and how it can cause cancer, obesity, and other diseases. I created an anonymous survey to assess UPF consumers' knowledge of what an ultra-processed food is and how often they consume them. I asked for race, education, age, and where they live. I asked what they ate for breakfast, lunch, and dinner the day they completed it. I also asked about their knowledge of NOVA classification. The next step is to send out this survey to friends and family and on social media and analyze the data I receive.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 171

Torchia, Ari

Effect of Molecular Layer Deposition (MLD) Coating, Sodium Hydroxide Treated, and Untreated Stilbite on Adsorbtion of Copper in Soil

Research Proposal, Environmental Research Proposal

Excess copper in soil impedes plant growth and makes fertile soil unproductive and unable to be farmed. This is a global issue, specifically in undeveloped countries that don't have the resources to sustain themselves. Using zeolites however, effective copper remediation in soil is possible by changing the zeolite's pore size. In the experiment, lima beans will be used in an environment with copper to test zeolite's effectiveness in removing copper. Additionally, the condition where the zeolite's pore size decreases would utilize a Molecular Layer Deposition (MLD) coating with precursor chemicals that overlap to reduce pore size. The experimental condition where the pore size increases would involve zeolites being treated with NaOH by submerging zeolites in it before being dried. Finally, to determine how much of the copper was adsorbed by the zeolite, a UV-Spectrophotometer and cuvette filled with soil from each condition will individually determine concentration of copper. The expected results of the study are that larger deviations in pore size from the atomic radius of copper cause less copper to be adsorbed, whereas the closer the pore size is to copper in size, the more copper is adsorbed. The results could be explained by a larger pore size allowing the zeolite to adsorb larger molecules, but the closer the pore size is to the size of the material being absorbed, the less molecules can be adsorbed. Through this experiment, superior remediators of copper could be created and sent to communities who can more efficiently grow food, diminishing world hunger.

King School

Teacher: Victoria Schulman

Project # 172

Vitikov, Nikita & **Arnold, Matthew**

Evaluating Therapeutic Antisense Oligonucleotide as a Disinfectant

Research Proposal, Teams (Research Proposal)

Acinetobacter Baumannii is a nosocomial bacteria that is heavily resistant to antibiotics. A. Baumannii has been found in many highly sanitized hospitals infecting sick patients, and leading to illnesses such as pneumonia. In figure 3, Antisense oligonucleotide therapy (ASO) is a new field of study that attempts to bind to RNA to exert or inhibit protein expression (Dhuri, 2020). ASO have been used against bacteria such as E. Coli, C. Difficile (see figure 1 and 2), B. Fragilis, and E. Faecalis, and yielded lower percent growth in these bacteria (Sharma, 2018). This study aims to find if other bacteria can survive in ASO. To do this, the cell growth of Corynebacterium pseudodiphtheriticum (see figure 5), will be measured and closely monitored in the solution. The growth of the bacterium will be compared to its growth in a solution without the oligonucleotides. A mixture of 1.5 g of 4-aminopyridine and 1.16 g of 1,10-dichlorodecane in 26 mL of amyl alcohol will be stirred and refluxed in N_2 for 21 hours to make the solution. After which, the solution will be mixed with the bacterium. A separate mixture with no oligonucleotides will also be tested simultaneously as a control group. The percent growth will be measured under a spectrophotometer over 24 hours. The results are predicted to decrease the percent growth in the bacterium similar to B. Fragilis and E. Faecalis. This study hopes to find a new possible treatment for antibiotic-resistant bacteria.

Joel Barlow High School

Teacher: Paul Testa

Project # 173

Walsh, Gianna

Examining the Effects of Theater Participation on College Level Theater Students vs Regular College Students' Self Esteem Level

Research Proposal, Behavioral Research Proposal

Self-esteem is critical in college students' academic achievement, social relationships, and overall well-being. Acting offers a structured and creative platform for self-expression, emotional exploration, and empathy development, which may positively influence self-esteem. However, limited research exists on the psychological benefits of acting for college students. This study explores the relationship between participation in acting classes or theater programs and self-esteem levels among college students aged 18–25. Using the Rosenberg Self-Esteem Scale (RSES) as a quantitative measure, self-esteem levels of 100–150 participants, including acting participants and non-participants, will be compared. The survey will also collect demographic data, frequency of acting involvement, and open-ended responses on the perceived impacts of acting. We hypothesize that acting participants will exhibit significantly higher RSES scores compared to non-participants, suggesting enhanced self-esteem. Additionally, we anticipate a positive correlation between the frequency or duration of acting involvement and self-esteem levels. Expected findings could highlight acting as a valuable tool for personal development, reinforcing prior research on its benefits for emotional and social competencies. This study will also address gaps in the existing literature by focusing on college students, an underrepresented demographic in theater research, and emphasizing the immediate effects of acting participation. Results may have implications for integrating theater into college curricula, therapeutic programs, and institutional support for theater initiatives. Future research should consider longitudinal approaches to evaluate the durability of acting's impact on self-esteem and expand sample diversity for broader applicability.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 174

