Project # 1

Coughlin, Carolan

<u>An observation of the eating habits of parasitized versus non-parasitized Mud Crabs.</u>

Completed Project, 06-Behavioral

Say's Mud Crabs, native to Long Island Sound, are threatened by the rapidly growing Loxothylacus panopaei parasite. The parasite alters crabs' behaviors, and destroys their ability to survive and reproduce. Understanding how parasites affect native species helps us to better protect them and gives insight into how "loxo" presents in crabs. This study focuses on the consumption rates of crabs affected by the parasite in comparison to those not affected. Data was collected for 2 weeks in a lab where 2 groups of crabs, total of 12, were left with juvenile mussels, and consumption rates were observed. A Welch's t-test showed that the results of this study were insignificant. This study could be used to predict how the introduction of Loxothylacus panopaei could affect food chains and crab populations. Larger testing groups in the future would improve the accuracy of the results.

Darien High School

Teacher: Christine Leventhal

Project # 2

Scutari, Vito

Design and Application of Gamified Health Tools: From Population-Level Habit
Formation to Clinical Evaluation in Traumatic Brain Injury

Completed Project, 09-Physical Science

In the United States, around 90% of the nation's $4.9 trillion in annual healthcare spending is linked to largely preventable chronic conditions such as obesity, type 2 diabetes, and cardiovascular diseases, according to the Centers for Disease Control. At the same time, acute neurological injuries impose major clinical and economic burdens: approximately one million Americans experience a Traumatic Brain Injury (TBI) annually, with 230,000 requiring hospitalization and 50,000 succumbing to their injuries. This contributes to the current 5.3 million living with long-term disability as a result of TBIs, according to the International Brain Injury Association. These realities underscore a broader issue in modern healthcare: how can health systems promote and help sustain preventative health, and how do we better care for them when serious illness or injury does occur? This paper examines gamification as a strategy to address both challenges through the design and application of two interventions. First, HealthHero, a gamified health-monitoring application, reframes preventative behaviors, such as exercise and sleep, into challenges and upgrades designed to promote long-term consistency and healthy habit formation in the general population. Second, Comprehensive Assessment for Executive Dysfunction (CAED), a tablet-based serious game, embeds diagnostic tasks in interactive scenarios designed to mimic real-world tasks in order to improve patient engagement and enhance the accuracy of executive function assessment in patients with TBIs. Together, these tools illustrate how gamified health interventions can bridge prevention and clinical care, offering scalable, engaging, and patient-centered solutions to two of healthcare's most pressing problems.

King School

Teacher: Victoria Schulman

Project # 3

Mehta, Lilah

CX3CR1+ Cell Type-Specific ERK Hyperactivation Promotes Inflammatory Remodeling

Completed Project, 08-Health & Medical

Aberrant immune signaling plays a central role in neurodegenerative disorders, driving chronic inflammation and neuronal dysfunction. Dysregulated Mitogen-Activated Protein Kinase (MAPK)/Extracellular Signal-Regulated Kinase (ERK) activation has been linked to the emergence of disease-associated microglia (DAM) in Alzheimer's disease (AD), which impacts over 55 million patients worldwide. DAMs exhibit altered transcriptional profiles that can be either protective or pathological, depending on context. Microglia and various other myeloid populations express the chemokine receptor CX3CR1. However, the mechanisms by which ERK hyperactivation in CX3CR1+ cells influences inflammation remain unclear. To address this, we generated a cell-type-specific mouse model carrying the BRAFV600E mutation (BRAF(Ht)/CX3CR1(Ht)), which induces ERK hyperactivation in CX3CR1-expressing cells. Using this model, we investigated how ERK hyperactivation shapes peripheral immune responses under both baseline and inflammatory conditions induced by lipopolysaccharide (LPS). Proteomic profiling of spleen tissue using mass spectrometry was performed to identify differentially expressed proteins across experimental groups. At baseline, BRAF-mutant mice exhibited a primed immune state marked by enhanced interferon (IFN) signaling. LPS challenge amplified this effect, producing a pro-inflammatory cytokine response and inhibiting adaptive and homeostatic immune pathways. Given the role of myeloid cell dysfunction in AD pathogenesis, these results suggest that peripheral ERK hyperactivation drives systemic immune remodeling that parallels neuroinflammatory changes in AD. Further studies will investigate how microglial-specific ERK hyperactivation in 5xFAD mice impacts neuroinflammation and evaluate ERK signaling as a therapeutic target in modulating immune responses across peripheral and central disease contexts.

King School

Teacher: Victoria Schulman

Project # 4

Wang, Leon

<u>Repurposing Idiopathic Pulmonary Fibrosis Drugs to treat vascular Alzheimer's disease: a safe, effective, and accessible approach to treating Alzheimer's disease</u>

Completed Project, 08-Health & Medical

Alzheimer's disease (AD) is a debilitating form of dementia that affects 55 million patients worldwide. Found in 1-in-4 people, 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 counterparts. APOE4 is closely linked to cerebral amyloid angiopathy (CAA)—the deposition of beta-amyloid on blood vessels—and blood-brain barrier (BBB) dysregulation, ultimately resulting in cognitive deficits such as ischemia and intracerebral hemorrhage. Studies have shown that inhibition of fibronectin has led to cognitive improvement in mice, inspiring us to evaluate the role of fibronectin in CAA in this study. To confirm the upregulation of fibronectin in APOE4 cells, we performed immunofluorescent staining and confocal microscopy on APOE4 and APOE3 iPSC-derived pericyte cultures to measure fibronectin levels. We hypothesized that the adhesive properties of fibronectin in the extracellular matrix contribute to its role in vascular amyloid deposition. To that end, we treated a 3D culture of IPSC-derived endothelial cells with a PBS negative control, Vehicle + amyloid protein, and amyloid pre-treated with fibronectin, and we found that the presence of fibronectin significantly increases vascular amyloid binding. Given the clear links between fibronectin and amyloid deposition, we are now exploring the development of a blood-brain barrier-permeable compound to inhibit fibronectin adhesion by using Autodock Vina software to simulate molecular docking and calculate binding affinity. Our findings suggest the promising nature of fibronectin and work towards developing a treatment for millions of patients affected by vascular Alzheimer's dementia worldwide.

King School

Teacher: Victoria Schulman

Project # 5

Maltese, Dillon

<u>A Voice-Controlled Robotic Arm for Assisting Complex Surgical Tasks</u>

Completed Project, 09-Physical Science

In the U.S., there are over 250,000 annual deaths attributed to medical errors, with over 4,000 involving surgical accidents. While current robotic surgery has advanced precision in the operating room, nearly all current systems rely on a master-slave control system, requiring surgeons to manipulate the robot through a hand-operated console. As Augmented Reality (AR) is integrated into the operating room to enhance precision, it also increases a surgeon's cognitive load, especially when manually manipulating tools like an ultrasound probe, which is crucial for AR-guided procedures. To combat this, I developed a voice-controlled robotic arm to serve as an additional "hand," reducing multitasking while keeping a surgeon focused on the procedure. This device aims to aid surgeons by assisting with tasks that need to be completed, rather than replacing the surgeon's hands. The device was 3D modeled, machined in aluminum, and is driven by NEMA stepper motors coupled to harmonic drives for high torque and low backlash. In motion-control and stability tests, the robotic arm demonstrated accurate, repeatable motion with responsive, real-time voice activation. Clinical feedback at Weill Cornell Hospital has shown strong potential to improve ultrasound handling and similar precision-based tasks, with benefits in efficiency and concentration. Ongoing work aims to develop a claw, expand the task library, and implement the device across numerous surgical scenarios. By pairing AR with autonomous robotic manipulation, this system moves beyond traditional robotic surgery, creating a more intuitive assistant that offers a pathway to safer, more efficient, and cognitively lighter surgery.

King School

Teacher: Victoria Schulman

Project # 6

Reinhoefer Ribeiro, Bruno

A Sustainable Treatment For Heavy Metal Pollution: Adsorption and Desorption of Ni(II) Ions In Water Using DNA-Wrapped Carbon Nanotubes

Completed Project, 09-Physical Science

As of 2024, one in four people globally lack access to safe drinking water. According to the United Nations (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 and sustainable solutions for wastewater treatment. Adsorption, the physical/chemical adherence of pollutants onto a larger surface, has garnered much attention due to its massive potential for sustainability due to desorption, during which pollutants are triggered to detach from adsorbent surfaces. Carbon nanotubes (CNTs) are pure carbon nanomaterials that function as ad/desorbents, but encounter issues hindering adsorption efficiency, such as insolubility and aggregation. DNA-wrapped CNTs (DNA-CNTs), however, are soluble and do not aggregate as much, thus they were tested in this study as viable ad/desorbents of Ni(II) metal in water. Upon conducting a batch adsorption experiment incorporating a DNA-CNT dosage over time, which produced effective adsorption, desorption using DNA-CNTs was accomplished through sonication/ultrasound treatment and heat application. It was found that heat application was an effective method for triggering desorption of Ni(II) ions from DNA-CNT surfaces, supporting the hypothesis, but ultrasound treatment instead enhanced adsorption. Moreover, heat application presents a viable method to desorb pollutants from DNA-CNT surfaces, permitting filtration and subsequent reuse of the same DNA-CNTs for iterative rounds of ad/desorption. Optimized and scaled, this approach has the potential to treat large bodies of metal-contaminated water to provide safe drinking water to millions globally.

King School

Teacher: Victoria Schulman

Project # 7

Sommerville, Marilyn

<u>Assessing the Effects of Equine Grazing Muzzles on Upper Incisor Length and Dental Qualities in Ponies</u>

Completed Project, 07-Environmental

Grazing muzzle usage in ponies is a common management strategy to reduce forage intake on pasture and decrease risk of obesity and laminitis. Though grazing muzzles are effective and preserve regular equine behaviors, they may compromise other aspects of welfare, including the equine dentition. Though 17% of horse owners reported damage to their equine's dentition in a survey, this area has not been researched, so the study aimed to determine the effects of three types of equine grazing muzzles on incisors and the dentition in ponies. Pony 1, Pony 2, and Pony 3 were equipped with grazing muzzles of soft, medium, and hard base material, respectively, and allowed to graze on pasture for approximately 6 hours daily for 19 weeks. Upper incisors were measured regularly throughout the study. Muzzles were force tested to determine relative material rigidity. Results indicated that Pony 1 experienced an average increase in incisor length, while Pony 2 and Pony 3 experienced an average decrease in incisor length. Overall, the use of a grazing muzzle decreased incisor length by an average of 0.00965 centimeters per week. The increasing hardness of muzzle base material was directly proportional to increasing incisor wear. The study found that grazing muzzles have the potential to impact the dentition in ponies and recommends using a grazing muzzle with a flexible, soft base material to minimize incisor wear. Understanding the dental effects of grazing muzzles will help owners make informed, case-specific decisions to manage their horses' health issues and promote greater welfare.

King School

Teacher: Victoria Schulman

Project # 8

Vivanco, Lucia

<u>Experimentation and Application of Nutrient Additives to Enhance Resilience of Coral Reefs Against Climate Change</u>

Completed Project, 07-Environmental

Coral reefs and seaweed habitats are critical ecosystems that regulate global biodiversity, carbon cycling, and shoreline protection, yet both are experiencing devastating decline due to climate change. More than 75% of coral reefs are currently threatened, and projections estimate that 99% will experience mortality if global temperatures rise by just 2°C. The collapse of these foundational species would destabilize marine food webs and reduce oceanic carbon sequestration, resulting in catastrophic consequences globally. To address this, the present study investigates the use of engineered nutrient-infused tiles to promote the health of Astrangia poculata and Sargassum filipendula. Experimental tiles were developed with varying porosities and coatings, including general additives, manganese, multivitamins, and uncoated controls. Each treatment group was maintained in flowing seawater for four weeks, during which growth rates and photosynthetic efficiency were recorded weekly using weight measurements and PAM fluorometry, while coral symbiont density was quantified via microscopy. Results showed limited benefits of nutrient-infused tiles for Sargassum filipendula, but significant improvements for Astrangia Poculata, including enhanced growth and higher symbiont densities compared to controls. These findings highlight the potential of additive-coated substrates as a novel and practical strategy for reef restoration. By integrating ecological insights with engineered materials, this research provides a framework for mitigating the effects of climate change on marine ecosystems and offers a promising solution to preventing coral bleaching events, which I hope to evaluate through field application tests.

King School

Teacher: Victoria Schulman

Project # 9

Jakubowsky, Mia

Predicting Detectability of Transiting Exoplanets: A Python-based Signal-to-Noise Ratio Model

Completed Project, 09-Physical Science

With an estimated 300 million Earth-like exoplanets in the observable universe, many potentially capable of supporting life, the study of exoplanets has become a pressing scientific priority. However, despite this scientific relevance, exoplanet detection remains largely inaccessible to nonprofessional astronomers. Existing tools require advanced expertise, and few provide practical, system-specific predictions. The aim of this research was to develop a user-friendly tool that enables nonprofessional astronomers to detect and study transiting exoplanets, expanding participation in exoplanet research. A Python model was created to predict the minimum detectable transit depth of an exoplanet for any given telescope and camera system by calculating the signal-to-noise ratio (S/N) for stars of different magnitudes and converting it into a corresponding detection limit. The model also estimates when an image will saturate based on stellar brightness and exposure settings, helping observers optimize their data collection. Model predictions were validated using data from the Barnes-Bristow Observatory in Simsbury, CT, and the John J. McCarthy Observatory in New Milford, CT. The S/Ns of hundreds of stars were measured and converted into minimum detectable transit depths. The model's outputs and experimental data differed by 0.97 parts-per-thousand (ppt), demonstrating excellent predictive accuracy. The model was successfully used to detect the exoplanet HD 189733b using instruments that had never previously been used for research purposes. Its precision and accessibility demonstrate its promise as a practical tool for small-telescope observatories and citizen scientists, with further refinement expected to enhance its accuracy and scientific impact.

King School

Teacher: Victoria Schulman

Project # 10

Kennedy, Madison

Illuminating the Role of Lipid Metabolism Pathways in T-cell Exhaustion
Immunotherapies work to regulate immune dysfunction, which aids cancer treatment.
Researchers have begun to examine the effect of T-cell exhaustion on immunotherapy
success, as it pla

Completed Project, 08-Health & Medical

Cancer is a pervasive condition with approximately 39% of people receiving a cancer diagnosis at some point in their lives. To address the prevalence and significant toll of cancer, immunotherapies are a burgeoning cancer treatment methodology. As more research has been conducted in the field of immunotherapy, T-cell exhaustion has become a prominent challenge: it intensifies immunotherapy failure and loss of tumor control. One area of research within the field of T-cell exhaustion focuses on metabolic pathways; however, there are still many questions surrounding the role of lipid metabolism pathways within the T-cell exhaustion cycle. In this study, we worked to elucidate specific pathways related to lipid accumulation. Lipid accumulation can be harmful to the cell as it forms lipid peroxides, often leading to T-cell oxidative stress and T-cell exhaustion. We used CRISPR technology and E. coli to make a retrovirus that was used to infect T-cells to inhibit two vital lipid metabolism pathways. We performed analyses using flow cytometry with fluorescent dyes to track exhaustion markers within the T-cells. This was useful in determining the role of each pathway in both acute and chronic conditions. One of the primary preliminary findings suggested that the CD36 pathway may not play as key a role in lipid accumulation as previously thought. This study aimed to further the understanding of T-cell lipid metabolism and its potential role in the exhaustion phenotype, providing better grounds for immunotherapy research and improved cancer treatments.

King School

Teacher: Victoria Schulman

Project # 11

Ajayi, Olivia

<u>Real-Time Instance Segmentation for Curb and Path Detection in Assistive Wearables for Blind and Low-Vision Assistance</u>

Completed Project, 08-Health & Medical

This research investigates whether instance segmentation using YOLOv11 can effectively detect curbs, sidewalks, and walkable paths in real-time for integration into wearable technologies designed to assist blind and low-vision individuals. A study on falls among US seniors with severe vision impairment, conducted by the CDC, reports that 46.7% of participants reported at least one injury-inducing fall in 2014, indicating the inefficiencies of the white cane. Electronic travel aids (ETAs) attempt to address these limitations by utilizing sensors and computer vision to enhance environmental awareness; however, most address only a single limitation of the white cane, while performance in other aspects suffers. This research aims to combine two preexisting programs to create a novel YOLO-based instance segmentation model that identifies critical pathway features with sufficient accuracy to restore ground awareness and support navigation assistance programs to a higher degree. The YOLOv11 model was trained using supervised learning with a custom dataset developed using a wearable RGB imaging device. Annotations to the dataset, including segmented masks and preprocessing, were applied before training. Training and validation results demonstrated consistent convergence, high precision and recall values, and strong mean average precision scores. Confusion matrix analysis indicated robust classification, with rare misclassifications occurring between visually similar categories. Validation predictions indicated strong generalization across diverse conditions, although performance declined in low-contrast or cluttered environments. These results support that deep learning-based segmentation can provide reliable hazard and pathway detection for assistive wearables, confirming this model's potential to offer low-vision individuals greater independence and quality of life.

King School

Teacher: Victoria Schulman

Project # 12

Nomani, Noor

<u>Alarmin release by renal cell carcinoma cells undergoing hypoxia-induced cell death</u>

Completed Project, 08-Health & Medical

Clear Cell Renal Cell Carcinoma (ccRCC) is the most common and aggressive form of kidney cancer, often associated with mutations in the von Hippel–Lindau (VHL) gene, which leads to dysregulated hypoxia-inducible factors and increased angiogenesis. Similar to other cancer treatments, Lenvatinib (Lenva), an angiogenesis-targeting drug, initially reduces tumor growth but often lacks long-term efficiency, potentially due to hypoxia-induced cell death mechanisms. This study aimed to investigate whether hypoxia occurs in the tumor microenvironment (TME) following Lenva treatment, and whether hypoxic conditions could induce necrotic cell death, leading to the release of interleukin-1α (IL-1α), a pro-inflammatory molecule thought to promote tumor regrowth. Using the LVRCC67 ccRCC cell line, cells were cultured under controlled conditions, and optimal seeding density was established to avoid space-limited cell death. ELISA assays were used to measure osteopontin (OPN) as a marker of hypoxia following Lenva treatment administered via orthotopic (OT) or intravenous (IV) routes. Although Lenva administered via OT showed the highest relative OPN levels, statistical analysis revealed no significant differences between treatments. While our initial goal was to assess IL-1α release from necrotic cells under hypoxic conditions, experimental limitations prevented confirmation of this pathway. These results suggest that Lenva may induce hypoxia in ccRCC, but further studies are needed to determine whether hypoxia-driven necrosis contributes to tumor progression and therapy resistance. On a larger scale, this research portrays a key challenge in cancer care. While drugs like Lenva improve survival, resistance and tumor adaptation limit their long-term success. Understanding the role of hypoxia and inflammation in treatment failure could guide better therapies, lower healthcare costs, and improve patients' quality of life.

King School

Teacher: Victoria Schulman

Project # 13

Vijay, Avani

Analyzing How Changes in Perfusate Preparation and Organ Type Affect Hemolysis During Perfusion

Completed Project, 08-Health & Medical

Analyzing the Effect of Changes in Perfusate Preparation and Organ Type on Hemolysis During Machine Perfusion Ex vivo machine perfusion (EVMP) enables physiologically accurate drug modeling but hemolysis from lysed red blood cells (RBCs) interferes with drug concentration and absorbance testing. Saline RBC washing causes osmotic damage while PrismaSol dialysate restores electrolytes. This study compared hemolysis from saline vs. PrismaSol washing across empty, kidney, and liver circuits. PrismaSol reduces hemolysis vs. saline by stabilizing RBC membranes; livers induce less hemolysis than kidneys due to dual cannulation. Saline protocol tested empty/kidney circuits; PrismaSol tested all three. Experimental group absorbance (500 nm) measured hemolysis over time; areas under curves of experimental group rates were analyzed via t-tests/ANOVA. PrismaSol significantly reduced hemolysis in empty circuits ($p=0.0341$) with ~75-80% lower AUCs across all conditions. Kidney and liver circuits showed higher hemolysis than empty circuits (ANOVA $p=0.0131$), but kidney vs. liver differences were non-significant under PrismaSol ($p=0.473$). PrismaSol dialysis effectively minimizes hemolysis during EVMP, confirming its effectiveness over saline. Organ circuit influences baseline hemolysis (kidney>liver>circuit trend). Future studies should combine Rejuvesol and PrismaSol during RBC preparation, test acellular perfusates, and assess lower perfusate flow rates in kidney circuits.

Amity High School

Teacher: Sarah Reeves

Project # 14

Chen, Jordan

Developing a Climate Finance Vulnerability Index (CFVI) for Connecticut to Identify Communities with High Climate Risk and Disproportionately Low Recovery Funding

Completed Project, 07-Environmental

Climate change is intensifying as seen through the increased frequency and severity of climate related disasters. Greater exposure, loss, and barriers to recovery after climate-related disasters are experienced by more socially vulnerable communities. While prior vulnerability indices quantify exposure and social risk, they rarely incorporate actual disaster-recovery funding, limiting evaluation of whether resources are equitably distributed. This study develops a Climate Finance Vulnerability Index (CFVI) for Connecticut to assess whether communities with higher composite need, defined as the interaction of hazard exposure and social vulnerability, receive comparatively less disaster recovery funding. Social vulnerability indicators were pulled from the CDC/ATSDR Social Vulnerability Index (2022). Hazard exposure was pulled from the FEMA's National Risk Index, aggregated from the census tract to the planning region level. Disaster funding data was compiled from FEMA Public Assistance (PA v2) and Individual Assistance Housing datasets (1998–2024). All data was then normalized, and converted into funding-to-damage ratios. Regression analyses were run for composite need score vs finance score to evaluate alignment between composite need scores and funding outcomes across Connecticut's eight planning regions. The results indicated a low correlation between composite need and disaster funding ($R^2 = 0.1733$) which was not in support of the hypothesis. This suggests that allocation of financial resources is not proportional to the funding, where where some high-need regions are adequately funded while others remain under-supported. These findings align with prior research highlighting administrative complexity, eligibility constraints, and informational barriers as drivers of inequitable recovery outcomes.

Amity High School

Teacher: Sarah Reeves

Project # 15

Knispel, William

<u>The Impact of Administering Varying Levels of Glucose Immediately Following Head Trauma on Chronic Traumatic Encephalopathy.</u>

Completed Project, 08-Health & Medical

Chronic Traumatic Encephalopathy (CTE) is a degenerative brain disease linked to repeated head injuries, particularly in contact sports like football. Post-mortem studies of athletes' brains show elevated tau protein, a hallmark of CTE. Currently, CTE can only be diagnosed postmortem, and no treatments exist, making early prevention after traumatic brain injury (TBI) vital. Glucose is the brain's main energy source and may influence recovery, but both too little and excessive glucose can be harmful. This study used Drosophila melanogaster to model TBI by applying a controlled impact. Flies were divided into four groups: a control group receiving no glucose and three experimental groups receiving 2%, 8%, or 15% glucose solutions in H_2O. The recovery time (how quickly flies resumed movement) was measured post-injury. Results showed that all glucose groups recovered faster than controls, with the 2% group recovering the quickest and most consistently, indicating an optimal dose. Higher glucose doses (8% and 15%) also improved recovery but with greater variability, suggesting potential metabolic stress at higher levels. These findings imply moderate glucose intake after a TBI aids recovery by addressing the brain's energy crisis, supporting the Glucose Facilitation Effect. Excessive glucose offers minimal benefit and may cause harm due to metabolic stress. Overall, this research highlights glucose's potential as an immediate treatment following head injuries and underscores the importance of dosage. Proper glucose management could reduce short-term brain damage and lower the risk of developing CTE later in life.

Ridgefield High School

Teacher: Ryan Gleason

Project # 16

Kapoor, Akriti

<u>Determining the Impact of Weather Conditions on Microplastic Deposition in the Quinnipiac River Marsh</u>

Completed Project, 07-Environmental

Microplastics pollute aquatic environments, significantly threatening the ecosystems there. Marshes act as natural filters and carbon sinks, but their role in trapping microplastics, specifically in different rainfall, has not been studied. The purpose of this research was to investigate how precipitation levels influence the concentration and distribution of microplastics within the Quinnipiac River Marsh. The independent variable was the amount of precipitation. The dependent variable was the amount of microplastic. Constants include, the amount of water being sampled, and how often sampling is happening. The control was no precipitation. It was hypothesized that an increase in rain would result in more accumulation of microplastics in the marsh area. 1 liter water samples were collected from the marsh area, 100 meters downstream, and 100 meters upstream, every week. Samples were first filtered with coffee filters and then nylon membrane filters. The filtered remains were analyzed under a dissecting microscope, and the amount of pieces of microscopes were recorded, as well as the precipitation in the previous 24 hours. A total of 7 trials were conducted. The study found a positive correlation between precipitation and microplastic concentration across all sites, showing a 70% increase in microplastics (approximately 3 pieces per liter) for every inch of rain. The downstream location had the highest overall accumulation. This data had a p-value of above 0.05, so it is not statistically significant, and the null hypothesis cannot be rejected. This data implies aquatic organisms living downstream are at greater risk of ingestion of microplastics.

Amity High School

Teacher: Sarah Reeves

Project # 17

Kennedy, Ava

<u>Determining the Presence of Northern Long-eared Bats in Weston, Connecticut Using the Titley Chorus</u>

Completed Project, 07-Environmental

This study was conducted to determine the possible prevalence of Northern Long-eared bats' roost locations in Weston, Connecticut. This experiment was completed using the application of the Titley Chorus, an ultrasonic monitor system that takes in and records bat echolocation calls while labeling frequencies, and the Anabat MacBook Application, which shows frequencies, time of calls, dates, and times of information from the monitoring. White Nose Syndrome is slowly eliminating Northern Long-eared bats, along with other species of bats, and this experiment can be connected to the destruction of White Nose Syndrome on bat colonies in Weston, possibly increasing the spread of disease if they are moving to other colonies. This concluded that Northern Long-eared bats have a reduced presence in Weston, Connecticut, but have populations of Big Brown bats and Tricolored bats. It was hypothesized that Northern Long-eared bats will have a lower call detection rate compared to other species in Connecticut.

Weston High School

Teacher: Stacey Greenberg

Project # 18

Creegan, Paige

<u>TeaNourished TM</u>

Completed Project, 07-Environmental

Although chemical fertilizers contain nitrogen, phosphorus, and potassium for optimal growth, they also simultaneously lead to soil deterioration, a mass production of algae blooms, as well as several diseases. I decided to invent my own solution to this problem by making my own all natural plant fertilizers where tea became my focus because they contain all of the essential nutrients needed to grow to their fullest potential. Phase I tested Earl Gray and green tea in a controlled environment with radish seeds. Control plants grew taller on average than any plant grown with tea. Phase II involved testing English Breakfast tea and coffees with varying levels of caffeine. This phase partially supported my hypothesis because the English Breakfast tea plants grew the most by a large margin. The first prototype of TeaNourished (Phase III) combined the most successful outcomes from Phases II and III, the Peach with Ginger and Turmeric (60% by volume) and English Breakfast (40% by volume). Phase IV Parts A and B consisted of Chamomile, Mint Medley, and Lemon Lift Teas. The radish plants grew the tallest in the presence of chamomile tea. In Phase IV, teas made from the German chamomile plant were tested. Chamomile Vanilla performed the best out of all the groups, so it continued to be used in Phase V along with the Mint Medley tea from Phase IV, Part C. These two teas were chosen because they contain apigenin and other compounds that help with weed suppression, antioxidants, and energy conservation.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 19

Kompalli, Srestha

<u>Determining the Role of Detective Workload, Team Composition, and Detective Experience in Relation to Use of Forensic Science in Solving "Whodunnit" Homicides</u>

Completed Project, 06-Behavioral

Homicide clearance rates have been decreasing significantly in the United States since 1960, occurring in conjunction with advancements in DNA technology. Therefore, the issue of whether or not DNA evidence is helping to solve homicide cases rises. This study analyzed the impact of detective variables, including experience, workload, and team composition, on forensic science use and homicide clearance in order to determine if other detective practices are more likely to impact case clearance than forensic science use. 184 NYPD homicide cases, filtering for whodunnits to examine how detective workload, staffing, and experience were analyzed to determine influence on forensic evidence use. These factors' collective impact on case clearance rates were analyzed, determining how resource allocation and investigative variables drive arrest outcomes. Cases with high workload were most likely to use DNA evidence. The results also showed that DNA evidence was most likely to be used in cases with a high number of detectives and those cases were most likely to be cleared. Finally, inexperienced detectives were more likely to use DNA evidence and were also more likely to clear cases. Further research on this topic can include the influence of different variables on forensic evidence use. It could also use more complex statistical analyses, should such resources be made available for use. Variables such as motive variables and witness variables could be tested with detective variables, similarly, to determine if correlations are present. This project implies which practices and detective structures are most effective in clearing homicides.

Amity High School

Teacher: Sarah Reeves

Project # 20

Luciano, Rory

<u>Designing a Drone Attachment to Efficiently Collect Multiple Water Samples in the Duration of One Mission</u>

Completed Project, 09-Physical Science

Environmental monitoring by water sampling is necessary to determine the safety of water for drinking and sanitation purposes. Hand sampling water is currently the most common way to collect samples, but it is lengthy and costly. One current solution to this problem is the use of drones to collect a water sample. The purpose of this project is to design an attachment for a drone to pump multiple samples of water during one mission. The criteria for this project are that it must collect multiple samples and store them, and record relevant data. The constraints for this project are that it must be built with a low budget and must be built with available resources. This project was designed using Autodesk Fusion and was 3D printed. Multiple revisions were designed to fit the criteria the best. It was tested two feet above a bin of water, for twenty trials to ensure accuracy and reliability. When tested, the pump was successful 70% of the time, and the switch was successful 25% of the time. Additionally, the GPS data was accurate within 253 inches, which is within the criteria. After multiple iterations, a proof of concept was semi-successfully designed, manufactured, and tested. The final iteration could not self-clean and also proved unreliable when switching between different outputs. Future designs should focus on increasing reliability and decreasing the size. This project is a starting point for future designs of a drone attachment that can sample water more efficiently.

Amity High School

Teacher: Sarah Reeves

Project # 21

Ding, Celine

<u>Comparing the Herbicide Phytoremediation Abilities of Native vs Non-native Aquatic Plants to Filter Glyphosate from Connecticut Waters</u>

Completed Project, 07-Environmental

There is an increasing concern over the agricultural use of glyphosate impacting the environment. Through drift and runoff, the toxic herbicide enters bodies of water, threatening organism health.The use of phytoremediation, using aquatic plants to absorb contaminants within water, has previously been tested as an environmental and cost friendly option for filtering heavy metals and detergents, but there is limited knowledge of the effectiveness of aquatic plants filtering glyphosate. This study compared the phytoremediation abilities of native and invasive aquatic plants in Connecticut. Duckweed and hydrilla were chosen as the native and invasive species, respectively. It was hypothesized that water samples exposed to duckweed would result in a higher amount of glyphosate absorbed due to the plant's ability to accumulate contaminants within its roots. Experimental trials were conducted in triplicates of each species with two controls per trial. The aquatic plants were exposed to a glyphosate and water solution. Resulting water samples were filtered and run through a Liquid Chromatography Mass Spectrometer. Currently, data analysis is still ongoing, so results are based on predicted data. The results showed that the hydrilla samples had a higher average glyphosate concentration of 1178 mg/L, meaning less herbicide was absorbed compared to the duckweed samples with a lower average glyphosate concentration of 926 mg/L. The T-Test yielded a p-value of 1.69×10^{-9}, indicating a statistically significant difference in glyphosate uptake. Findings suggest that aquatic plants possess adaptations that help control herbicide levels in ecosystems, reducing stress on organism health.

Amity High School

Teacher: Sarah Reeves

Project # 22

Balamurugan, Karishma

<u>Designing a Novel Ultrasound and Ambient RF Wireless Charging System for a Pacemaker While Minimizing Misalignment Loss</u>

Completed Project, 08-Health & Medical

Currently, pacemakers rely on batteries that last on average 6–10 years, and eventual depletion requires invasive, risky, and costly surgeries. While researchers have attempted to harvest power from the body's own biological functions, these methods are often harmful and generate insufficient energy, leading to the emergence of wireless energy transfer. Ultrasound energy harvesting using triboelectric nanogenerators generated ~1 mW, but required external transducers and suffered misalignment loss. In another study, RF systems achieved a 33.8% efficiency, less energy than ultrasound, but RF waves are abundant in the environment (Wi-Fi, 5G, etc). No studies have made a hybrid of these methods, accounted for safety guidelines and tissue attenuation, and tackled misalignment loss. Therefore, the purpose of this project was to develop a hybrid ultrasound and RF wireless system that could reliably power pacemakers, addressing the limitations of single-mode harvesting methods. This project demonstrated a hybrid battery system that reduces and, in some cases, entirely eliminates battery replacement. The device remained within NIH guidelines (1.85°C average), mitigating misalignment power loss (retaining 90.5% of original power output). Phantom tissue and poor circuit connections could have caused power loss, limiting instantaneous output to 30.836 µW, below the 100 µW target, but sufficient to extend pacemaker lifespan when paired with a battery (if a pacemaker needs 40 µW, then the lifespan is 4x original). Beyond pacemakers, the system could power other implants with minor frequency adjustments. Future research should explore different circuit layouts, live tissue validation, and biocompatible/miniaturized construction.

Amity High School

Teacher: Sarah Reeves

Project # 23

Hofstatter, Sarah

<u>Determining the Effect of Feeding Frequency on Total Sleep Duration of Horses</u>

Completed Project, 06-Behavioral

Sleep is a universal animal behavior characterized by decreased activity or environmental awareness. Horses' normal total sleep duration (TSD) is 2-3 hours per 24-hour period, and equine welfare may worsen if sleep is disrupted by stressors like noise, unfamiliar environments, or pain. In horses, the risk for acidosis-related abdominal pain increases as portion size enlarges, but the impacts of feeding frequency on equine sleep have yet to be explored. The purpose of this project was to determine the effect of common feeding frequencies (once, twice, or three times per day) on horses' TSD. The hypothesis was that if horses were fed less frequently in a day, then they would have a reduced TSD because larger meals can cause discomfort that disrupts horses' sleep. All horses (n=6) in this study had their daily hay and Buckeye Nutrition Supreme 14 Pelleted Nutrition concentrate given in one, two, or three meals for one week in one of two random orders, for a total of three weeks. Horses then had their TSD recorded for 24 hours on the sixth day of each treatment using Riverwind Supply 2-Megapixel Multiplex HD Bullet Cameras. There was no correlation between feeding frequency and TSD (p=0.18; SE=21.04). This was likely caused by variation in age, breed, and weather, as well as the small sample size and data-collection window. The results of this study suggest that ideal feeding frequency differs between horses and that TSD may not be directly impacted by feeding frequency.

Amity High School

Teacher: Sarah Reeves

Project # 24

Kaoroptham, Anaya

<u>Implementing the use of the split luciferase complementation assay to study HIV protein interactions</u>

Completed Project, 09-Physical Science

HIV remains a significant global health concern, responsible for over 600,000 deaths in 2024. The virus depends on host transcription machinery for replication, requiring essential protein-protein interactions between viral and host factors such as CDK9 and Cyclin T1. While traditional biochemical methods like co-immunoprecipitation confirm these interactions, they cannot measure binding dynamics in living cells. Split-luciferase assays offer a promising alternative by dividing luciferase into two nonfunctional fragments that reconstitute and emit light when proteins interact. However, no studies have systematically tested whether this system can reliably detect HIV-related protein interactions in mammalian cells. This project aimed to determine whether HIV protein-protein interactions can be detected using bioluminescence reconstitution. We hypothesized that protein interactions would bring luciferase fragments together, reconstituting the enzyme and producing detectable light. CDK9 and Cyclin T1 were each fused to luciferase fragments and expressed in human kidney cells via calcium phosphate transfection. After 24-48 hours, luminescence was measured using a microplate luminometer across 24-well plates over multiple trials. The results strongly supported the hypothesis: cells expressing both CDK9–Luc and Cyclin T1–Luc produced 1654 RLUs, representing an approximately 10-fold increase compared to controls expressing individual fusion proteins (CDK9–Luc: 139 RLUs; Cyclin T1–Luc: 163 RLUs). This fold-change exceeded the predetermined threshold of 2.0, demonstrating successful luciferase reconstitution. These findings establish that split-luciferase assays can effectively monitor HIV protein interactions in live mammalian cells, providing a valuable tool for real-time detection that could support drug screening and mechanistic studies of HIV transcription.

Amity High School

Teacher: Sarah Reeves

Project # 25

Schroeder, Ivy

<u>In working with Dr. Michael Macey, we ask how do we know what exactly to search for, in terms of biosignatures, on icy moons, given they may be destroyed by radiation and pressure? How can scientists make sure they are using tools and missions as adequate</u>

Completed Project, 09-Physical Science

The subsurface oceans of Europa and Enceladus represent high-priority targets in the search for extraterrestrial life. However, detecting biological activity remains challenging due to extreme thermal gradients(Ashkenazy et al., 2019), high salinity brines(E. M. Spiers et al., 2023), and intense surface radiation(Nordheim et al., 2018). This study evaluates the detectability of three terrestrial microbial analogues: Desulfobulbaceae, Carnobacterium, and Methanosarcina barkeri, under simulated icy moon conditions. It is hypothesized that microbes capable of anabolic activity in cold, hyper saline environments(e.g., Desulfobulbacceae) leave behind stable lipid signatures that can be distinguished from abiotic hydrocarbons by the SUrface Dust Analyzer(SUDA) because biological lipids exhibit specific, repeating carbon-chain length patterns not found in non-living mineral chemistry(Pradas et al., 2018). To test this, microbial survival limits from the NASA BASE data base(base acronym here) were cross referenced with instrument sensitivity specifications for the Europa Clipper Mission(date launched here perhaps). The results compare the efficiency of the SUDA and MAss Spectrometer for Planetary EXploration(MASPEX)(Waite et al., 2024, Kempf et al., 2025) instruments in distinguishing true biotic metabolites from abiotic background noise produced by geological or hydrothermal processes. This research provides a framework for prioritizing "structural" and truly active biosignatures over transient metabolic gases in high radiation and salinity environments.

Darien High School

Teacher: David Lewis

Project # 26

Eddy, Edward

Edward Doubovik Mentor: Dr. Thomas Bellama Designation: Engineering Developing a Convolutional Neural Network and Computer Vision Pipeline (MediaPipe and LSTM) for Automated Wrist Rehabilitation Exercise Recognition and Feedback Generation Access to consi

Completed Project, 08-Health & Medical

There is currently a critical shortage of physical therapy professionals, which limits the ability of patients to receive frequent, high-quality rehabilitative care. This project addresses this gap by developing an automated pipeline for real-time wrist rehabilitation exercise recognition and corrective feedback. By combining MediaPipe for pose estimation and a Long Short-Term Memory (LSTM) neural network, the system is designed to classify wrist flexion and extension movements into "bad," "okay," and "perfect" form categories. The methodology involved recording 160 exercise sequences and preprocessing the data into joint angles and velocities to ensure the model learned motion patterns rather than spatial coordinates. The LSTM model was trained using an 80/20 train-test split over 60 epochs. Experimental results demonstrated a high validation accuracy of 90.62%. Also, the system achieved a 1.00 precision in identifying "bad" form, ensuring that improper movements which might cause further injury are caught reliably. To meet the demands of real-time use, the system was optimized for the lowest possible latency. The total cycle time, from MediaPipe extraction to feedback output, was measured at 0.080 seconds, significantly outperforming the industry-standard real-time threshold of 0.200 seconds. While the model showed strong performance overall, future iterations will focus on balancing the dataset to improve recognition of "perfect" form and expanding the framework to other joints and rehab from other injuries. This research provides a cost-effective, scalable solution for remote patient rehab, allowing individuals to recover independently while ensuring exercise safety and proper recovery.

Amity High School

Teacher: Sarah Reeves

Project # 27

Speicher, Emma, Gleason, Calista

<u>The effect of rising sea levels on the germination and survival of Lathyrus Japonicus (beach pea)</u>

Completed Project, 10-Teams (Completed Project)

Rising sea levels caused by climate change increase salt concentrations in coastal environments, which may affect native shoreline plants. This experiment examined how increased salt concentration impacts the germination and survival of Lathyrus japonicus (Beach Pea). It was hypothesized that seeds exposed to higher salt concentrations would have lower germination, survival, and growth rates. To test this, Beach Pea seeds were planted in three trays of sand collected from Penfield Beach and watered with either distilled water, distilled water with added salt, or natural seawater from Long Island Sound. The plants were grown under a growth lamp and watered every two days for five weeks, while germination, survival, and growth were recorded. In our results it is shown that when the Beach Pea plants are grown in distilled water, they have a higher growth rate then when grown with saluted water. This mirrors the effect of rising sea levels on shoreline plants contributing to the lack of growth.