Wijesekera, Soumya

Determining an Individual's Driving Ability while Injured

Research Proposal, Health Research Proposal

Soumya Wijesekera Determining an Individual's Driving Ability While Injured On average, Americans spend around 60.2 minutes a day driving. While driving, the most common movements are radial deviation (tilting the wrist towards the thumb), ulnar deviation (tilting the wrist towards the pinky finger) and elbow movement. A common type of splint for upper extremities injuries is a long arm splint, which is used for immobilization of the wrist and elbow. The purpose of the research question is to determine an individual's ability to drive while being injured. It is hypothesized that if an individual is placed in a long arm splint, their ability to drive will be less than if they complete the driving test with no splint at all, because long arm splints limit upper extremity mobility. First, the long arm splint will be made and attached to the participant's dominant arm prior to completing the driving test. The SimuRide Home Edition Driving Simulator and a steering wheel hardware set will be purchased to mimic a driving simulation, and the number of successful parking maneuvers, lane changes and turns by the participant will be recorded. Next, the participant will complete the same typing test without a splint. Data will be analyzed by evaluating the participant's number of successful parking maneuvers, lane changes and turns during all trials, and a T-test statistical analysis test will be performed. Increasing knowledge of one's driving ability while injured can correlate with one's ability to return to driving and every day routines.

Amity High School

Teacher: Sarah Reeves

Project # 175

Williams, Catherine

What Is The Incidence of Silent Heart Disease in The Police Force of Fairfield County Calculated by Calcium Score?

Research Proposal, Health Research Proposal

Police officers nationwide face increased risks of heart disease and elevated calcium levels due to factors including high stress, irregular work schedules, trauma exposure, and unhealthy habits exacerbated by their profession. Addressing this under-researched issue, this study aims to evaluate the calcium scores (CAC) of police officers aged 30 and above in Fairfield County, Connecticut. The primary objective of this study is to assess if an institutional wide quality improvement project aids in identifying coronary artery disease and/or other non-cardiac incidental findings among first responder voluntary participants in Fairfield County. The secondary objective of this study is to assess if participants implemented any behavioral, lifestyle or medication changes after their CT calcium screening visit. Data collection will include age, race, gender, medical history, medications, comorbidities and radiology reports. Finally, this study aims to raise awareness and prioritize cardiovascular health, not only for those in Fairfield County but for first responders nationwide.

Darien High School

Teacher: Christine Leventhal

Project # 176

Yan, Elise

Lentinula Edodes (Shiitake Mushroom) extracts delivered in Mesoporous Silica Nanoparticles (MSNs) to preserve food

Research Proposal, Environmental Research Proposal

The amount of meat recalled each year is high. In 2023, over 125,000Kg of ground beef were recalled and of that nearly 33,000Kg contained toxin-producing E. coli (FSIS, 2023). Additionally, 194.7 million Kg of beef were lost due to discoloration alone (Ramanathan, 2021). Beef spoilage is caused by microbes and lipid oxidation which causes foul odors and discoloration, making it unappealing to consumers (Ismail 2008). There are negative economic and environmental impacts due to waste that caused by these spoilages. The demand for natural preservatives is high. Creating long-lasting natural preservatives that are palatable to a variety of consumers is required. This study aims to produce long-lasting, natural antimicrobial and antioxidant extracts from Lentinula Edodes (shiitake mushrooms) loaded into Mesoporous Silica Nanoparticles (MSNs) to extend their shelf-life (Lu, 2021). Shiitake mushrooms have antioxidant and antimicrobial effects due to the polysaccharides and phenolic compounds they contain (Eliuz, 2021). These properties within the extracted solution will be confirmed by agar well diffusion, resazurin microtiter assay, total phenolic content tests, DPPH radical scavenging assay, and an oxygen radical absorbance capacity assay. When effectiveness is confirmed, the extracts $\pm$ MSNs will be evaluated for their antioxidant and antimicrobial effectiveness in long term meat preservation. This research could generate a new natural, sustained release food preservative. Additionally, it could help reduce environmental waste in the US, as it is estimated that a 1% waste reduction could help save a significant amount of water and energy, while decreasing carbon dioxide emissions.

Staples High School

Teacher: Amy Parent

Project # 177

Young, Sienna

Effect of dietary sweeteners on lipid accumulation in obese C. elegans to evaluate if calorie-free sweeteners promote weight reduction.