Fairfield Warde Highschool

Teacher: Ryan Gleason

Project # 28

Pavan Kapoor, Pavan Kapoor

<u>Developing a Feeding Tube for Continuous EKG Measurement and AI-Based Diagnosis of Various Cardiac Conditions</u>

Completed Project, 08-Health & Medical

Continuous cardiac monitoring is essential for patients requiring enteral nutrition, yet traditional methods often rely on unnecessary external equipment. Integrating ECG sensors directly into feeding tubes provides an alternative for real time cardiac monitoring. The purpose of this project was to develop a multifunctional feeding tube capable of continuous ECG measurement and AI based diagnosis of various cardiac conditions. Key criteria included achieving 90% diagnostic accuracy and maintaining patient comfort, while constraints required a maximum 3mm diameter and a budget under $150. The methodology involved attaching electrodes to a feeding tube connected to an Arduino based circuit, while a CNN based AI model was developed in Python to interpret the data. Testing was conducted using ballistic gel to simulate esophageal tissue. Results showed the hardware displayed signals with 100% accuracy, though the AI model only achieved 70% accuracy during real time trials and 80% on public datasets. The project successfully proved the concept of a dual-purpose medical device, though future research must focus on utilizing medical grade components and refining the AI algorithm to meet clinical validation standards. To address the current 70% accuracy rate, future work should implement a larger, more diverse training dataset and investigate noise filtering techniques to mitigate interference from esophageal movement, ensuring the model reaches the 90% accuracy threshold required for important medical decision making.

Amity High School

Teacher: Sarah Reeves

Project # 29

Brandon, James

<u>MOSMIDI: Mean Opinion Score system for MIDI audio quality perception</u>

Completed Project, 06-Behavioral

MOSMIDI: Mean Opinion Score system for MIDI audio quality perception, a joint development program with PhD Zixun Guo and Queen Mary University of London C4DM. Subjective evaluation has since been a challenge in symbolic music generation research. Models typically were assessed using audio-based MOS frameworks that rendered MIDI into audio files like MP3 and WAV. Confounding variables like timbre, quality, and post-processing made fair and just evaluatory methods more difficult for researchers. We introduce MOSMIDI, a web-based MOS software designed specifically for these comparative tests of generative symbolic music through MIDI representation. MOSMIDI adapts web-based listening test concepts to operate directly on the data. It takes standardized sonification, visual representations, and all to support side-by-side comparison of generation models like MOONBEAM and collected subjective ratings through an easily configurable workflow. It takes a React-based front end and a Flask back end to push a full browser-based software. By decoupling symbolic music from downstream audio, it enables more faithful and promising assessment of generative models' music decisions. The extensive and flexible framework addresses a gap in symbolic music evaluation, allowing people in the field to fine-tune and refine their models.

Darien High School

Teacher: Christine Leventhal

Project # 30

Babic, David

<u>Investigating the Impact of Governance Effectiveness on Economic Crisis Resilience: A Fixed-Effects Analysis of G-20 Countries During the Great Recession and COVID-19</u>

Completed Project, 06-Behavioral

Global economic crises threaten national economies, yet countries show varying resilience in recovery trajectories. This study investigates whether governance quality– measured through World Governance Indicators (political stability, government effectiveness, and control of corruption)– influences economic outcomes during the Great Recession (2008-2009) and the COVID-19 pandemic (2020). Using panel data from available G20 countries spanning 2000-2022, we employed fixed-effects regression models with within country-level clustering to examine the relationships between baseline governance indicators and two key outcomes: annual GDP growth and unemployment rates. Results reveal several distinct governance-crisis dynamics across events. During COVID-19, countries with medium-level government effectiveness demonstrated superior post-shock recovery compared to both low and high effectiveness nations, suggesting moderate institutional flexibility facilitates more adaptive pandemic responses. Conversely, the Great Recession favored stronger institutional strength, with high government effectiveness countries experiencing significantly better immediate GDP shock buffering. Political stability showed modest effects primarily during crisis onset rather than recovery phases. Control of corruption showed marginal significance in bolstering unemployment rates during COVID. Notably, all governance indicators demonstrated weaker associations with unemployment outcomes across both crises. These findings suggest that governance quality operates through crisis-specific mechanisms, financial crises reward institutional robustness, while health crises may benefit from adaptive governance structures for reducing GDP shock. This research contributes to understanding how institutional quality shapes economic resilience, offering insights for policymakers regarding governance investments and crisis preparedness strategies across different shock typologies.

Amity High School

Teacher: Sarah Reeves

Project # 31

Morton, Kehara

<u>Classifying Migraine Subtypes Using Machine Learning: A Study of Data Bias</u>

Completed Project, 08-Health & Medical

Chronic migraines are a neurological disorder affecting 1-2.2% of the global population. There are many different types of migraines that people may experience. The seven classes of migraines (0-6 respectively)--migraine with aura, migraine without aura, basilar-type aura, sporadic hemiplegic migraine, familial hemiplegic migraine, typical aura without migraine, and other migraines--were considered. The objective of this study is to do an analysis on data bias seen in migraine studies by classifying seven subtypes of migraines using random forest (RF) and artificial neural network (ANN) machine models through Python. Nine different random forest machine models were created ranging in test-train splits from 35%:65% to 75%-25%. Data analysis included: precision, recall, and F1-score, confusion matrices, and feature importances of the attributes considered in the initial data. The results of this study indicate that there was data bias within the initial data set as patients, particularly in classes 2, 3, 4, and 5 as they were consistently insufficiently classified. These results suggest that data bias in migraine studies may contribute to disparities in clinical care, underscoring the need to decrease bias by including similar numbers of patients with each type of migraine being studied.

Darien High School

Teacher: Christine Leventhal

Project # 32

Santin, Matteo

Assessing the Preclinical Activity of Tisotumab Vedotin Against Uterine Serous Cancer Cell Lines by Testing the Dose-dependent Cell Viability After Exposure to the Antibody-drug Conjugate

Completed Project, 08-Health & Medical

Uterine serous carcinoma (USC), an aggressive and clinically challenging subtype of endometrial cancer, frequently exhibits high levels of tissue factor (TF) expression, yet effective targeted therapies remain limited. This study investigated the preclinical efficacy of Tisotumab Vedotin (TV), a TF-targeting antibody-drug conjugate, in USC cell lines with varying TF levels. The USC cell lines were analyzed for surface TF expression, identifying USC-ARK2 and USC_ARK20 as positive expressors and USC-ARK4 as a non-expressor. In vitro assays showed that TV significantly reduced cell viability in the TF-overexpressing line, with a low IC50 of 84ng/ml and 33ng/ml statistically significant results ($P < 0.05$), while no significant effect was observed in the non-expressing line ($P > 0,05$). These findings indicate that TV effectively targets and kills TF-overexpressing USC cells, supporting its potential as a therapeutic option. Further in vivo studies are needed to confirm its safety and efficacy, but the results suggest DV could advance to clinical trials and offer a promising new treatment for patients with TF-positive USC.

Amity High School

Teacher: Sarah Reeves

Project # 33

Baranidharan, Ananyasri

Evaluating Fluorine-to-Hydrogen Substitution in PFOS to Predict Safer Variants Using Molecular Orbital Calculations

Completed Project, 09-Physical Science

Per- and polyfluoroalkyl substances (PFAS) are man-made chemicals used for their water-resistant and nonstick properties. One of the most common PFAS compounds is perfluorooctane sulfonate (PFOS). It is a common contaminant due to past mass production of goods like nonstick pans and firefighting foams, and improper disposal of PFOS. Its strong carbon–fluorine bonds resist decomposition, causing environmental persistence, bioaccumulation, and potential health risks, including carcinogenicity. This research investigates whether PFOS contains electronically weak fluorine sites that are more susceptible to chemical modification than others. Modifying these fluorine sites would help us lower the molecule's toxicity and increase its solubility. Fluorine atoms in molecular orbitals with strong antibonding overlap and smaller HOMO–LUMO gaps have lower electronic stability and may be favorable targets for hydrogen substitution. Using WebMO with Gaussian, the PFOS structure was geometry-optimized and analyzed via molecular orbital calculations. Orbital visualizations and eigenvalues were used to identify antibonding regions, and orbital energy differences ($\Delta E = E\text{-LUMO} - E\text{-HOMO}$) were calculated and converted to electron volts to compare fluorine-site stability. The results indicate that PFOS is not uniformly stable: fluorine positions 14, 15, 18, and 19 consistently appear in antibonding regions across multiple orbitals and are associated with lower ΔE values (≈ 7–15 eV), suggesting reduced electronic stability and a better site for hydrogen substitution. However, even sites with higher ΔE, such as the fluorine position at 22, may be replaced with hydrogen if the antibonding character is strong. These findings suggest "forever chemicals" may contain predictable electronic weak points, providing a framework for PFOS degradation and remediation strategies for a global environmental and public health concern.

Darien High School

Teacher: Christine Leventhal

Project # 34

Amir, Aiza

RATIONALE: Artificial Intelligence (AI) tools are increasingly woven into the routines of adolescents, supporting everything from academic assignments to coping with emotional challenges. While AI offers efficiency and instant problem-solving, overrelianc

Completed Project, 06-Behavioral

Adolescents are increasingly turning to generative AI tools and chatbots in their academic and social lives, raising questions about how this reliance may shape their emotional coping and confidence. This study tested whether more frequent AI tool use is associated with adolescents' cognitive reframing skills and emotional self-efficacy, defined as confidence in their own emotional judgments. Adolescents (N = 18) completed an online survey reporting average daily AI use and standardized self-report measures of cognitive reframing (CERQ-Short) and emotional self-efficacy (Youth ESES), along with grade and gender. Data were cleaned and analyzed using correlation matrices and multiple regression models, with grade and gender as covariates; total screen time was excluded because it strongly overlapped with AI use. Results showed that frequent AI tool use was not a statistically significant predictor of either cognitive reframing or emotional self-efficacy, although a positive trend emerged between AI use and positive reappraisal. Grade significantly predicted positive reappraisal, and gender showed a marginal association with emotional self-efficacy, but gender did not significantly moderate links between AI use and outcomes. In this small sample, frequent AI use alone did not appear sufficient to meaningfully change adolescents' cognitive reframing or confidence in their emotional judgments, suggesting that developmental factors like grade may play a larger role. The findings point to the need for larger, more detailed studies that distinguish between types of AI use and employ longitudinal or experimental designs to clarify when AI use supports emotional resilience and when it may undermine independent coping.

Amity High School

Teacher: Sarah Reeves

Project # 35

Schwartz, Ezra

<u>Comparing Deep Learning Approaches to Improve the MRI Diagnostic Accuracy of Rotator Cuff Tears</u>

Completed Project, 08-Health & Medical

Rotator cuff tears are common injuries (20% general population;40% athletes (Yamamoto2010)). Undiagnosed injuries lead to chronic instability and pain. Magnetic resonance arthrograms(MRA) provide high sensitivity(≈90%) and specificity(≈95%) but invasive and costly. Magnetic resonance imaging(MRI) is less invasive but offers lower sensitivity(≈80%)/specificity(≈85%). This study will improve diagnostic accuracy of MRI detecting rotator cuff tears using CNNs and transfer learning. UNets, used for musculoskeletal classification, will demonstrate novel methodology gaining representations of features extracted from anatomically similar data. The study will test accuracy of transfer learning, single(grouped) vs double(successive) vs single(non-grouped) for encoder using hip MRIs(n=>1000;NHI) and knee MRIs(n=1370;StanfordCA) to capture general structural patterns. Final models will classify healthy versus torn rotator cuffs MRIs confirmed by surgical reports, the diagnostic gold standard(n>300). All models will use PyTorch. Metrics (sensitivity, specificity, and AUC) will evaluate models' performance. This study builds on prior work, which achieved 69% accuracy using a 3Dimensional neural network without transfer learning(Shim2020), and hypothesized that anatomically relevant datasets with transfer learning will yield better results. In this study, it was found that end to end training achieved an accuracy of 89% and through the usage of double transfer learning accuracy was 54% (opposite of the hypothesis). Through the use of UNets, this study successfully outperformed the current literature when evaluating accuracy on rotator cuff dataset obtained.

Staples High School

Teacher: Amy Parent

Project # 36

Hari, Jay

<u>Discovering Novel Targets for the FMN Riboswitch to Test the Utility of Computational RNA-folding Methods to Address Multidrug Antibiotic Resistance</u>

Completed Project, 08-Health & Medical

Rapid discovery of antibiotic molecules is essential to reducing the antimicrobial resistance crisis(Frieri,2017). Computational methods may be an important resource to increase the antimicrobial pipeline. While novel therapeutics have been successfully developed through computational pipelines, RNA-based efforts are understudied(Ren,2023). Computational determination of RNA tertiary structures lags behind that of protein structures, and its use in identifying ligands has been limited(Bernard,2025). This study evaluated the accuracy of one novel and two established RNA-folding algorithms, next using the best performer to computationally and experimentally determine antimicrobial chemicals that inhibit the FMN riboswitch in E. coli to assess whether computational pipelines of ncRNA-targeting are accurate, and to demonstrate the utility of targeting ncRNAs. A pool of small molecules similar to Ribocil and FMN, known ligands of the FMN riboswitch, have been narrowed down through a three-tiered cheminformatic analysis to potential hits. Positive computational hits(n=1) will be tested in two bioassays in an E. Coli K-12 model system: a dose-response assay where growth curves and MICs will be compared across different administered concentrations of compounds, and a resazurin growth curve assay. It was first discovered that a novel transformer approach is an ineffective RNA-folding algorithm. It was next found that trRosettaRNA is the best existing RNA-folding model, despite being significantly inaccurate, yet good for comparative usage. Three novel candidate compounds have been identified for antimicrobial research. Future studies should focus on testing the discovered possible ligands in bioassays.

Staples High School

Teacher: Amy Parent

Project # 37

Imanov, Emma

<u>Developing an Ambient-Light Lock-In UV Fluorescence Imaging System for Enhanced Forensic Evidence Detection</u>

Completed Project, 06-Behavioral

Ultraviolet (UV) fluorescence imaging is widely used for detecting trace evidence; however, its effectiveness is often limited by background noise and ambient lighting conditions. This study evaluated whether lock-in UV imaging improves signal quality compared to traditional static UV imaging. Fluorescent samples were imaged across multiple surface types and lighting environments, including indoor and daylight conditions, and signal-to-noise ratio (SNR) and contrast ratio were quantitatively analyzed. Results showed that lock-in UV imaging consistently outperformed static UV imaging. The average SNR for static UV imaging was 1.66, while lock-in UV imaging achieved an average SNR of 5.70, representing an improvement of over 240%. Contrast ratios also increased by approximately two to three times when using lock-in imaging, indicating stronger separation between evidence and background. Notably, under bright indoor lighting (700 lux), SNR increased from 1.55 (static UV) to 5.35 (lock-in UV), and under daylight conditions (1200 lux), lock-in imaging maintained contrast ratios above 2.0 while static UV imaging dropped near unity. A two-sample t-test comparing SNR values between imaging methods resulted in a p-value of 0.002 at an α-level of 0.05, confirming a statistically significant improvement with lock-in UV imaging. These findings demonstrate that lock-in UV imaging provides a more reliable method for fluorescent evidence detection, particularly in environments with high ambient light, and may enhance forensic and analytical imaging applications.

Amity High School

Teacher: Sarah Reeves

Project # 38

Francis, Nolan

<u>The Mechanisms of Mitigating Effects of Vitamin D Supplementation on Duchenne Muscular Dystrophy in C. elegans</u>

Completed Project, 08-Health & Medical

Duchenne Muscular Dystrophy (DMD) is a genetic disorder that causes progressive muscle wasting and weakness. This occurs because of mutations in the dystrophin gene, which is essential for maintaining the integrity of muscle cells (Association, 2025). DMD's impact extends beyond physical limitations, significantly burdening affected individuals and their families emotionally and financially. Vitamin D3 has a small positive effect on muscle strength determined via meta-analysis (Baudart, 2014), and vitamin D insufficiency is frequently observed in DMD patients (Bian, 2018); however, studies in DMD mouse models have reported inconclusive effects of vitamin D3 supplementation on muscle pathology and function (Debruin, 2019; Baudart, 2014). This prospective investigation evaluates the effects and mechanisms of vitamin D3 supplementation in a DMD Caenorhabditis elegans (C. elegans) model. In this model, vitamin D3 (0.1 µM-100 µM) improved locomotive behavior ($p< 0.04$ across groups), longevity (reduced hazard ratio by up to 10%), and reduced reactive oxygen species levels. Supplementation also significantly lowered mechanistic calcium accumulation in muscle cells as measured by a calcium reporter fluorescence assay (all tested concentrations $p < 0.05$ vs. control), but did not alter the kinetics of Aldicarb-induced paralysis (log-rank $p > 0.45$ across groups). Collectively, these findings indicate that vitamin D3 may offer protective effects against muscle damage in DMD through muscular calcium regulation. These preliminary results suggest vitamin D3 could be an affordable strategy to improve muscle function and extend lifespan in affected individuals. Given its established safety, accessibility, and low cost, prospective vitamin D3 supplementation in DMD patients warrants further mammalian investigation to clarify long-term benefits, underlying mechanisms, and dose concentration.

Staples High School

Teacher: Amy Parent

Project # 39

Nehro, Stella

<u>Post-Robbing Behavioral Shifts in Native and Invasive Bees</u>

Completed Project, 07-Environmental

Post-Robbing Behavioral Shifts in Native and Invasive Bees The western honey bee, Apis mellifera, though a widely valued crop pollinator, has become an invasive species that competes with native species (Bombus impatiens) for resources, primarily nectar. One mechanism by which A. mellifera gains access to nectar is primary robbing, in which bees bite holes in the base of flowers, and is subsequently exploited by other pollinators through secondary robbing. This study aims to understand how the presence of robbing holes affects the abundance, composition, and foraging behavior of both native and invasive pollinators after nectar robbing has occurred on a flower native to Connecticut, Monarda fistulosa. Specifically, average pollination time, visit location, and pollination frequency. It is hypothesized that the introduction of nectar robbing will decrease pollination frequency and pollination time of native species, and will increase visitation rates of invasive species. Examining how visitation location differs will help explain why some plants experience reduced pollination when invasive bees dominate, even if total visitation rates appear high. Understanding the interactions between invasive and native bees will help inform decisions on how best to protect biodiversity and maintain a healthy ecosystem.

Darien High School

Teacher: David Lewis

Project # 40

Mejnartowicz, Vilas

<u>Analyzing the Effects of Follicle Cell Position on Piwi Expression and Fluorescence Signal Specificity in Drosophila Melanogaster</u>

Completed Project, 08-Health & Medical

Piwi proteins are essential regulators of germline development in Drosophila melanogaster, yet their spatial distribution within specific ovarian follicle cell populations remains poorly understood. This study investigated whether Piwi expression differs between tip and non-tip follicle cells in the egg chamber, given the proposed role of tip cells in primordial germ cell regulation. Ovaries were dissected, stained with DAPI, GFP, or GFP-Piwi, and imaged using laser microscopy. Tip and non-tip regions of interest were quantified across 30 control images and 15 GFP-Piwi images from three independent trials. DAPI consistently showed higher fluorescence in tip cells, indicating an inherent or imaging-related brightness unrelated to Piwi. In contrast, GFP controls showed no tip enrichment and were often brighter in non-tip regions, directly contradicting the DAPI pattern. GFP-Piwi displayed higher fluorescence in tip cells at stages 9 and 10b; however, because this pattern mirrors the DAPI brightness artifact, it is unclear whether the observed increase reflects true Piwi enrichment or simply natural tip-region brightness. The contradictory control patterns therefore make the GFP-Piwi signal ambiguous and prevent confident interpretation of tip-specific Piwi accumulation. These findings provide only tentative evidence that Piwi may be enriched in tip follicle cells and highlight the need for more rigorous normalization and imaging approaches. Future work should incorporate automated segmentation, improved fluorescence-correction methods, and targeted manipulation of Piwi in tip cells to determine whether spatial Piwi distribution contributes to primordial germ cell positioning and germline specification.

Amity High School

Teacher: Sarah Reeves

Project # 41

Sidhartha, Aditi

Differential Effects of Folic Acid Concentration on Cell Viability in MDA-MB-231 Triple Negative Breast Cancer Cells and HEK293 Normal Kidney Cells

Completed Project, 08-Health & Medical

Folic acid, the synthetic form of vitamin B9, is essential for DNA synthesis and cell division and is widely consumed through foods and supplements. While adequate folate intake supports genomic stability, excessive intake may influence cancer progression in a cell-type–dependent manner. This study investigated the effects of increasing folic acid concentrations on cell viability in MDA-MB-231 triple-negative breast cancer cells compared to HEK293 non-cancerous cells and examined associated changes in oxidative stress and cell-cycle regulation. Both cell types were cultured under identical conditions and treated with increasing concentrations of folic acid. Cell viability was assessed using the Alamar Blue assay and Trypan Blue staining. Gene expression of SOD1 (Superoxide Dismutase 1), an antioxidant enzyme, and p21 (CDKN1A), a regulator of cell-cycle arrest, was measured using qRT-PCR. Results revealed dose-dependent and cell-specific responses to folic acid. MDA-MB-231 cell viability decreased from approximately 100% at 0 nM to 78–80% at 1000 nM folic acid, indicating growth inhibition or cellular stress at higher concentrations. In contrast, HEK293 cells exhibited a biphasic response, with reduced viability at intermediate concentrations (~50 nM) followed by recovery to approximately 85% viability at 1000 nM. In MDA-MB-231 cells, SOD1 expression increased at low folic acid levels but decreased at higher concentrations, while p21 expression remained elevated, consistent with reduced antioxidant defense. These findings demonstrate that folic acid exerts dose-dependent and cell-specific effects, supporting normal cell adaptation while limiting viability in triple-negative breast cancer cells, highlighting the importance of balanced folic acid intake in public health.

Amity High School

Teacher: Sarah Reeves

Project # 42

Tian, Sarina

Investigating the Effect of Podocyte-Specific Lrp1 Expression on Kidney Function and Podocyte Integrity

Completed Project, 08-Health & Medical

Low-density lipoprotein receptor-related protein-1 (Lrp1) is a multifunctional cell receptor involved in lipid metabolism, endocytosis, immune regulation, and cell cycle control. In the kidney, Lrp1 is ubiquitously expressed, including in podocytes, specialized cells that preserve the glomerular filtration barrier and prevent protein loss into urine. Podocyte injury is a major cause of glomerular disease, accounting for 75% of kidney failure in the U.S., but the role of Lrp1 in podocytes remains unclear. This project will determine the role of podocyte Lrp1 in maintaining the glomerular filtration barrier and kidney function. If Lrp1 is lost in podocytes, then the filtration barrier is disrupted and proteinuria with kidney injury occurs, because Lrp1 contributes to essential cellular processes. The independent variable is podocyte-specific expression of Lrp1, while dependent variables are podocyte function and kidney integrity, measured through proteinuria and morphology. Constants include standardized laboratory conditions, with wild-type littermate mice as controls. Podocyte-specific Lrp1 knockout mice and wild-type littermates will be used. The mentor will provide animals, perform animal work, and collect urine and kidney tissues. Genotyping will confirm podocyte-specific Lrp1 loss by immunofluorescence and evaluate podocyte morphology in vivo and in vitro. Urinary protein will be measured by ELISA, kidney morphology assessed by histological staining, and data statistically analyzed under mentor supervision. Kidney morphology and urine protein will be quantified using ImageJ and GraphPad Prism. Comparisons between Lrp1-deficient and control mice will determine whether results support the hypothesis. This project is significant because it clarifies the role of Lrp1 in podocyte biology.

Amity High School

Teacher: Sarah Reeves

Project # 43

Lamour, Luke

<u>Determining the Impact of Vowel Contrast Between First (L1) & Second (L2) Languages Adopted Upon Eye Gaze in Mandarin-English Bilinguals</u>

Completed Project, 06-Behavioral

This study investigated how vowel contrast difficulty between Mandarin (L1) and English (L2) influences eye gaze behavior during Mandarin speech recognition. While Mandarin uses tones to distinguish meaning, shifting to non-tonal English requires phonetic recalibration. We hypothesize that increased vowel contrast difficulty, measured by how closely Mandarin vowels map to English categories, correlates with decreased eye gaze stability on target images and increased shifts toward competitors. Mandarin-English bilingual adults will be recruited from Portland State University. Participants will undergo proficiency assessments (MiNT, BDS, AoA) to determine language dominance. During the core task, an Eyelink Remote eye tracker will record fixations as participants hear Mandarin words and select between a target and a phonologically similar competitor image. Vowel conditions are categorized as easy, medium, or hard. Data will be analyzed using mixed-effects logistic regression and ANOVA. The hypothesis was refuted as medium vowel trials yielded the longest reaction times (1259.68 ms) compared to easy (1159.17 ms) and hard (1173.31 ms) trials. This suggests that medium contrasts may trigger higher cross-language activation, creating a greater competitive balance between images when vowel categories overlap. The results highlight the complexity of bilingual speech perception, where moderate phonetic similarity may create more cognitive interference than distinct differences. Future research should utilize a continuous scale for vowel contrasts and control for language dominance to better understand heritage language maintenance and inform bilingual education.

Amity High School

Teacher: Sarah Reeves

Project #

Completed Project,

Teacher:

Project # 45

Taleb, Eva

KNO_3 masses (per 1.0 L) 0 mg N/L → 0.000 g KNO_3 (control) 1 mg N/L → 0.00722 g KNO_3 (7.22 mg) (avg in Ridgefield) 50 mg N/L → 0.36090 g KNO_3 (360.90 mg) (extreme) Terrestrial procedure: Materials 15 pots (label treatment & arrangement) 2.0 kg homogenized

Completed Project, 07-Environmental

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. Nitrogen is a common component in fertiliser due to its qualities in promoting photosynthesis. The excess nitrogen that wasn't absorbed by the plant is carried into waterways and forests by runoff. Nitrogen runoff negatively impacts plants by overstimulating growth, causing them to develop weak roots and stems while disrupting soil nutrient balance. This excess nitrogen favors fast-growing, nitrogen-loving invasive plants, allowing them to outcompete native species that are adapted to low-nutrient conditions. As invasive plants grow more aggressively, they crowd out native plants for space, sunlight, and water, reducing biodiversity and weakening the stability of the ecosystem overall. The purpose of the experiment is to investigate how nitrogen pollution affects native and invasive species differently on land at different doses. 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 at a medium dose of nitrogen runoff. These results could be beneficial to local community efforts to combat the negative effects of invasive species.

Ridgefield High School

Teacher: Ryan Gleason

Project # 46

Byrne, Erin

<u>Background Artificial intelligence-generated content (including audio, images, and video synthesis), is becoming increasingly accessible, having previously been exclusive to advanced special effects technology. This technology poses numerous threats, such</u>

Completed Project, 06-Behavioral

Artificial intelligence-generated content (including audio, images, and video synthesis), is becoming increasingly accessible, having previously been exclusive to advanced special effects technology. This technology poses numerous threats, such as the spread of disinformation, fraud, and the creation of non-consensual imagery. As deepfake technology becomes highly advanced and widespread, the average online content consumer is increasingly susceptible to deception. Recent studies indicate that A.I. faces are often indistinguishable from human faces. In some cases, A.I. faces are perceived as more realistic than human faces, a phenomenon termed hyperrealism. These realistic faces are created using general adversarial networks (GANs), which are popular deep learning architectures. GANs pit two artificial neural networks (a generator and a discriminator) against each other. Starting with random pixels, these generators iteratively learn to create artificial faces until they are indistinguishable from the human faces used in their training image data set. Additionally, studies have indicated that there are large individual differences in the ability to detect AI generated faces. It is also found that people with the worst ability to detect AI faces have the least insight into their errors, placing them at additional risk of AI deception. One possible explanation behind this phenomenon is that people's capacity to recognize AI faces is related to their ability to recognize human faces. People with exceptionally good facial recognition are called "super-recognizers." Many studies on the stability of facial recognition ability conclude that it is a relatively stable trait, suggesting that the detection accuracy of AI faces is likely to remain stable. This experiment aims to not only test the hyperrealism effect but also to measure the improvement of the human detection accuracy of AI faces across trials.

Ridgefield High School

Teacher: Ryan Gleason

Project # 47

Quadri, Meher

<u>Identifying and Targeting of Key Genes in Transcriptome Profiling in Ovarian Cancer Patients Ovarian cancer (OC) is among the most lethal gynecological malignancies due to late-stage diagnosis and metastasis. RNA sequencing (RNA-seq) enables identificatio</u>

Completed Project, 08-Health & Medical

Ovarian cancer remains one of the most lethal gynecological malignancies due to late-stage diagnosis, molecular heterogeneity, and limited effectiveness of conventional therapies. Advances in transcriptome profiling have enabled large-scale analysis of gene expression patterns, offering valuable insights into the molecular mechanisms driving ovarian cancer progression. This study focuses on identifying differentially expressed genes (DEGs) in ovarian cancer patients using transcriptomic data and bioinformatics tools. Key oncogenes and tumor suppressor genes were analyzed to determine their roles in tumor growth, metastasis, and therapy resistance. Pathway enrichment and gene network analyses were employed to highlight dysregulated biological processes, including cell cycle regulation, apoptosis, and DNA repair pathways. The findings emphasize the potential of transcriptome-based biomarkers for early detection and targeted therapy, contributing to more personalized and effective treatment strategies for ovarian cancer patients.

Amity High School

Teacher: Sarah Reeves

Project # 48

Accinelli, Leighton, Accinelli, Stella

<u>The effect of Climate Change on Asclepias Incarnata and its Impact on Monarch
Migration.</u>

Completed Project, 07-Environmental

Climate change is rapidly affecting plant growth and survival, with rising temperatures
that are threatening native species like Swamp Milkweed (Asclepias Incarnata). This
study aims to investigate the impact of varying temperature on seed germination rates
and growth. The swamp milkweed seeds are going to be cold-stratified and planted in
different temperature environments. All other variables, such as light exposure,
watering, and soil type, are being kept constant to isolate the effect of temperature.
Data is going to be collected over two weeks should show that the seeds kept in the
higher temperature environment displayed decreased plant health. These findings
highlight the urgent need for awareness about climate change's impact on the
ecosystem. Promoting solutions like solar energy, forest conservation, and reducing
fossil fuel usage can help protect plant species and support sustainable agriculture in
the face of climate change.

Ridgefield High School

Teacher: Ryan Gleason

Project # 49

Lacour, Oliver

<u>Human vs. Algorithm: Measuring AI's Impact on Negotiation Efficiency</u>

Completed Project, 09-Physical Science

Recent advances in artificial intelligence raise the question of whether AI can be effective in high-stakes areas such as business negotiations. This project tested the performance of a custom AI negotiation agent in the context of Amazon's acquisition of Whole Foods in 2017. It was assessed as: 1) preparation tool, 2) support tool for human negotiators and 3) standalone negotiator on Amazon's behalf. I hypothesized that AI would greatly boost preparation speed, enhance reliability and improve outcomes as a tool, but be outperformed by humans as a standalone negotiator since it lacks emotional intelligence. The results indicate that AI consistently processes data much faster than humans. The best negotiation outcomes occurred when humans used the AI as a support tool. The standalone agent negotiated competitively and sometimes outperformed humans, but was still weaker than the human-AI combination. Overall, the AI was able compete with human negotiators and excelled as a negotiation assistant, significantly improving consistency.

King School

Teacher: Victoria Schulman

Project # 50

Howard, Rylie

<u>Determining the Relationship Between PDQ-39 Self-reports and Neurocognitive Testing in Patients Undergoing Deep Brain Stimulation Evaluation Parkinson's disease is the second most common neurodegenerative disorder in the United States, and is characterize</u>

Completed Project, 08-Health & Medical

Parkinson's disease is the second most common neurodegenerative disorder in the United States, characterized by motor symptomology and impaired cognition. If medications or therapies are unsuccessful, Deep Brain Stimulation (DBS) is a surgical treatment option, proved successful due to the careful candidacy through neuropsychological testing such as MoCA and questionnaires such as PDQ-39. The purpose of this project is to determine if there is an association between self-reported quality of life and cognitive performance in patients with Parkinson's disease being evaluated for DBS. The hypothesis is that if there is a relationship between patients' quality of life and their cognitive function, then higher PDQ-39 scores (i.e., poorer quality of life) will be associated with lower cognitive scores. The independent variable is the patient's self-reported symptoms documented by the PDQ-39. The dependent variable is objective cognitive function, measured by the MoCA. In this study, 41 patient reports were evaluated through deidentified data of their MoCA and PDQ-39 scores. All data were entered into SPSS and two-tailed bivariate correlational analyses were utilized. Results suggested a significant relationship between subjective reports and objective data, supporting the hypothesis. Overall, this is important because subjective symptom reports are often considered less reliable than objective testing in neurological disorders. Future research could include a correlation between different measures, such as RBANS or MMSE, to further enhance the importance of the PDQ-39 in neuropsychological testing, or correlating these test scores before and after treatment with DBS, to determine the quality of life outcome of the operation.

Amity High School

Teacher: Sarah Reeves

Project # 51

Brahma, Aditya

Developing Explainable AI and Deep Learning Models for Reliable Concrete Crack Detection

Completed Project, 09-Physical Science

Cracks in concrete structures like bridges, roads, and buildings can be very dangerous if they are not found early as even small cracks can significantly reduce structural strength and lead to catastrophic failures. While artificial intelligence (AI) and deep learning models are good at finding cracks in images, many AI models act like "black boxes" providing high accuracy without explaining their decisions. This lack of transparency makes engineers hesitant to trust them for safety-critical decisions. This project develops an explainable artificial intelligence (XAI) framework that not detects concrete cracks accurately and also shows its visual interpretability of how the AI makes its decisions. Three deep learning models were tested called Convolutional Neural Network (CNN), ResNet-50, and Vision Transformer (ViT). All models were trained using the same settings on 40,000 concrete images and tested on new images they had never seen before. The explainability analysis framework used Grad-CAM based heat maps that highlight the parts of an image the AI focused on when making a decision. The results showed important differences between models. In contrast, CNN and ResNet-50 consistently highlighted true crack regions, enabling engineers to verify model decisions. The Vision Transformer, while accurate, often highlighted large areas and did not clearly show exact crack locations. This study shows that high accuracy alone is not enough. Engineers need AI systems that explain their decisions. Explainable AI can help decision-making and shows that interpretable models can improve safety, reduce false alarms, and support reliable maintenance of critical structures.

Amity High School

Teacher: Sarah Reeves

Project # 52

Bozzuto, Ian

Analysis of Approval-Based Committee Voting Methods using Real-World Ballot Data

Completed Project, 06-Behavioral

In contrast to a typical "Plurality" Ballot which involves voting for only one candidate, an Approval Ballot involves voting for any number of candidates. While the application of approval ballots to single-winner elections is trivial, where the candidate that is approved on the greatest number of ballots wins, there exist many ways to apply approval voting to multi-winner elections, called Approval-Based Committee (ABC) Rules. These ABC Rules have been compared via both mathematical analysis as well as application to non-political contexts, like selecting validators on a digital blockchain. However, there is currently a gap in existing literature on how these perform in real-world political elections. This study closes this gap by looking at Block Plurality Voting (BPV) elections in the US, which work similar to Approval Voting but with an upper limit on the total number of candidates approved. Data is taken from over 160 municipal races in Dane County, Wisconsin and various counties in Colorado and California. A variety of existing methods for mathematically comparing ABC Rules are used for comparison using the Python library abcvoting. This research comes at a time when organizations advocating for Approval Voting are considering the use of the method for real-world political elections, and will help to increase confidence in how these ABC Rules perform in practice. Some further avenues of research after this study is conducted could be more competitive elections or scored multi-winner rules.

Darien High School

Teacher: David Lewis

Project # 53

Hills, Addy

<u>Cross-Cohort Analysis of Crohn's Disease and Ulcerative Colitis Across 5 Countries: Exploring Disease Classification, Treatment Patterns, and Clinical Characteristics</u>

Completed Project, 08-Health & Medical

Crohn's disease is becoming more common around the world, especially in countries that have recently become more industrialized. Differences in healthcare systems may affect how the disease appears and how it is treated. This study compares how Crohn's disease is classified, treated, and experienced by patients in several countries: Iran, Brazil (São Paulo and Campinas), Chile, Vietnam, and South Korea. The analysis used standardized data from medical registries and published patient cohorts. Crohn's disease types were grouped using the Montreal classification system. Differences between countries were analyzed using statistical tests that compare groups, with additional simulation methods used when sample sizes were small. Adjustments were made to account for multiple comparisons. The study found meaningful differences between countries in disease location, disease behavior, treatment use, and clinical outcomes. Overall, the results suggest that differences in diagnostic practices, access to treatment, and healthcare infrastructure play a major role in shaping how Crohn's disease (and ulcerative colitis) presents and is managed across countries.

Darien High School

Teacher: Christine Leventhal

Project # 54

Li, Matthew

<u>Explanatory machine learning modeling of a seven-molecular marker panel for immune checkpoint inhibition response per RECIST v1.1 in metastatic urothelial carcinoma</u>

Completed Project, 08-Health & Medical

Immunotherapy treatment has been folded into the standard of care for metastatic urothelial carcinoma (mUC). Traditionally, treatment for mUC consists of platinum-based chemotherapy. The FDA has recently added immune checkpoint inhibitors (ICIs), such as atezolizumab, a PD-L1 inhibitor, to the first- and second-line treatment options as a secondary treatment after chemotherapy. Immunotherapy has been known for its lower rate of side effects; however, only a small subset of patients exhibits any benefit. Prior work has evaluated complex genetic signatures, tumor mutational burden (TMB), clinical factors, and multi-omics machine learning models in this setting; however, the performance of a small molecular marker panel under realistic sample sizes is less represented. Here, we used the RNA-seq and RECIST v1.1-derived patient outcomes data from a subset of the phase II IMvigor210 dataset. The RNA-seq data for a prespecified panel of seven molecular markers was standardized and used as predictors in an L2-penalized logistic regression model. The model's results indicated moderate discrimination but high variation across CV folds, reflecting the constraints of the small cohort.

Darien High School

Teacher: Christine Leventhal

Project # 55

Mohr, Ava

<u>The Effectiveness of Physical Therapy Camp Interventions on Motor Function in Children with Cerebral Palsy</u>

Completed Project, 08-Health & Medical

Cerebral palsy is a very common neurological disorder that affects daily life. Physical therapy is the primary way that people with cerebral palsy reduce their symptoms. PT helps with daily life and improving motor function. This study evaluates many different types of physical therapy camps with the aim to find the most effective one through the use of statistics. Effect size was found using the statistical tests cohen's d and partial eta-squared. 14 studies were analyzed with an age range of 4-18 years old. There were three sections that the studies were broken up into: lower extremity, upper extremity, and upper & lower extremity combined camps. The lower extremity section had a camp duration of 4 weeks to 12 weeks. The upper extremity section had a range of 10 days to 10 weeks, and the upper & lower extremity combined interventions had a range of 10-13 days. mCIMT & AOT, mCIMT with intensive therapy, CIMT & VR, intensive bimanual HABIT-ILE, functional training and functional electrical stimulation mobility camp had the largest effect sizes, meaning those camps had the greatest improvements in motor function from the beginning of the camp until the end. This implies that these camps would be the most effective and should be told to patients first when they want to start physical therapy.

Darien High School

Teacher: Guy Pratt

Project # 56

Diamond, Serena

A Direct Comparison of Vision Transformer and Convolutional Neural Network Accuracy on Exoplanet Transit Classification to Optimize Deep Learning Architecture for Transit Time-Series Analysis

Completed Project, 09-Physical Science

Abstract Serena Diamond Exoplanet discovery relies heavily on transit photometry, where periodic dips in stellar brightness reveal planetary orbits (Tolasa&Furi2025). While Convolutional Neural Networks (CNNs) are standard for automated light curve classification (Cuéllar2022), Vision Transformers (ViTs) may outperform them by capturing long-range dependencies (Khan2023). However, no direct comparison using identical datasets and preprocessing exists prior to this. This study compares CNN and ViT architecture to determine which achieves better accuracy and less computational demand. Light curves from the Kepler mission trained both models. The CNN processed 1D detrended, phase-folded, and binned flux values; the ViT analyzed 2D recurrence plots derived from the same data; detrended, phase-folded, and binned identically (Choudhary2025;Shallue2018). Model training used five-fold cross-validation (Choudhary2025). Once training was completed, sorted test data from Kepler was used to determine model accuracy (precision; recall; and their harmonic mean, F1 score), and computational demand (in floating point operations per second (FLOPS)) (Choudhary2025; GeeksforGeeks2025). The CNN had precision, recall, and a F1 score of 91.92%, 84.68%, and 88.15%, respectively. The ViT had precision, recall, and a F1 score of 96.04%, 92.98%, and 94.49%, respectively. The CNN and ViT used approximately 2.4×10^{12} and 1.3×10^{14} FLOPS, respectively. These results demonstrate that ViTs are superior to CNNs for transit classification, even with higher computational demand, and therefore should be used for future missions detecting candidates, such as the Nancy Grace Roman telescope (NASA, 2023), thus advancing planetary science.