Research Proposal, Health Research Proposal

Obesity, a chronic and complex disease, has reached pandemic status, with prevalence rates affecting over 42% of the U.S. population by 2018 (Boutari, 2022). Dietary sweeteners (DSs) have emerged as a widely used alternative to regular sugar to combat obesity, yet their impact on lipid accumulation and other obesity-related metrics remain controversial. This study aims to investigate the effects of various DSs on lipid accumulation in glucose-induced obese C. elegans. Popular sweeteners and controls include Glucose, Saccharin Sodium (SOD), Sucralose (SUC), Neotame (NEO), and Stevia at both environmental and allowable daily intake concentrations (Jiang, 2024). Impact will be analyzed through multiple assays including fat content analysis via Nile Red staining, body length and width measurements using microscopy, locomotive behaviors, and biochemical assays to evaluate lipid metabolism-related enzymes. These methods will provide insight on the physiological impacts of DS's on obese C. elegans. It is anticipated that Neotame will reduce lipids in obese C. elegans, while SOD and SUC will increase lipid accumulation, with variations depending on the environmental or allowable daily intake concentrations. Stevia, one of the most popular DSs, has yet to be studied and, therefore, can not be evaluated into the hypothesis. Using glucose as a control has never been studied. This research could provide valuable and novel insight into the potentials of specific dietary sweeteners at environmental or ingested concentrations to reduce lipid accumulation and reduce obesity in the general population.

Staples High School

Teacher: Amy Parent

Project # 178

Zaback, Emma

The Effect of Minimization on Adolescents in Police Interrogations: False Confessions

Research Proposal, Behavioral Research Proposal

This study investigates the dangers of minimization tactics used in police interrogations and their influence on adolescents. Minimization, a legal interrogation tactic, downplays the seriousness of a crime to elicit confessions by suggesting leniency or portraying the crime as less severe (Luke & Alceste, 2020; Senese, 2014). While foundational research by Dr. Fabiana Alceste and Professor Luke Kassin has examined how minimization affects adults, limited literature addresses its effects on adolescents, prompting the current investigation. The research seeks to answer, "How does minimization imply leniency via pragmatic implication?" (Stine, 2024). We hypothesize that minimization tactics may work even more effectively on adolescents, who often fail to act in their own best interests due to their underdeveloped risk assessment and decision-making abilities (Nightingale and Fischhoff, 2001). Data will be collected through Qualtrics, an online survey software, from high school students aged 14 to 18. Participants will review interrogation transcripts across four conditions: control, minimization tactic, direct promise, and honesty theme. They will then respond to a questionnaire assessing sentencing expectations, leniency inferences, perception of crime severity, and perceived usefulness of cooperation. To ensure safety and confidentiality, all responses will be anonymous, and the study will undergo IRB and school review. Parents and students must provide informed consent. By raising awareness about manipulative interrogation tactics and their impact on adolescents, this study aims to influence policy changes and promote ethical interrogation practices that safeguard the rights of minors.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 179

Zerboulis, Joanna

Botulinum Toxin effect on Muscle Spasticity in Parkinsons Patients

Research Proposal, Health Research Proposal

Muscle tension and spasticity significantly hinder the quality of life in patients with Parkinson's disease (PD), limiting mobility and causing extreme stiffness. This study investigates the efficacy and safety of injecting small doses of botulinum toxin (BoNT) to alleviate these symptoms. In previous studies, botulinum toxin has been successful in reducing muscle spasticity in post stroke patients. This randomized, double-blind, placebo-controlled clinical trial includes 90 PD patients experiencing moderate to severe muscle tension. Participants will receive targeted intramuscular injections of either BoNT or saline placebo in affected muscle groups. Motor function will be measured by the Unified Parkinson's Disease Rating Scale (UPDRS) and muscle spasticity will be measured via electromyography. Each will be taken at baseline and 12 weeks post-treatment. It is hypothesized that BoNT will result in a statistically significant reduction in muscle tension and improved motor function without compromising overall muscular strength. Expected results include improved UPDRS motor subscale scores and enhanced patient-reported outcomes related to pain and mobility.This study could enhance the therapeutic potential of BoNT for PD-related spasticity, offering a way to manage motor symptoms and improve patient quality of life. If successful, this trial may pave the way for BoNT to become the default symptom alleviator for PD.

Darien High School

Teacher: David Lewis

Project # 180

Zhang, Violet

The Anti-Tumor Effect of N1 Neutrophil-Derived Exosome

Research Proposal, Health Research Proposal

Tumor-associated neutrophils (TANs) play a key role in tumor progression, and neutrophils in the N1 state have anti-tumor effects; moreover, neutrophils can secrete exosomes extracellularly to exert tumor-regulating functions. In this study, we attempted to establish an in vitro method for inducing TANs to polarize toward N1, and extracted their exosomes to test their anti-tumor functions. By adding sea buckthorn fruit oil to HL60 cells and detecting the relevant markers of TANs polarization direction, CD206, CCL2 and Arg2, it was found that sea buckthorn fruit oil could significantly inhibit the polarization of HL60 in the N2 direction and increase the proportion of N1 polarization. Extracted in vitro-induced exosomes from HL60 cells, and added the exosomes into human gastric adenocarcinoma cells AGS cells, it was detected that the exosomes could reduce the survival rate of AGS cells, and Western Blot assay detected that the exosomes could promote the apoptosis of AGS cells by affecting the Bax/Bcl-2 pathway. This study provides a new idea to prepare exosomes with anti-tumor effects in vitro.

The Ethel Walker School

Teacher: Melissa Bernardo