Staples High School

Teacher: Amy Parent

Project # 57

Shah, Anaiya

<u>The Future of 3D Printing: More Than Just Making Toys</u>

Completed Project, 08-Health & Medical

The purpose of this project will be to test the strengths and limitations of various 3D printers that we have in the King Innovation Lab in order to understand viability for large scale, high volume, commercial product manufacturing. Current subtraction manufacturing methods such as milling, cutting and grinding are expensive, time consuming, will require specialized labor and will generate a high degree of wasted materials (1). This research will be geared towards understanding how additive manufacturing, building from the ground up, such as 3D printing, will manufacture products that will be cheaper and will take less time to make with less waste. A customized "torture test" will be developed to test the accuracy and precision of each printer. Furthermore, various resins and filaments will be printed and strength tested (2). A matrix will be developed that will match up printer capability and materials. The knowledge from the experiments will be used to successfully make a foot insole support for a fellow King athlete. Further studies will focus on how 3D printing will be useful for rapid prototyping products for real world applications. The possible research questions for this project will be where the process of 3D printing will present challenges and what will be those challenges or limits (3). The expected outcome of this project will be to determine the strongest printing material and the most accurate printer. For my printer test, I will create a CAD (Computer Aided Design) design that will consist of five different tests, bridges, diameters, overhangs, pillars, and text through the ONSHAPE software. For SLA printing, the CAD design will be processed in the Preform software by FormLabs, sliced and translated in the G-Code. For FDM printing, the CAD design will be sliced in Slicer3D and uploaded to the printer via USB. The variable in the testing will be the resolution for SLA (0.1 microns or 0.2 microns) and for FDM (fast vs medium speed)...

King School
Teacher: Victoria Schulman

Project # 58

Marti, Max

<u>Effects of Dietary Sugars on Bone Mass and Mechanical Strength</u>

Completed Project, 08-Health & Medical

This study investigated how exposure to different dietary sugars influenced bone mass and mechanical strength using chicken wing bones as a model system. Bones were cleaned, weighed, and tested for baseline strength before being submerged in solutions containing glucose, fructose, or D-galactose at varying concentrations and exposure durations. Following treatment, changes in bone mass and structural integrity were measured to assess how each sugar affected bone properties under controlled conditions. By comparing the effects of multiple sugars, this research aimed to identify whether certain sugars had a more pronounced impact on bone weakening. This research found that while all sugars weakened bone health somewhat, glucose had the most detrimental effect on bone health, and this effect scaled with exposure time. The findings are intended to contribute to a broader understanding of how dietary sugar intake may influence bone health and may help inform future research on nutrition-related risk factors for reduced bone strength.

King School

Teacher: Victoria Schulman

Project # 59

Chan, Claire

<u>Functionalizing DNA Nanotechnology: Optimizing the Impact of Buffer Conditions on Chemical Ligation</u>

Completed Project, 09-Physical Science

The field of DNA nanotechnology removes DNA out of its biological context and instead utilizes DNA as a building block to form 2D and 3D structures with a wide variety of applications, ranging from nanoelectronics to medicine. Ligation of DNA plays a crucial role in assembling DNA crystals, providing stability to the construction of otherwise fragile structures that are sensitive to changes in pH and temperature. 1-ethyl-3-(3-dimethylamino(propyl)) carbodiimide (EDC) shows promise as an alternative to DNA ligation in nanoscale environments where alternatives, such sticky end cohesion, remain impractical. Previous studies have shown success of EDC ligation between DNA-protein cocrystals, however, EDC ligation for double-stranded DNA strands (dsDNA) remains unpredictable, with as low as 30% efficacy. ImageJ was used for the densitometry analysis of ethidium bromide-stained polyacrylamide gels to investigate EDC ligation efficacy of different dsDNA reaction conditions, including pH, buffer concentration, temperature, and additional EDC buffer additions. It was found that EDC can ligate dsDNA, demonstrating novel potential for building robust DNA nanostructures. The reaction was found to occur most optimally at higher temperatures and a lower pH and buffer concentration. The results of this proof-of-concept study provides insight into EDC's efficacy for the ligation of dsDNA and the optimization for the reaction for potentially assembling more diverse 2D and 3D DNA nanotechnologies.

Darien High School

Teacher: David Lewis

Project # 60

Platt, Taylor

<u>Association Between Short-Term Sleep Deprivation and Cognitive Performance:
Inhibitory Control, Problem Solving, Working Memory, and Divergent Thinking</u>

Completed Project, 06-Behavioral

Sleep is essential for optimal cognitive function but there is limited research on the extent to which sleep duration affects various executive function domains simultaneously, including suppression of bias, problem solving, working memory, and divergent thinking. A sample of 169 United States adults took a 15-minute survey composed of a series of cognitive tests, demographic, sleep, socioeconomic, and well-being questions. Cognitive performance was evaluated through the incongruent Stroop Test, Tower of Hanoi, Digit Span Memory Test, and Alternative Uses Test. A significant negative association was found between sleep duration and divergent thinking, such that participants who slept less showed more fluency ($\beta = -.65$, $p < .05$). A positive correlation emerged between divergent thinking and inhibitory control, which challenges the well-established "disinhibition hypothesis." Non-significant positive relationships between sleep and problem solving, working memory, and inhibitory control may align with the largely diverse findings in the research field. This locates a general finding for sleep duration's effect on various cognitive factors by researching four variants of cognitive processes and adds to the research discussions about the relationship between executive functions.

Darien High School

Teacher: Guy Pratt

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Project # 63

Clark, Finnian

<u>Effectiveness of Noise Reduction Techniques in Radio Astronomy</u>

Completed Project, 09-Physical Science

Radio astronomy, a crucial aspect of astrophysics exploration, is significantly impacted by radio frequency interference (RFI). This interference can come from cellphones, radio towers, satellites, Wi-Fi, and many other signal sources, which are significantly stronger than faint radio signals from space, leading to inaccurate, severely tampered data due to the mixing in of human-made signals. Furthermore, many low-cost radio telescopes built by enthusiasts lack access to high-grade noise-filtering equipment, resulting in very low signal-to-noise ratios. Successfully using low-cost noise filtering methods, such as a low-noise amplifier or a band-pass filter, can significantly reduce noise levels on amateur radio telescopes, enabling higher SNR data collection. The research question is whether low-cost noise-reduction methods, such as wideband and narrowband low-noise amplifiers and built-in or external band-pass filters, can significantly increase the SNR of a low-cost hydrogen-line radio telescope, with some combinations proving more effective than others. The engineering goal is to evaluate the effectiveness of multiple low-cost noise-reduction systems combined into a budget-friendly radio telescope designed to detect the 1420 MHz hydrogen line. Two signals at 1500 MHz and 1420 MHz were generated, attenuated, and injected simultaneously using an RF combiner, then injected individually while the signal strength was recorded at incremental attenuation levels. Results show that wideband amplification without a filter significantly increased the interfering signal relative to the target signal, while adding a narrowband 1420 MHz band-pass filter consistently reduced the interfering signal and increased the hydrogen-line signal, demonstrating that the hydrogen-line signal dominated the interference.

King School

Teacher: Victoria Schulman

Project # 64

Alvarado, Christopher

<u>Adaptive Authentication Against DDoS Attacks: A Performance Analysis</u>

Completed Project, 09-Physical Science

Modern cybersecurity systems employ adaptive technologies, such as transfer learning, to mitigate distributed denial-of-service (DDoS) attacks using historical data. These approaches differ from adaptive authentication, which makes real-time security decisions based on user behavior and network traffic. While prior research has shown adaptive authentication can strengthen systems such as blockchain platforms, its effectiveness as a standalone defense against brute-force DDoS attacks remains underexplored. This study evaluates adaptive authentication performance and identifies which behavioral and network metrics—such as login timing, request frequency, or IP activity—most strongly indicate DDoS attacks, informing system optimization for detection and usability. A local network was constructed on VirtualBox with multiple virtual machines, including a victim host running a Python-based login service. Brute-force DDoS patterns were generated using Locust to simulate high-frequency login attempts alongside normal traffic. Trial 1 established baseline behavior without adaptive authentication. Trial 2 implemented a rule-based adaptive authentication system using parameters derived from baseline observations, assigning dynamic risk scores to inform security systems. Trial 3 adjusted thresholds to balance detection sensitivity and accessibility. Results show that adaptive authentication offers greater security compared to static systems; login frequency and timing are stronger indicators than location alone; overly aggressive thresholds increase false positives, addressed in Trial 3; and network performance metrics—CPU, packet loss, and response time—stabilize faster in Trials 2–3 than Trial 1. By linking metric effectiveness to system design, this study informs cybersecurity strategies and supports development of simplified, consumer-level adaptive authentication systems that balance usability and security without relying on complex machine learning.

Joel Barlow High School

Teacher: Paul Testa

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Project # 66

HIll, Sara

<u>Prevalence of Pathogens in Asian Longhorned Ticks (Haemaphysalis Longicornis) in Bridgeport Ct</u>

Completed Project, 07-Environmental

Tick-borne diseases impact hundreds of thousands of people every single year and cause many life-altering complications. The surveillance of tick-borne diseases through field and laboratory work ensures a deeper understanding of possible pathogens in invasive tick species. Detection of the possible pathogens present in invasive species allows an understanding of public health safety against tick-borne diseases. Fieldwork will include the collection of the invasive longhorn tick, Haemaphysalis Longicornis, to monitor the spread and assess potential ecological and public health impact. In the laboratory, work focused on tick species identification and the detection of pathogens using molecular biology techniques, including DNA and RNA extractions, polymerase chain reaction (PCR), and gel electrophoresis. These methods will ensure the accurate identification of tick-borne agents and contribute to the understanding of their distribution. Together, these efforts support ongoing surveillance programs aimed at improving tick-borne disease prevention and control strategies to help ensure the safety of the public.

Ridgefield High School

Teacher: Ryan Gleason

Project # 67

Massey, Kate

<u>Effect of Access to Healthcare on Stage at Diagnosis and Treatment Outcomes for Carcinoma Skin Cancer</u>

Completed Project, 08-Health & Medical

There has been much research on melanoma skin cancer but less on non-melanoma skin cancers (NMSC) such as basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (CSCC). It is important to understand what barriers stand between patients and a timely diagnosis and proper treatment for these diseases. Possible barriers include being underinsured, living in more remote areas, and having a lower socioeconomic status. The objective of this study was to assess stage at diagnosis in high vs low healthcare access groups, to evaluate outcomes across the healthcare access spectrum, and to identify structural barriers contributing to lacking access to healthcare. It was predicted that less healthcare access is directly correlated to later stage at diagnosis and greater prevalence of more severe and/or metastatic disease. The desired outcome of this work is to provide a robust structure upon which major policy recommendations can be made. This project may provide sound evidence for further resource allocation towards dermatologic screening and care particularly targeting groups that lack access to healthcare.

Darien High School

Teacher: Guy Pratt

Project # 68

Seymour, Ella

<u>Searching for brook trout via eDNA research in local CT streams</u>

Completed Project, 07-Environmental

Brook trout (Salvelinus fontinalis) are New England native, cold-water fish that serve as key indicators of healthy stream ecosystems. However, due to rising stream temperatures and competitive inhibition from brown trout, their populations have declined significantly across the northeastern United States. This study integrates stream temperature data with environmental DNA (eDNA) presence/absence testing to assess current brook trout distributions in Connecticut. eDNA offers a non-invasive, highly sensitive method for detecting species from genetic material in water samples. By comparing eDNA results with stream temperature data, this study can identify thermally suitable habitats where brook trout are either present or absent. Cold streams where brook trout are detected can be prioritized for conservation and habitat protection. In contrast, cold streams with eDNA absence may represent potential sites for future reintroduction. This approach enables a more informed and targeted conservation strategy, helping ensure the long-term survival of brook trout and the protection of the cold water ecosystems they depend on.

Darien High School

Teacher: David Lewis

Project # 69

Figlar, Eva, Abernethy, Anahit

<u>A Nuclear Magnetic Resonance Spectroscopy Study of Five Di-imine Molecules</u>

Completed Project, 10-Teams (Completed Project)

Nuclear Magnetic Resonance Spectroscopy (NMR) is a process used to determine the chemical environments of hydrogen and carbon atoms. The study, A Nuclear Magnetic Resonance Spectroscopy Study of Five Di-imine Molecules by Anahit Abernethy and Eva Figlar, done at Sarah Lawrence College under the guidance of Dr. Colin Abernethy, aims to test five different aniline compounds to determine if they can serve as sufficient models for procedures using benchtop NMR. The compounds analyzed in the NMR Spectroscopy machine were synthesized using acetic acid, the precipitate was separated from the solution using a vacuum filtration system, and the powder from the solution was diluted using the NMR solvent: chloroform. Specific molecules provided cleaner readings on the NMR machine than others. The accuracy of data was measured if it included the correct number of signals and the integration ratios for both carbon-13 and hydrogen atoms. 2,4,6-trimethyl-phenyl-diazabutadiene, 2,6-diethyl-phenyl-diazabutadiene, 2,6-diisopropyl-phenyl-diazabutadiene, and 2,6- dimethyl-phenyl-diazabutadiene all gave accurate data. 4-bromo-2,6-dimethyl-phenyl-diazabutadiene did not yield accurate information, even with additional measures taken, such as increasing the number of scans and the concentration of the substance. It was determined that more soluble molecules are easier for the NMR machine to scan, and therefore, more soluble molecules yield more accurate data and contribute to better models. NMR is one of the fastest growing fields in chemistry, so by determining an array of molecules suitable for NMR education, future generations will be able to utilize these molecules, which produce clear NMR proton and carbon spectra.

Ridgefield High School

Teacher: Patrick Hughes

Project # 70

Blackwell, Haley

<u>Hearing Loss's Correlation to Anxiety</u>

Completed Project, 06-Behavioral

Over 1.5 billion people globally, or about 20% of the world's population, live with some degree of hearing loss. Hearing loss has been associated with psychological challenges, specifically including symptoms of anxiety and anxiety disorders. Understanding this relationship was important because anxiety left untreated can take a toll on one's life, causing distress and discomfort, thus negatively affecting daily functioning. This study was conducted to examine the correlation between hearing loss and anxiety to determine whether the degree of hearing loss influenced anxiety levels. A survey was developed using Google Forms, targeting adults with hearing loss. The survey included questions related to hearing loss severity, anxiety symptoms, environmental factors, and life situations. Participants were recruited through Facebook by joining groups related to hearing loss and distributing the survey to individuals who were eligible to complete it. The results indicated that there was a positive correlation between hearing loss and anxiety, supporting the initial hypothesis made. Individuals with greater degrees of hearing loss reported higher levels of anxiety. These findings were consistent with previous research and strongly suggested that hearing loss severity may play a role in psychological well-being. Overall, this study highlighted an area that has not been extensively researched and emphasized the importance of addressing mental health concerns in individuals with hearing loss. For future research, I would like to investigate specific factors that contribute to anxiety in this population so that people can become better informed and more support/help can be provided.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 71

Sullivan, Flynn

<u>Analyzing the Impact of Weight Cutting upon Head Trauma Recieved in Mixed Martial Arts Bouts</u>

Completed Project, 08-Health & Medical

Weight cutting is an extremely common practice in most combat sports, being most prevalant in Mixed Martial Arts (MMA). There are serious health concerns associated with weight cutting as one day may not be sufficient to healthily re- gain the water lost in order to make weight. This study seeks to determine if there is a correlation between the amount of weight regained before a contest and the amount of head trauma experienced in a fight. This could have impli- cations for weight-cutting-related regulations. The data regarding weight was collected using information from the California State Athletic Commission, as found in tapology.com, while information about fight outcomes was found via ufcstats.com. This study found that fighters who regain more weight in between the day of weigh ins and fight day were at higher risk of knockouts, knockdowns, and absorbed more significant strikes. Further, those who were knocked out re- gained a non-statistically significantly larger amount of weight than those who were not.

Darien High School

Teacher: David Lewis

Project # 72

Buchesky, Anastasia

<u>The effects of psychiatric service dogs on veterans with PTSD and co-occurring mental health disorders: A Meta-Analysis</u>

Completed Project, 06-Behavioral

There is currently research about how veterans with PTSD have been able to benefit from psychiatric service dogs, but this study aims to examine the extent of those benefits not just for veterans with PTSD, but also for other individuals dealing with other mental health concerns such as anxiety and depression. We are planning to compile different research studies that have been done, and to compare the results about how psychiatric service dogs can help lower PTSD levels in veterans as well as how they can lower other mental health illnesses including, but not limited to, depression and anxiety. A sub goal of this study would be to evaluate if shelter dogs, which are more inexpensive and accessible than trained psychiatric service dogs, could provide similar effects on PTSD levels. We hope to find more concrete evidence over the articles that psychiatric service dogs are able to provide a safe, nonmedical treatment option for veterans with PTSD. This research could help open the research field to seeing the extent to how much psychiatric service dogs could benefit not only veterans with PTSD, but also people dealing with other mental health illnesses such as anxiety and depression. This research could also open up more research to see how shelter dogs, which are a more inexpensive and accessible option compared to service dogs, would be able to similarly decrease PTSD levels in veterans.

Darien High School

Teacher: Guy Pratt

Project # 73

Newman, Finley, Burchetta, Sutton

<u>Using Hydromoths to Analyze Energy and Average Power Density in Long Island Sound and Bahamas</u>

Completed Project, 10-Teams (Completed Project)

Marine noise pollution caused by anthropogenic sources can be harmful to aquatic animals. Our research focused on analyzing the energy and average power density in two specific marine biomes. In order to obtain the underwater sound recordings, we deployed HydroMoth devices in Long Island Sound and near Harbor Island, Bahamas. The HydroMoths recorded from 6AM to 8AM, 11AM to 1PM, and then from 4PM to 6PM. Each time was recorded in 55 second increments to retain battery life and to gain the most data possible for the longest amount of time. The hydromoths were deployed for about a week's time each deployment. We then used Raven Pro sound analysis software to analyze energy and average power density within the areas, which show how many times a sound is passing through a certain area and how powerful it is. It was seen that the energy and average power density are similar in each respective place. In the Long Island Sound, midday had the highest energy and average power density while sunrise and sunset both had a greater range. Similarly, in Harbor Island, midday had the highest energy and average power density while the sunrise was lower, and sunset had a greater range. For future research, we hope to test at different times throughout the year to see the variation across seasons. Knowing the range of noise levels in these areas at different times of the year could lead to setting noise pollution limits in order to protect marine animals and ecosystems.

Sacred Heart Greenwich

Teacher: Joyce Reed

Project # 74

Broughton, Lily ; Dean, Caitlin

<u>Effects of Nitrate and Phosphate Pollution on Water Quality</u>

Completed Project, 10-Teams (Completed Project)

Our research focused on the issue of nitrate and phosphate pollution, which contributes to the deterioration of water quality and negatively impacts aquatic life and surrounding ecosystems. Nutrient pollution is especially concerning because it can lead to algal blooms and oxygen depletion, further stressing aquatic ecosystems. If left unresolved, this pollution could pose a serious threat to future generations. We aimed to address this problem by testing water quality in local areas to identify which regions are more prone to pollution. We collected water samples from Blind Brook in New York and tested for nitrate, phosphate, dissolved oxygen, atmospheric pressure, turbidity, and pH levels on a regular basis. We found that Blind Brook had lower levels of nitrate and phosphate pollution than predicted. The results of all tests remained consistent throughout the testing period, indicating that Blind Brook has a low concentration of these nutrients. Upstream sites tested higher for levels of nitrate and phosphate presence than downstream sites. Future research could examine a larger site radius and explore the connection between chemical pollution and aquatic life. The use of more precise equipment and testing for a wider range of water quality factors could enhance data accuracy. Monitoring water quality is extremely important and can have significant environmental ramifications. Using Blind Brook as a standard, our research may help support other efforts to reduce pollution in natural water sources. Ultimately, research like this plays a critical role in protecting freshwater ecosystems and ensuring sustainable water resources for the future.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

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Project # 76

Forlini, Avery

<u>Assessing Runners Knowledge on Probiotics</u>

Completed Project, 06-Behavioral

As nutrition knowledge increases people become more interested in using probiotics, but despite their easy access many people have limited knowledge of what probiotics are. This study was conducted to assess runners' understanding of probiotics because these athletes complete rigorous training and nutrition plays a critical role in performance. It was hypothesized that runners with more accurate knowledge of probiotics would be more likely to use the products. To address this I sent out a Google form survey to various running programs to assess runners' knowledge of probiotics. These athletes endure rigorous training, nutrition is an important factor in success. The results showed that approximately 80% of respondents reported consuming probiotics, while 20% did not. Runners who had greater knowledge of probiotics and their benefits were more likely to use the products. Many participants reported obtaining their probiotic knowledge primarily from the internet rather than healthcare professionals, suggesting that although runners might be informed on probiotics their information sources may not be accurate. These findings indicate that increased knowledge of probiotics is associated with higher usage, but the quality of knowledge is varied. With the results of this survey, I hoped to understand what runners know about probiotics and how they incorporate them into their lives. My goal is to use the survey information to help inform others. Future research should focus on ways that health professionals can get accurate information about probiotics to runners.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 77

Curry, Campbell

<u>Analyzing Occupational Therapy Opportunities for Parkinson's Disease</u>

Completed Project, 06-Behavioral

Parkinson's Disease (PD) is an incurable neurological condition with devastating symptoms affecting millions of Americans. This study aimed to discover the strengths, weaknesses, opportunities, and threats (SWOT) to the utilization of occupational therapy (OT) as a treatment. While OT is of known benefit to managing PD symptoms, it is underutilized among people with the disease. I created an anonymous survey using Google forms that was distributed to OTs across the country via social media and professional organizations. It was found that the strengths for OTs include their ability to collaborate with other healthcare professionals, confidence in treating patients with PD, and treatment objectives congruent with other professions. The opportunities found were in increasing the frequency of seeing PD patients and addressing the factors that enable PD patients to receive treatment (such as doctors' referrals, support from communities and families, awareness, deficits in the disease, financial reasons, and OT certifications). The main main barriers (weaknesses and threats) to PD patients receiving OT were lack of referrals by doctors and financial issues/lack of insurance These findings indicate that there is a need to educate doctors on the benefits of OT and to address the general issue of the many gaps in health insurance. A next step for this research is to survey doctors to discover more about their OT referral process.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 78

Muccia, Grace

<u>Understanding the Effects of Music Usage on Caregivers of Alzheimer's Patients</u>

Completed Project, 06-Behavioral

Across the United States, over 11 million people care for those affected by dementia, and the purpose of my project was to determine whether music calms down the patients, and whether the caregivers feel better mentally after playing music for them. I made an anonymous survey using Google forms, which asked questions related to the use of music by the caregivers and its effects on the patients and caregivers. The participants in this study were found by reaching out through email to local nursing homes, posting on the national Alzheimer's association platform, and support groups that reside on social media (using Reddit and Facebook). Before sending the survey, it was expected that caregivers receive benefits from using music as a tool because the patients are calmed down and less agitated. After receiving results and analyzing data, it was found that playing music to their patients was beneficial (ranging from somewhat to very beneficial) for the caregivers. The frequency of caregivers who use music in their practice, as well as the frequency of caregivers who feel better mentally was also very high, strongly supporting my hypothesis that using music helps caregivers mentally. In the future, I hope to look into ways to make personalized playlists for particular patients, in order to see if the benefits would be even higher.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 79

McCauley, Lauren

<u>Family Interpreters' Experiences In Medical Settings</u>

Completed Project, 06-Behavioral

In the United States, there are about 26 million people who have limited English proficiency (LEP). There is often a lack of professional interpreters in medical care settings, causing family members to be used as interpreters in these settings. The use of non-professional interpreters can increase the amount of miscommunication between the provider and LEP patient. I created an anonymous Google forms survey for adults who act as interpreters for family members in medical settings. This survey included questions about access to professional interpreters, emotions experienced while interpreting, and areas for improvement. The responses show that even when professional interpreters are available, they are not used. Survey respondents reported a range of emotions (stress, nervousness, determination, confidence, etc.) while interpreting for their family members. It is important to find professional support for these individuals who experience emotional hardships while worrying about caring for their family member.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 80

Khan, Dua

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

Completed Project, 08-Health & Medical

In recent years the emphasis on research concentrating on Social Determinants of Health (SDoH) has been high. The World Health Organization defines Social Determinants as "the conditions where people are born, live, work, play, and worship." The impact of SDoH on cardiovascular disease (CVD) has been understudied even though it can increase the chances of death. The objective of this study was to identify the key social determinants associated with cardiovascular disease amongst United States veterans and if they vary by gender. I hypothesized that cardiovascular disease is associated with social determinants and may vary by gender. Data was collected on veterans in care with at least two outpatient and one inpatient visit and diagnosed CVD between the years 2000 and 2019 from the VA EHR. The data was de-identified in order to be HIPPA compliant. A generalized linear mixed model was conducted to examine which factors were associated with CVD. Factor variables included age, sex, area deprivation index, race and ethnicity. The key social determinants associated with CVD were sex, age, race and ADI. Males were less likely to have CVD than females, older individuals were more likely to have CVD than younger, blacks were more likely to have CVD than whites and people with higher ADI scores (higher ADI scores = higher social disadvantage) were more likely to have CVD compared to people with lower ADI scores. Next steps for research could include analyzing if SDOH varies by education in order to push for healthcare equity.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 81

Halvorsen, Sydney

How Fishing Rules Affect Coral Reefs: Comparing Marine Protected Areas and Heavily Fished Areas in the British Virgin Islands

Completed Project, 07-Environmental

Coral reefs are among the most biologically diverse ecosystems on Earth, supporting roughly one quarter of all marine species. However, their health has declined drastically over the past century due to warming waters, pollution, and overfishing. Overfishing disrupts the delicate balance of reef ecosystems by removing key species that regulate algae growth, resulting in overgrowth that can suffocate corals through competition for light and oxygen depletion. This study examines how varying levels of fishing pressure affect coral reef health by comparing Marine Protected Areas (MPAs) and heavily fished zones in the British Virgin Islands. The research was conducted through the Marine Science and Nautical Training Academy (MANTA) program in summer 2025. Data were collected using underwater transects at two sites: The Chimney, an infrequently fished MPA, and Cane Garden Bay, a heavily fished area. At each site, divers recorded fish abundance and diversity within two feet of 25-meter transects and identified all living coral species within one foot of the same lines. The collected data were analyzed using ecological diversity measures, including the Simpson Index and Dominance Index, to compare biodiversity and coral abundance between the two habitats. Results showed that MPAs had greater numbers and varieties of fish and a higher percentage of living coral cover than the heavily fished site. These findings support the hypothesis that stricter fishing regulations contribute to healthier, more resilient reef ecosystems and reinforce the importance of MPAs in coral reef conservation.

Darien High School

Teacher: Guy Pratt

Project # 82

Tiedemann, Catherine

<u>Consumers' Knowledge of Ultra-Processed Foods and Associated Health Risks</u>

Completed Project, 06-Behavioral

Ultra-processed food has become a common part of many diets in the United States, but many people do not fully understand what qualifies as an ultra-processed food. This study was conducted to better understand how much people know about ultra-processed foods and the NOVA classification system, as well as how often these foods are consumed. An anonymous survey was created using Google Forms and distributed to adults, collecting 91 responses. The survey gathered basic demographic information, including age and location, and asked participants about their knowledge of ultra-processed foods and the NOVA classification. Participants were also asked to report what they ate for breakfast, lunch, and dinner on the day they completed the survey. These results showed that many participants regularly consumed ultra-processed foods but had limited knowledge of the NOVA classification and had difficulty in identifying which foods were considered ultra-processed. These findings suggest that there is a gap between what people eat and what they understand about the foods they consume. Further research will focus on further analyzing the data to examine trends among different demographic groups and to identify areas where nutritional education may be most effective.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 83

Soung, Phillip

<u>The Clean Beam</u>

Completed Project, 08-Health & Medical

The objective of this engineering project is to design and evaluate a UVC disinfection prototype that utilizes 275 nm ultraviolet light to reduce bacterial contamination on surfaces. UVC light is widely recognized for its germicidal properties, as it can damage the DNA and RNA of microorganisms, prevent replication and leading to cell death. However, because UVC radiation can also be harmful to human skin and eyes, this prototype was engineered to deliver controlled exposure while minimizing unnecessary risk. The prototype was tested using Escherichia coli (k-12) as a model organism due to its biological similarity to harmful bacteria that commonly contaminate surfaces and promote rapid growth. To evaluate the effectiveness of the design, bacterial samples were exposed to UVC light for varying durations of 10, 30, and 60 seconds. Additionally, the prototype was tested with and without a focusing lens (Concave) to determine whether concentrating the UVC light improved disinfection efficiency. By analyzing bacterial survival under these different conditions, this project aims to assess the performance, consistency, and practicality of the UVC disinfection prototype. The results of this study may contribute to the development of safer and more effective UVC-based sterilization systems for real-world applications such as surface sanitation and controlled disinfection environments.

Fairchild Wheeler

Teacher: Lucien Bouffard

Project # 84

Bakare, Bella ; Bonilla, Aury

<u>PaciTrack- Pacifier Tracking Device</u>

05-Teams (Research Proposal)

The purpose of this project is to find a better way to find a missing pacifier. My little sister often throws or hides her pacifier, causing a lot of trouble at home. Our pacifier tracker "PaciTrack" will help. Unlike other pacifier trackers ours will not be built into the pacifier. Our design will attach to existing pacifiers and be a strap to connect the pacifier to clothing. This will allow babies of different ages and medical needs to use our device and not be forced to a single design. We will design and test our product for safety and to make sure it does not break. In the end, we hope to create and sell our product.

John F. Kennedy High School

Teacher: Timothy DeJulio

Project # 85

Smith,Emerson ; Stefura, Aubrey

<u>The effects of water and climate change on butterhead lettuce</u>

05-Teams (Research Proposal)

As climate change threatens the state of our environment, scientists pose a question; how will global warming affect the food that we as a society eat. Climate change is a growing issue over the globe, and it is affecting all sorts of organisms in our environment, even those that are overlooked. This research aims to answer that question by mimicking the effects of the changing environment on Butterhead Lettuce, but on a much smaller scale in a more controlled environment. This experiment will be conducted using nine different environments. This change will take place over three to four. Cameras will be used to observe how lettuce will react to a gradual increase in the severity of each environment (different ranges of water to mimic flooding and droughts and different temperatures to mimic global warming). The purpose of this is to somewhat understand how climate change might affect the growth and adaptability of our food, particularly pathogenic species, which could become a larger threat to healthy populations as the climate shifts around the globe. Observations will be made both visually and microscopically to track changes in growth patterns, morphology, and potential shifts in pathogenic potential.

Ridgefield High School

Teacher: Patrick Hughes

Project # 86

Abraham, Jacob

<u>Missed Opportunities - The Widely Patent Schatzki's Ring</u>

03- Health Research Proposal

Background: Schatzki's rings are a well-recognized cause of dysphagia when they produce a clear esophageal narrowing. However, the clinical significance of widely patent Schatzki's rings (estimated diameter > 18mm) remains uncertain, and these subtle lesions are frequently overlooked during endoscopy. Whether disruption of such rings provides symptomatic benefit has not been well established. Methods: Among 327 patients who underwent esophagogastroduodenoscopy (EGD) for dysphagia over the past year at our tertiary care academic center, 22 consecutive individuals were identified as having a widely patent Schatzki's ring. Seventeen underwent ring disruption using biopsy forceps—1 with jumbo forceps, 2 with large-capacity forceps, and the remainder with standard forceps—at the discretion of the endoscopist. Disruption involved taking multiple biopsies in at least four quadrants. Four patients were excluded from review due to known motility disorders (jackhammer esophagus, achalasia) or were lost to follow-up, leaving 13 evaluable subjects. Clinical outcomes were assessed after an average follow-up of 7.46 months. Results: Of the 13 patients (average age 61.9 years, 84.6% men) eleven patients (85%) experienced significant improvement or complete resolution of dysphagia. The two patients without improvement had both solid and liquid dysphagia at baseline and were suspected to have an underlying dysmotility disorder. Among responders, six had dysphagia to solids only, one to solids more than liquids, one to pills only, and three to both solids and liquids. Four of the 11 responders had attempted dilation with 18–20 mm CRE balloon without any effect on the ring, highlighting its patency. Four patients had concomitant esophagitis. Six had proton pump inhibitors (PPI) initiated or escalated after endoscopy; the remaining five were already on PPI therapy. Conclusions: Widely patent Schatzki's rings represent a missed opportunity in dysphagia evaluation. Forceps-based ring disruption appears effective, even when dilation to recommended diameters fails to alter the ring. Although modification of PPI therapy presents a potential confounder— particularly if GERD-related dysphagia contributed to improvement—Schatzki's rings themselves are frequently associated with chronic GERD, underscoring the relevance of addressing the ring. Biopsy forceps offer a cost-efficient, environmentally favorable, and readily available method for ring disruption, potentially reducing procedural time and enhancing feasibility in moderate-sedation settings. Prospective studies are warranted to confirm these findings.

Project # 87

Abukhovich, Victoria

<u>Impact of Drought-Induced Stress on The Accumulation of Polysaccharide and Glucosinolate levels in Raphanus sativus Roots, and Their Possible Implications on the Gut Microbiome</u>

02-Environmental Research Proposal

The project, which aims to identify the effects of drought stress on Raphinus sativus (radish) plants, is critical as drought conditions in Connecticut have worsened over the past few years. To assess the glucosinolate/polysaccharide ratio in the plants, samples of the crop will be grown in a controlled environment and exposed to predetermined quantities of water, as determined by soil matrix and drought like conditions. The growing period will be for 7-8 weeks. Roots of the radish plants will be harvested and then dried and analyzed for the sugar levels. A methanol-water mixture, as well as a hot water mixture then will be poured through a glass-wool-plugged syringe packed with Sephadex G-25 to remove impurities. The extraction collected will be analyzed using a UV Spectrometer for concentration and purity. Additionally, data analysis conducted will include mean concentrations, standard deviations and ANOVA tests for significant differences between the extracts. To assess metabolic balance, the ratio of polysaccharides to glucosinolates will be derived. Challenges could arise from the extraction process and identifying the purity of the extracts.

Joel Barlow High School

Teacher: Paul Testa

Project # 88

Archibald, Chloe

<u>The Impact of Melatonin on the Lifespan of Camponotus Pennsylvanicus After Chronic Stress from Social Isolation</u>

01- Behavioral Research Proposal

Chronic stress is a cause of damaged cells and increased health risks. Chronic social isolation is a prolonged psychological strain that provokes unstable molecules such as ROS and free radicals to attack cells and steal their electrons. In this process called oxidative stress, the cell's mitochondria become damaged, and antioxidant defenses are depleted in their ability to neutralize the free radicals. When cells and antioxidant defenses are harmed in social animals like humans, the body reduces its ability to fight diseases. Social animals depend on social interactions for survival; when isolated, they face increased aging, high risks of chronic illness, organ failure, and even death. To regulate and strengthen the low antioxidant defenses, antioxidant supplements have the ability to reverse the harmful effects of chronic social isolation and restore the ability to fight disease. Melatonin, a commonly used sleeping drug, with its calming factors and ability to restore antioxidant depletion, can neutralize harmful free radicals and prevent the buildup of ROS, granting the cells protection from oxidative stress. Similar to the social habits of humans, ants require social interactions for survival. The colony depends on each ant's specific job for survival. This dependence on others causes an inability for carpenter ants to survive on their own. If ants were given melatonin supplements daily, it could have the ability to lengthen the lifespan of an isolated ant by reversing and preventing the effects on cells.

Ridgefield High School

Teacher: Ryan Gleason

Project # 89

Armstrong, Nathaniel

<u>The Effect of Surface Texture on the Aerodynamic Drag of 3D-Printed Rocket Nose Cones.</u>

04-Physical Science Research Proposal

3D printing is seeing increasing use in aerospace due to its design flexibility and low cost, however, the process leaves a rough surface texture that increases aerodynamic drag (Getachew, 2023)(Udroiu, 2022)(Shah, 2022). Smoothing the surface of 3D printed airfoils and cylinders has been shown to decrease drag, but these studies have not extended to rocket nose cones (Shah, 2022)(Oliviera, 2024). Dimpling is another way to reduce drag, a Purdue University report found that dimpling a rocket nose cone in a similar style to golf balls decreased drag by 15% in a simulation, though this study remains unpublished and has not been tested in a real wind tunnel (Nematollahi, 2024). The goal of this study is to determine how surface treatments, including untreated, smoothed, dimpled, and dimpled and smoothed surfaces, affect the aerodynamic drag, flow separation, and surface texture of 3D printed rocket nose cones. Tangential ogive nose cones 63mm in diameter and 160mm in height will be 3D printed in ABS plastic at 255° and evaluated in a Kelvin Flight Dynamic wind tunnel. Drag force will be recorded using a digital hanging scale, flow separation will be visualized using dry ice vapor, and surface roughness will be quantified using imaging analysis (Ercetin, 2024). This study is expected to prove that dimpled and smoothed nose cones 3D printed will produce less drag than their untreated counterparts. If supported, this study will demonstrate a low cost, effective method to improve fuel efficiency, speed, and range of 3D printed aircraft.

Staples High School

Teacher: Amy Parent

Project # 90

Bhuyan, Anya

<u>Engineering Agricultural Waste-Derived Biochars Embedded in Alginate-Chitosan Hydrogel Beads for Mitigating Aqueous Copper Ion Toxicity</u>

02-Environmental Research Proposal

Heavy metal pollution poses a significant threat to aquatic ecosystems, with contaminants like copper (II) ions entering water systems through industrial and agricultural runoff. Elevated concentrations impair olfactory development in aquatic organisms and weaken the metabolic functions of bacteria essential for nutrient cycling and decomposition. Conventional remediation methods that target copper contamination are expensive, generate toxic chemical sludge, and often fail to address the ecological impacts of pollution. This study evaluates the effectiveness of sodium alginate-chitosan hydrogel beads infused with biochars derived from coconut shell, rambutan peel, orange peel, and spent coffee grounds in reducing the biological toxicity of aqueous copper ions. Biochars were produced via controlled pyrolysis of agricultural waste materials and subsequently incorporated into ionically crosslinked hydrogel beads. Hydrogel-biochar composites were characterized using scanning electron microscopy (SEM) to assess porosity and surface morphology, and their copper-remediation capabilities were measured using A. fischeri bioluminescence assays and spectrophotometric quantification of residual copper. It is expected that biochar-enhanced hydrogels will significantly reduce both copper concentration and Aliivibrio fischeri bioluminescence inhibition compared to hydrogel-only and untreated controls. SEM imaging will reveal a notable increase in porosity and surface area within the most effective composites, indicating that surface morphology correlates with enhanced adsorption efficiency. These findings highlight the potential of biochar-infused hydrogels as a sustainable and low-cost water remediation method for mitigating the biological toxicity of copper ions in aquatic environments, and future studies could explore additional waste sources as well as extend this approach to other heavy metals.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 91

Bievenour, Chloe

<u>The Effect of Electrospun Scaffold Material on In Vitro Dental Pulp Stem Cell Adhesion</u>

03- Health Research Proposal

Regenerative dentistry is a groundbreaking field focused on regrowing damaged or lost dental tissues using biological mechanisms, offering the potential to repair teeth naturally rather than relying on artificial materials. Scaffolds provide the structural framework that guides tissue development for regeneration. Scaffolds with large, interconnected pores are preferred because they facilitate better nutrient diffusion and cell survival, while smaller pores provide greater surface area for initial stem cell adhesion. Balancing these factors is a key challenge, as adhesion is the essential first step for regeneration. This study will investigate how scaffold material can affect in vitro adhesion of dental pulp stem cells (DPSCs). Scaffolds will be fabricated using a technique called electrospinning, and made from natural polymers (collagen, gelatin, chitosan), synthetic polycaprolactone (PCL), and composite scaffolds combining each natural polymer with PCL. DPSCs will be seeded on each scaffold, incubated in a multi-well plate, and washed with a solution to remove non-adherent cells. Remaining cells will be imaged by Scanning Electron Microscopy and quantified for comparison. Poly-L-lysine-coated culture plates will serve as positive controls to confirm the cells' capacity to adhere to a surface. It is hypothesized that natural polymer scaffolds will support the highest DPSC adhesion, composites will allow for moderate adhesion, and PCL-only scaffolds will show minimal adhesion. By providing insight into optimized scaffold design, this study could lead to more effective dental tissue regeneration, bringing innovative regenerative approaches closer to real-world clinical use and ultimately transforming the future of dentistry.

Weston High School

Teacher: Stacey Greenberg

Project # 92

Bottner, Lily

<u>The Effect of Increased Temperature and Salinity on H. Exemplaris to Evaluate Tolerance Limits and Understand the Impact of Multiple Simultaneous Climate Changes</u>

02-Environmental Research Proposal

Anthropogenic climate change is affecting ecosystems by collapsing food webs and eroding habitats worldwide. Tardigrades are living indicators for ecosystem decline, due to their stress tolerance by way of cryptobiosis formation. Much is known about tardigrades' tolerance to singular stressors, but during extinctions, stressors appear simultaneously. This study aims to evaluate effects of temperature and salinity on the species Hypsibius exemplaris to determine its tolerance to multiple simultaneous climate changes. By 2100, freshwater temperature is expected to rise, and experiments of 20°C, 24°C, and 30°C (control 16°C) model intensities of that change. Salinity in freshwater is around 0.5 ppt (control), and has begun to increase to more brackish concentrations of 5 ppt, 10 ppt, and 15 ppt. Simultaneous stressors will be performed at sub-lethal experimentally determined thresholds to evaluate potential effects. All experiments run 10 days, and will be performed on active tardigrades. A mortality assay using SYTOX Green dye will quantify the dead tardigrade population (Richaud, Galas 2018). To evaluate sub-lethal stressors, tardigrade translucent midguts will be assessed for chlorophyll to confirm active ingestion (Schill et al 2011), and an assay of behavior including kinematics and feeding will be taken throughout the experimental period (Anderson et al. 2024). It is hypothesized that tardigrades will show signs of stress, but overall be tolerant to combined effects of salinity and temperature, since they have survived many extinctions previously. If tardigrades, which are tougher than most, fail to survive current ecosystem changes, this may warn that the entire microbial web is at risk.

Staples High School

Teacher: Amy Parent

Project # 93

Brosnan, Rhona

<u>The Effects of Lactobacillus rhamnosus on Gut Barrier Integrity in a High-Permeability Model</u>

03- Health Research Proposal

Celiac disease is a serious autoimmune disorder in which gluten ingestion triggers an immune response that damages the lining of the small intestine. It affects approximately 1 in 133 Americans, or about 1% of the global population, and its prevalence is increasing (Beyond Celiac). Gluten ingestion leads to the formation of gliadin peptides that disrupt intestinal tight junctions, increasing epithelial permeability. This "leaky gut" allows gluten peptides to cross the epithelial barrier, triggering inflammation and intestinal damage. Currently, there is no medical cure for celiac disease, and the only effective treatment is a lifelong gluten-free diet. This study will investigate the efficacy of Lactobacillus rhamnosus in restoring epithelial barrier integrity in a high-permeability in vitro intestinal model. An in vitro gut lining will be formed using Caco-2 cells, a human colorectal adenocarcinoma cell line commonly used as a standard model of the intestinal epithelial barrier. Increased permeability will be induced using ethanol as a mild chemical stressor to temporarily disrupt epithelial tight junctions, modeling celiac-associated intestinal damage. Three experimental groups will be tested: a healthy control, an ethanol-induced high-permeability (inflamed) control, and an ethanol-induced model treated with Lactobacillus rhamnosus. Changes in epithelial permeability will be evaluated by measuring the transfer of a safe fluorescent tracer across the epithelial layer.

Ridgefield High School

Teacher: Patrick Hughes

Project # 94

Buser, Hannah

<u>Effects of high-definition transcranial direct current stimulation (HD-tDCS) on Superior Longitudinal Fasciculus connectivity in patients with disorganized Schizophrenia</u>

01- Behavioral Research Proposal

Disorganized Schizophrenia (DS) is a subtype of the well-known psychiatric disorder, Schizophrenia. This disorder is characterized by hallucinations, delusions, negative emotions, and with the addition of flat emotion, disorganized speech, and haphazard behavior. Another characteristic of Schizophrenia, in general, is that it alters brain structure, leading to differences of connectivity within the brain. The Superior Longitudinal Fasciculus (SLF) is a white matter tract that is affected and it makes it difficult to deliver sensory and motor information to different parts of the brain. A treatment has been heavily studied in Schizophrenia but not in Disorganized Schizophrenia. Given that subtypes are researched so little, HD-tDCS, a type of electrical stimulation, could improve the connectivity of the SLF in Disorganized Schizophrenia. To determine whether this is true or not, participants would be diagnosed with DS using the DSM-IV-TR and would then be split into two groups of control DS and DS who are receiving treatment. An MRI would be conducted on every participant to establish the level of SLF integrity (before and after treatment) and to see where nodes of the HD-tDCS would be placed. After treatment, we can look at the final MRI results and see whether the connectivity increased, decreased or didn't change. I predict that the connectivity will increase given that the SLF is typically hypoconnected and with the right voltage from the HD-tDCS it will be able to enhance the movement of sensory and motor information within the tract.

Darien High School

Teacher: Guy Pratt

Project # 95

Coggins, Patrick

<u>The Impact of Stigma and Medication Side Effects on Treatment Adherence in Schizophrenia</u>

03- Health Research Proposal

Schizophrenia is a serious mental disorder that affects how people think, feel, and act. Many individuals with schizophrenia have difficulty staying in treatment even though treatment can help reduce symptoms. This project studied how stigma and medication side effects affect whether people continue their treatment. Information was collected from reliable medical and mental health sources. The results showed that people who experienced more stigma or stronger medication side effects were less likely to follow their treatment plans. Those who stayed in treatment had fewer symptoms and were able to function better in daily life. These findings suggest that reducing stigma and improving treatment options could help people with schizophrenia receive better care and live healthier lives.

Darien High School

Teacher: Christine Leventhal

Project # 96

Coppe, Andrea

<u>Slow tempo versus fast tempo efficiency in 5-7 year olds.</u>

01- Behavioral Research Proposal

Music is a common part of everyday life, yet its effects on attention and performance remain unclear. This experiment investigates how background music tempo affects performance, emotional arousal, and mood in 5-7 year olds in a sentence based task. Children will complete three conditions of a control group with ocean sounds, a fast-tempo classical music piece at 140 BPM, and a slow-tempo classical music piece at 45 BPM. The task will consist of the children determining whether sentences are grammatically correct and make sense, and recording how long it takes to decide. During each trial, the 5-7 year olds task will record reaction times, task completion time, and self-reported valence (mood) and arousal through a chart, measured before and after. Predicted results should show that slow-tempo music supports sustained attention, resulting in faster reaction times than fast-tempo music, with the control trial between the two. Fast-tempo music is expected to increase arousal, potentially leading to longer reaction times and greater variability in performance. These results will provide insight into how music tempo in background music affects the reaction time and emotional state of children during early developing stages of 5-7 years old.

Darien High School

Teacher: David Lewis

Project # 97

Cox, Hannah

<u>The Impact of Dance Movement Therapy on Social, Emotional, and Behavioral Outcomes in Individuals with Autism Spectrum Disorder</u>

04-Physical Science Research Proposal

This study aims to see if dance movement therapy (DMT) can impact an individual with autism positively. Some individuals with autism spectrum disorder (ASD) have limited vocabulary or are completely non-verbal. This study uses a mood assessment scale to help the individual indicate how they are feeling, before and after DMT sessions. Ideally, the individual will find that after the DMT sessions, they are more verbal with others, and will have a positive increase in social, emotional, and behavioral skills.

Newtown High School

Teacher: Timothy DeJulio

Project # 98

Denkin, Sierra

<u>Effect of Combined Intermittent Fasting and Curcumin Treatment on Colon cancer in Drosophila Melanogaster</u>

03- Health Research Proposal

Colon cancer (CRC) is among the most common cancer types, causing inflammatory and harmful cell growth in the colon. Treatment remains costly, and a multi-prong approach to treatment is often required (Cañellas,et al. 2024). The goal of this study is to evaluate if treatment with intermittent fasting (IF) and curcumin will reduce tumor burden in a CRC C. elegans model. Apc1/Apc2-RasV12 Drosophila M. is homologous to human CRC and used in various studies to evaluate the effects of cancer treatments. Drosophila will be treated with 100uM of curcumin with agar/medium and an IF ratio analogous to 5:2. The tumor number and size will be qualified through GFP Immunostaining of the mid-gut, showing tumor growth under a fluorescent microscope (Micchelli et al,2014). To assess the impact of the treatment approach on inflammation levels, the amount of reactive oxygen species (ROS) will be measured(Habib et al.,2021). Average lifespan of flies will also be assessed each day by counting the number of flies alive;Kaplan Meier analysis will be used to assess differences (Das et al.,2014.). It is predicted that IF and Curcumin will show a decrease in tumor size and ROS, and increase in lifespan. If treatment has a positive effect it could provide a broader perspective to the development of natural adjunctive CRC treatment approaches.

Staples High School

Teacher: Amy Parent

Project # 99

DiLeo, Sofia

<u>Evaluation the Therapeutic Potential of Curcumin in Improving Motor Neuron Health in Spinal Muscular Atrophy</u>

03- Health Research Proposal

Spinal Muscular Atrophy(SMA) is a genetic neurodegenerative disorder that is the leading cause of death in infants. There is currently no definitive cure for SMA, which leaves exploration for simpler therapies that may help ease the disease progression. Introducing different concentrations of curcumin into C. elegans could be a potential therapy leading to hope for SMA patients. The model system focuses on using C. elegans to express the smn-1 mutation and determine how different concentrations of curcumin affect neuromuscular abilities, as C. elegans have genes 80% homologous to humans. Different concentrations of curcumin at 0, 10, 20, 100, and 200 µM dissolved in 0.1% DMSO will be administered in the strain in larval stage 1. A body bends and thrashing assay will be conducted to visualize the loss of motor function in the worms. Additionally, a pharyngeal pumping rate will be calculated to determine neuromuscular function in the terminal bulb of the worm pharynx, and a defective movement test will also be administered showing possible defects in motion function. Lastly, a ROS assay will be performed to figure out what effect curcumin has on the oxidative stress of the diseased worms, which is expected to be a positive effect. Research leads to the idea that curcumin in the SMA worms will lead to improved motor function and oxidative stress, as curcumin research has proved to activate stress pathways that preserve neuromuscular characteristics. If proven correct, this would suggest that curcumin can be used as a regulator for SMA.

Staples High School

Teacher: Amy Parent

Project # 100

Dohil, Kiran

<u>Increasing Bioavailability of Turmeric Patches using Piperine</u>

03- Health Research Proposal

Turmeric, also known as the golden spice, has been an important natural medicine and commodity for centuries. Despite its long history, the effects of many diseases remain underrecognized. A rapidly growing way of consuming turmeric is through turmeric shots. However, these shots are often unpalatable and expensive, costing up to $4.58 for a 2.1 fl oz immune shot. To minimize the taste and cost, turmeric patches have been developed to deliver its benefits through the skin. Yet, shots are still preferred because turmeric has low bioavailability due to poor water solubility. Some compounds, such as piperine—the main active component in black pepper—can increase curcumin bioavailability by up to 2000%. This experiment aims to enhance turmeric's effectiveness by combining it with piperine to maximize absorption. It is hypothesized that if a patch contains both curcumin and piperine, it will deliver more curcumin through the skin compared to a patch containing only curcumin. In this experiment, piperine will be added to a turmeric microemulsion recipe. Assessments of curcumin absorption and transdermal penetration will compare turmeric-piperine patches to turmeric-only patches. Pig skin sections will be placed in diffusion chambers filled with phosphate-buffered saline (PBS), and the PBS will be collected hourly and analyzed for concentration. DNA gels will serve as replicas of human skin. Three replicates of each patch, including a plain control, will be tested for reliability. Results show that piperine improves skin absorption of curcumin, making turmeric's health benefits more effective and accessible.

King School

Teacher: Victoria Schulman

Project # 101

Dombrow, Leah

<u>Effect of Coenzyme Q10 and Epigallocatechin Gallate on Alpha-Synuclein Aggregation in Caenorhabditis elegans to Treat Parkinson's Disease</u>

03- Health Research Proposal

Parkinson's Disease (PD) is the second most common neurodegenerative disease, characterized by aggregation of alpha-synuclein protein and formation of Lewy bodies, leading to death of dopaminergic neurons and development of motor symptoms (Hughes 2022; He 2022). Currently, the drug levodopa is the standard for PD treatment (Pirker,2023); however, levodopa treats symptoms and does not address PD's root cause (Gandhi, Saadabadi 2023). This study explores alternate treatment for PD's root causes: alpha-synuclein aggregation and oxidative stress. There is little research exploring the effectiveness of combined treatment of antioxidants to combat oxidative stress and primary aggregation inhibitors to combat alpha-synuclein aggregation. The NL5901 strain of Caenorhabditis elegans will be used as a model system as it overexpresses human alpha-synuclein. L1 worms will be treated with either 2.5μM aggregation inhibitor epigallocatechin gallate (EGCG), 150μM antioxidant coenzyme Q10 (CoQ10), both EGCG and CoQ10, or no treatment (Song 2024; Ishii 2004). Nematodes will be assessed at L4, 1 week, and 2 weeks. Fluorescent microscopy will be used to view the aggregation of alpha-synuclein bonded to yellow fluorescent protein. ROS will be evaluated by incubating worm lysates with 250 μM of Chloromethyl-H2DCFDA and measuring for fluorescence intensity using the LS55 Fluorescent Spectrometer. Finally, a locomotion assay will be performed measuring motor function and lifespan will be assessed. It is hypothesized that combining the treatments CoQ10 and EGCG will be more effective at inhibiting the progression of PD than using one drug. If proven successful, it could steer PD scientific research in a new direction.

Staples High School

Teacher: Amy Parent

Project # 102

Edgar, Lilly

<u>Precision Medicine Applications in Amyotrophic Lateral Sclerosis</u>

03- Health Research Proposal

Amyotrophic lateral sclerosis is a progressive neurodegenerative disease that affects the motor neurons in the brain and the spinal cord. ALS affects around 30,000 people in the U.S. Early symptoms of the disease include muscle twitching, stiffness, weakness, slurred speech, and emotional changes. This disease is fatal and ultimately affects the patient's ability to swallow, breathe, and move. Patients die typically from respiratory failure, which happens 2-5 years after diagnosis. What makes ALS especially challenging is its rapid progression and lack of effective treatments that can stop the symptoms and the progression of the disease. The variability in symptoms and the parts of the nervous system affected makes ALS a highly heterogeneous disease, which complicates treatment and clinical management. Currently, only three disease-modifying therapies have been approved: Riluzole, Tofersen, and Edaravone. Precision medicine, a medical approach that seeks to tailor treatment to individual patients based on their unique genetic, molecular, and clinical profiles. In ALS, precision medicine can help identify which patients are likely to respond to specific therapies, improve clinical trial design, and ultimately provide more effective and personalized care.

Darien High School

Teacher: Christine Leventhal

Project # 103

Epstein, Hayley Epstein

<u>Evaluating Caffeine and the Antioxidant Chlorogenic Acid on Depression in a
Drosophila Model</u>

03- Health Research Proposal

Major Depressive Disorder, or MDD, is a neurological condition that affects 300 million people worldwide (Cui 2024), however, only 30% of diagnosed individuals reach full remission after treatment (Kennedy 2016). Because existing treatments are often ineffective, alternative options are required. There is some evidence that depression positively responds to coffee or caffeine but well-designed prospective evidence is lacking (Kim 2018). This study will look into whether caffeine or chlorogenic acid (the antioxidant part of coffee) can alleviate depression symptoms in a Drosophila melongaster model genetically modified to express the dSERT gene, which modifies the serotonin transporter (Knapp 2022). Flies will be treated with caffeine and chlorogenic acid that will be orally administered through Formula 4-24® Instant Drosophila Medium for 10 days. Impact will be measured through a series of behavioral and biochemical assays; courtship assay measuring social motivation and anhedonia (Knapp 2022), negative geotaxis to determine locomotor ability (Knapp 2022), and ROS to assess oxidative stress in neural tissue (Habib 2021). It is hypothesized that both caffeine and chlorogenic acid will mitigate depression symptoms, but caffeine will cause a more significant outcome/effect because of its ability to activate dopamine and serotonin pathways (Unsal 2025, Suh 2017). This research will provide prospective data on the impact of caffeine and chlorogenic acid in a depression model of drosophila. Positive results will support the potential secondary treatment for MDD with natural compounds to positively influence mental health.

Staples High School

Teacher: Amy Parent

Project # 104

Eruçar-Matthews, Altay

<u>Reducing Algal Growth of Chlorella Vulgaris by chemically inhibiting the absorption of nutrients with Humic Acid</u>

02-Environmental Research Proposal

Algal blooms are a widespread ecological and economic issue that are increasing in frequency and severity worldwide. The objective of this study is to evaluate the feasibility of Humic Acid as a treatment/preventive for harmful algae blooms(HABs). While it is known that humic acid is capable of binding nutrients and reducing algal growth, no study has rigorously evaluated the effects of humic acid on HABs triggered by common fertilizers. This study will observe the effects of specific concentrations of humic acid(HA) on algae blooms triggered by Miricle-gro, the most common fertilizer used in agriculture. Varying concentrations of humic acids(0.01%, 0.03%, 0.1%, 0.3%, and 1%) will be evaluated on preventing and treating HABs. Optimal density to assess algal biomass will be measured using a UV-VIS spectrometer at OD680 and OD750. In addition, dissolved oxygen, nutrients, and dry mass will be assessed. Based on the findings of previous studies, this study predicts that HA application will prevent and treat HABs if successful, this study will quantify Humic Acid concentrations successful at both treating and preventing HABs and provide a low cost, low toxicity solution to harmful blooms.

Staples High School

Teacher: Amy Parent

Project # 105

Fetner, Alexandra

<u>Effects of Probiotics Pediococcus acidilactici and Bifidobacterium longum on the Fat Accumulation, Oxidative Stress, and Lifespan of Caenorhabditis elegans with Induced Type 2 Diabetes Mellitus</u>

03- Health Research Proposal

Type 2 Diabetes Mellitus is a chronic disease that hinders bodies' abilities to use insulin. It's very common in the US, yet patients don't remain unhealthy (CDC 2024). Targeting the gut microbiota with individual probiotics has regulated dysbiosis, thus improving insulin resistance (Zhou 2022). Evidence for combining probiotics is limited. It's predicted that Pediococcus acidilactici and Bifidobacterium longum will be able to improve metabolic dysfunction in patients with T2DM. In a C. elegans model, P. acidilactici is normoglycemic and is proven to improve oxidative stress, and B. longum is an antioxidant bacterium that is proven to extend lifespan (Yavorov-Dayliev 2022)(Ai 2023). However, combination approaches are not well studied. N2 Bristol wild-type Caenorhabditis elegans model T2DM because their gut microbiota functions similarly to humans' (Yavorov-Dayliev 2022). Inducing C. elegans in high glucose agar gives them hyperglycemia, similar to T2DM. Both involve a disruption in insulin signaling pathways (Schlotterer 2009). Individual and combined probiotics will be evaluated for their effects on C. elegans' lipid accumulation, oxidative stress, and lifespan. Lipids will be analyzed through Nile Red and Oil Red O staining. Images will be taken with the Leitz Dialux 22 fluorescence microscope. Oxidative stress will be analyzed using fluorescent dye quantifying ROS levels on a fluorescent spectrometer. Lifespan is calculated by counting living and dead worms over time (Yavorov-Dayliev 2022). It's hypothesized that if combining the probiotics is successful in improving fat accumulation, oxidative stress, and lifespan in C. elegans, future research could determine they are significant for humans with T2DM.

Staples High School

Teacher: Amy Parent

Project # 106

Fiordalis, Hagan

<u>Investigating the Potential for Active Sound Production in the Smooth Dogfish (Mustelus canis) of the Long Island Sound.</u>

01- Behavioral Research Proposal

Elasmobranchs have long been considered acoustically silent due to the absence of specialized sound-producing organs. However, recent evidence of active broadband clicking in the rig shark (Mustelus lenticulatus) challenges this assumption and suggests that some sharks may produce sound intentionally as part of a defensive or behavioral response. This study investigates whether the smooth dogfish (Mustelus canis), a closely related species inhabiting the Long Island Sound, exhibits similar active sound production. The smooth dogfish shares a pavement-like dentition with the rig shark, which has been proposed as the mechanism enabling click generation. Using standardized underwater handling protocols and hydrophone recordings, this research tests the hypothesis that wild-caught M. canis will produce broadband clicks when handled. Acoustic characteristics will be analyzed using Raven Pro software, and linear mixed-effects models will account for variation in shark size and sex. Results are predicted to resemble those of the rig shark, with peak frequencies near 9.6 kHz and higher click rates during the initial phase of handling. Confirmation of sound production in M. canis would suggest that acoustic signaling may be a more widespread defensive mechanism within the genus Mustelus, contributing to a broader re-evaluation of shark sensory biology and behavioral responses to stress and human interaction.

Darien High School

Teacher: Guy Pratt

Project # 107

Fogel, Lucy

<u>The Effects of Stevia Versus Sucralose on the Abundance of Bifidobacteria in the Gut Microbiome</u>

03- Health Research Proposal

Non-nutritive sweeteners are used in the food industry as a sugar replacement due to their ability to reduce calories in food and beverages while maintaining sweetness. NNS sweeteners have long been blamed for their potential side effects such as cancer, heart disease, and stroke. However, there is not currently enough information about potential effects of these sweeteners on the health of the gut microbiome. By comparing different concentrations of stevia and sucralose fed to fruit flies, the effects of these NNS on the bifidobacteria in the gut microbiomes can be quantified. The flies will be fed various levels of the NNS sweeteners in their fly food, creating multiple populations. After five days, the flies' guts will be dissected and qPCR will be used to analyze the abundance of bifidobacteria in the different populations. It is projected that the stevia groups will have a lower cycle threshold number between 28 and 32, compared to the sucralose groups which is projected to be between 30 and 34. Further, as the concentration of both NNS sweeteners increases the cycle number should increase, indicating that the more NNS sweetener fed to the fruit flies the greater negative effect on the bifidobacteria in their gut microbiomes. The results from this research could extend existing knowledge as to how artificial NNS versus natural NNS impact the gut microbiome. In the future, this study could be replicated in human subjects and more gut microbiome bacterias could be investigated to get a broader understanding.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 108

Foley, Charlotte

<u>Brightness & Saturation Effects on Visual Attention and Memory</u>

01- Behavioral Research Proposal

This study examines how brightness and saturation interact with hue (warm vs cool) to affect visual attention and memory in social media images. TikTok users aged 13–25 will view images that vary in brightness, saturation, and color temperature. Attention will be measured using TikTok engagement data and self-reported focus ratings, while memory will be tested using Google Forms and TikTok polls immediately after viewing and again after a delay. The experiment uses eight image conditions and multiple posts per condition to reduce bias. The results are expected to show that brighter and more saturated images, especially warm-colored ones, lead to higher attention and better short- and long-term memory. This research helps explain how visual design choices influence engagement and recall on social media platforms.

Newtown High School

Teacher: Timothy DeJulio

Project # 109

Galgano, Elizabeth

<u>TBD</u>

02-Environmental Research Proposal

The use of chemical fertilizers produces immense amounts of greenhouse gases, while being costly for farmers. However, the use of other forms of fertilizer has uncertain effects on the plants. Previously, researchers have found that certain bacteria help grow plants even in unsustainable conditions. This experiment aims to find out the effects of bacterial fertilizers on the growth of Brassica rapa. I will be using bacteria provided by a lab that specializes in nano-coating bacteria in a metal-phenolic network (MPN) coatings in order to test the effectiveness of shelf stability and transportation. Data will be collected by measuring plant height, plant mass and root length. I will also be conducting experiments to find the ideal concentration of bacteria to improve plant growth. Lastly, I plan to test to determine where specifically the bacteria grows- on the outside of the root hairs or inside them. This experiment is expected to show that bacteria have a beneficial effect on the plants while colonizing inside the roots of the plants. This research is important because if bacterial fertilizers are proven to be an effective replacement for chemical fertilizers, it could lower the amount of greenhouse gases emitted into the atmosphere and cut prices for farmers.

Convent of the Sacred Heart-Greenwich

Teacher: Joyce Reed

Project # 110

Ghorpade, Rashi

<u>Delayed Alpha-Galactose Response Explained by Lipid and Protein Digestion</u>

03- Health Research Proposal

Alpha-gal syndrome (AGS) is a food allergy characterized by a delayed allergic reaction occurring several hours after consuming mammalian meat. Unlike typical food allergies that appear within minutes, AGS is triggered by IgE antibodies responding to galactose-α-1,3-galactose (α-Gal), a carbohydrate transmitted to humans via tick bites. This study investigates the biochemical basis of the delayed reaction, focusing on differences in the digestion and absorption of proteins and lipids. The experiment simulates human digestion by comparing the breakdown of a protein source (egg white) and a lipid source (animal fat). Samples are first exposed to acidic conditions with pepsin to mimic stomach digestion, then adjusted to neutral pH with the addition of lipase to simulate intestinal digestion, all at body temperature. It is hypothesized that α-Gal bound to lipids is absorbed more slowly than protein digestion products because the lipids must be packaged into chylomicrons and transported through the lymphatic system before entering the bloodstream. Expected results suggest rapid protein digestion and a slower lipid breakdown, providing a biochemical explanation for the 3–6 hour delay in AGS symptoms. This study is to understand how nutrient absorption and transport can influence the timing of immune responses and offers a model for understanding other delayed or atypical food allergies.

Ridgefield High School

Teacher: Patrick Hughes

Project # 111

Gibbons, Harper

<u>Constructing More Effective Hydrogels Through Oxidation</u>

03- Health Research Proposal

An abundance of carboxyl is essential to create hydrogels for sustained drug release. Carboxyl accounts for the cross linking density (Px), which refers to the number of physical cross links in a given volume. Groups of carboxyls allow the polymer to effectively crosslink with ions. A higher cross linking density results in tighter structural integrity, and slower release of the molecules. TEMPO- mediated oxidation is a process that converts hydroxyl groups into carboxyl groups. Although it is often used in cellulose derived hydrogels, it is not often used in alginate derived hydrogels. This experiment aims to compare the results of TEMPO-mediated oxidation on alginate hydrogels to regular hydrogels, and determine if TEMPO-mediated oxidation can effectively increase the amount of carboxyls.

Ridgefield High School

Teacher: Patrick Hughes

Project # 112

Gracia, Tessa

<u>The Impact of Turf Fields on the Environment and Humans</u>

02-Environmental Research Proposal

This study examines the relationship between the age of artificial turf fields and the frequency and type of injuries experienced by student athletes. As turf fields age, factors such as surface hardness, infill compaction, and reduced shock absorption may increase injury risk. Injury data will be collected through monthly reports provided by certified athletic trainers, including the sport played and type of injury. Information regarding the age of each turf field will be obtained from the athletic director. By analyzing injury patterns in relation to turf age, this study aims to determine whether older turf fields are associated with increased injury risk.

Ridgefield High School

Teacher: Patrick Hughes

Project # 113

Hanson, Avery

<u>The CpG overlap between Alzheimer's and Bipolar Disorder in the Cerebellum of Homo sapiens</u>

03- Health Research Proposal

Bipolar disorder (BD) and Alzheimer's disease (AD) share clinical associations, but quantifying the epigenetic overlap remains unknown, particularly within the cerebellum. The cerebellum is critical for emotional regulation and working memory, frequently disrupted in BD and AD. DNA methylation at Cytosine-Guanine-Phosphate (CpG) sites regulates gene expression. Abnormal DNA methylation at these sites potentially explains how chronic mood episodes in BD may contribute to neurodegeneration. This project aims to identify shared highly variable CpG sites across BD and AD to reveal common molecular signatures. Two publicly available cerebellar datasets, GSE38873 and GSE134379, were obtained from NCBI Gene Expression Omnibus (GEO), comprising 36 AD individuals, 225 BD individuals, and 179 healthy control samples. Using RStudio, both datasets were subsetted to 25,912 identical CpG sites for accuracy. Statistical analysis will include calculating the standard deviation across all CpG sites to assess epigenetic volatility and the mean CpG values to assess methylation levels in each group. A t-test will be used to determine whether the methylation difference between groups is statistically significant. Density plots and Venn diagrams will reveal shared highly variable CpG sites and methylation peaks. Preliminary findings reveal a 77% overlap in the 1000 most variable sites between AD and controls, establishing a baseline comparison for common highly variable sites. The remaining 23% uniquely variable sites in AD represent biomarkers of epigenetic instability. Identifying shared highly variable sites with a p-value < 0.05 unique to AD and BD would suggest an epigenetic link.

Darien High School

Teacher: Guy Pratt

Project # 114

Harrison, Lindsey

<u>Effects of Human-Composed Versus AI-Generated Music on Perceived Performance and Mood During Cardiovascular Exercise</u>

01- Behavioral Research Proposal

Harrison, Lindsey Effects of Human-Composed Versus AI-Generated Music on Perceived Performance and Mood During Cardiovascular Exercise Research Proposal, Behavioral Research proposal Investigating the intersection of musicology and exercise science, this study examines the psychological and physiological implications of music origin—human-composed versus AI-generated—on individuals during cardiovascular activity. While music is a recognized tool for enhancing athletic motivation, the rising prevalence of AI-driven media necessitates a deeper understanding of how the source of auditory stimuli affects the human experience. Participants from two distinct age groups (teenagers to mid-20s and ages 40–60) will be assessed using the Rate of Perceived Exertion (RPE) scale and post-exercise emotional surveys to measure enjoyment and mood. The research will follow a controlled experimental protocol where participants are randomly assigned to one of three conditions: human-composed music, AI-generated music, or a no-music control group. To eliminate cognitive bias, a blind-testing method will be employed so participants are unaware of the music's origin. The study upholds steady conditions by maintaining consistent volume levels, tempo ranges, and exercise environments across all trials. By comparing data within and between age groups, this research aims to identify how generational familiarity with technology influences the efficacy of AI-generated content. It is hypothesized that human-composed music will result in lower perceived exertion and higher enjoyment across both groups, with older participants demonstrating a more significant preference for human compositions due to a stronger traditional emotional connection. Ridgefield High School Teacher: Patrick Hughes

Ridgefield High School

Teacher: Patrick Hughes

Project # 115

Hernandez, Angelise

<u>Microplastics: A Threat to Health and Wildlife</u>

03- Health Research Proposal

Microplastics are tiny pieces of plastic smaller than 5 mm that are showing up more and more in the environment and in our food, water, and air (Smith et al., 2023; Wright & Kelly, 2021). People can be exposed by eating, breathing, or touching them, and once inside the body, they can build up in organs and cause problems like inflammation and damage to cells (Prata et al., 2021; Ragusa et al., 2024). Animals can also be affected, with microplastics harming their growth, reproduction, and the food chain, and they can carry harmful chemicals or germs (Jin et al., 2023). Even though scientists are still figuring out all the ways microplastics can hurt humans and wildlife, it's clear that they are a big environmental and health concern that needs more attention (Schwabl et al., 2023).

Newtown High School

Teacher: Timothy DeJulio

Project # 116

Hoffman, James

<u>Investigating the Effectiveness GFAP as a Marker of Astrogliosis in Schizophrenia</u>

03- Health Research Proposal

Astrocytes are a type of glial cell found throughout the central nervous system that fulfill a variety of roles, such as maintaining homeostasis and regulating neuronal activity in the brain. Schizophrenia, major depressive disorder, Alzheimer's disease, Parkinson's disease, and bipolar disorder are all both associated with astrocyte dysfunction and share some genetic connections. While astrocyte dysfunction is recognized as a key driver of neurodegenerative and psychiatric disorders, the exact, comprehensive mechanisms of astrocyte dysfunction are not yet fully understood. This meta-analysis aims to further our understanding of the overlap between these disorders by synthesizing post-mortem and molecular studies examining regional differences in glial fibrillary acidic protein (GFAP) expression, overlap of disease-specific differential expression profiles, and changes in mGluR5's effect on calcium hyperactivity as structural, transcriptional, and functional markers of astrocyte stress. By comparing these markers across different disorders through converting individual studies' results into quantitative values and then comparing variation this study aims to identify common astrocytic stress responses, which may help clarify the role of astrocyte dysfunction in neurodegeneration, point to a genetic basis of astrogliosis, and highlight shared glial pathways as potential therapeutic targets.

Darien High School

Teacher: David Lewis

Project # 117

Hopstaken, Carolyn

<u>Photocatalytic Degradation of Polypropylene via Iron-Modified Titanium Dioxide</u>

02-Environmental Research Proposal

Polypropylene is one of the most widely produced plastics and a major contributor to persistent microplastic pollution due to its resistance to natural degradation. As plastic waste accumulates in the environment, effective and environmentally compatible degradation strategies are increasingly necessary. Photocatalysis has emerged as a promising approach, utilizing materials that produce reactive oxygen species (ROS) under light irradiation to initiate polymer chain scission. While titanium dioxide (TiO_2) is a well-studied photocatalyst, its activity is largely limited to ultraviolet light. The potential of iron-modified TiO_2 systems for plastic degradation remains insufficiently explored, despite the environmental abundance of iron and its known role in facilitating redox reactions. Although Fe-doped titania has been studied for dye degradation, its application to polypropylene degradation has not been sufficiently explored, demonstrating a key knowledge gap in practical photocatalytic remediation. The aim of this study is to investigate if iron-modified TiO_2 can enhance the visible-light-induced degradation of polypropylene compared to unmodified TiO_2. It is hypothesized that the presence of iron oxide will improve interfacial charge separation, increase ROS generation and enhance photocatalytic activity under visible light irradiation. Iron-modified TiO_2 will be prepared as a physically mixed Fe_2O_3-TiO_2 composite via mechanical grinding and applied to polypropylene film. Samples will be exposed to controlled light irradiation, and degradation will be evaluated using Fourier Transform Infrared Spectroscopy (FTIR) through changes in the carbonyl index. This research seeks to provide insight into the feasibility of iron-assisted photocatalytic systems for polypropylene degradation under environmentally relevant and experimentally accessible conditions.

Joel Barlow High School

Teacher: Paul Testa

Project # 118

Huber, Elena

<u>Determining the Effects of the Size of a Watershed of a Bioswale on Plant Coverage and Overall Trashcount of Bioswales in New Haven Throughout the Seasons</u>

02-Environmental Research Proposal

Bioswales are vegetated land features designed to filter stormwater runoff, reducing pollutants. Watershed size, the land area draining into a bioswale, affects runoff volume, which influences pollutant load, plant coverage, and trash accumulation. The purpose of this study is to determine how watershed size affects plant coverage and trash accumulation in bioswales located in New Haven across different seasons. The hypothesis is that bioswales with medium-sized watersheds will have higher plant coverage and lower trash accumulation because they receive sufficient water and nutrients without being overwhelmed by excessive runoff and debris. The independent variable is watershed size, categorized as small, medium, or large. The dependent variables are plant coverage (percent cover) and trash accumulation (number of trash items). Constants include location (all bioswales are in New Haven), consistent quadrat size, standardized trash criteria, and uniform data collection methods. There is no control trial. Using a map of approximately 300 bioswales in New Haven, sites will be categorized into watershed size groups based on drainage area. Plant coverage will be visually estimated using quadrats, and trash will be counted following standardized criteria. Data will be collected over four-day periods during all seasons. The student will conduct field measurements, while the mentor will provide guidance, and bioswale locations. Data will be analyzed using box plots comparing plant coverage and trash counts across watershed sizes and seasons. Results will help inform urban green infrastructure design by clarifying how watershed size impacts bioswale health and maintenance needs, supporting more effective and sustainable stormwater management.

Amity High School

Teacher: Sarah Reeves

Project # 119

Hunt, Taylor

<u>The Effects of Varying Caffeine Exposure in the Mineralization Process of Larval
Zebrafish</u>

03- Health Research Proposal

While caffeine is known to have adverse effects for children, little research has been
conducted on the skeletal developmental disorders associated with caffeine
consumption. Zebrafish embryos developing into larvae serve as an excellent model for
studying these effects because of their rapid, observable development and relative
similarity to humans in their vertebrae. This study investigates the effects of caffeine
exposure on zebrafish, evaluating differences in development across multiple groups of
zebrafish exposed to varying levels of caffeine throughout the maturation process. In
addition to establishing whether caffeine does have severe effects on the rate of
skeletal development of zebrafish, this study should also prove whether timed release of
caffeine makes a sizable difference, as one group of zebrafish will be exposed to the
highest concentration of caffeine, but only for 24 hours as opposed to the five days for
all other groups. This will yield results regarding the "critical" stages of development,
and how much timed exposure can hinder mineralization.

Ridgefield High School

Teacher: Patrick Hughes

Project # 120

Iacovella, Sierra

<u>Pediatric school stress and biomarkers for upper-respiratory illness in teenagers</u>

03- Health Research Proposal

Stress is not easily avoidable in today's world, especially not for teenagers. Teens face many stressors in life and this is very hard to manage without proper support. So many, especially teenagers, go through life thinking that stress is just something that is normal, and a consequence that comes with life, not realizing the physical toll that it is doing to their body. Cortisol is a stress hormone that makes immune cells release cytokines, small protein messengers that attach to other cells when the body detects an infection or virus. When cortisol is constantly being activated, it disrupts this process, leading to various physical symptoms. Since teenagers consistently report being stressed, and stress is known to negatively affect physical health, it can be hypothesized that teenagers are at greater risk of getting sick, potentially with an upper respiratory illness. An anonymous survey using the Perceived Stress Scale (PSS) Questionnaire along with an original survey asking students about their levels of stress and how often they feel they get an upper respiratory illness will be conducted, and the results could suggest a correlation between the two. The PSS Questionnaire ranges on a scale, and the higher the number, the higher level of perceived stress. Teens consistently report being stressed, and the pressures of high school certainly don't help that. It is expected to be found that teens who report having a higher level of perceived stress will also report getting sick with an upper respiratory illness more frequently.

Joel Barlow High School

Teacher: Paul Testa

Project # 121

Jalakas, Heili

<u>Chaos Terrain on Europa: Could Water Pockets Under the Surface be the Cause?</u>

04-Physical Science Research Proposal

On Europa, one of Jupiter's moons, there are extensive regions of highly disrupted surface ice known as chaos terrain. These regions are characterized by fractured, rotated, and jagged ice blocks. Given Europa's extremely thick ice shell, it should theoretically be very difficult to deform the surface to the extent observed in chaos terrain, making the origin of this phenomenon a highly debated topic. In this study, we are testing whether simulated pockets of water embedded within Europa's surface ice can form chaos terrain when impacted by a simulated asteroid. Computer modeling software is being used to generate a cross section of Europa's upper surface with water pockets of varying sizes and depths placed inside. After impact the simulation outputs are analyzed across four variables: density, temperature, pressure, and damage. Preliminary results indicate that medium-sized asteroids (~1km diameter) impacting at around 3km/s are capable of collapsing subsurface water pockets up to 700m under the surface disrupting the ice consistent with chaos terrain morphology. After collapse, the simulation showed liquid water immediately filling in the cracks and refreezing, preserving the ice in jagged, uneven configurations. Shallower water pockets and smaller asteroids produced limited surface fracturing with no collapse, and larger impactors vaporized the ice and leveled the water pocket leaving just a crater and smooth ice behind. So far, these findings support our hypothesis that water pockets are a significant contributing factor to the formation of chaos terrain. If confirmed, these regions may serve as future landmarks of near-surface liquid water, providing promising targets for future water-sampling and astrobiological missions.

Darien High School

Teacher: Christine Leventhal

Project # 122

Joshi, Reva

<u>The Effect of Probiotics on Isolated Ants</u>

03- Health Research Proposal

The gut-brain axis plays an important role in regulating behavior, but its effects in insects are not well understood. Ants are highly social organisms, and social isolation can negatively impact their behavior. This proposed research investigates whether probiotics can improve behavioral outcomes in isolated ants. By comparing isolated ants with and without probiotics to non-isolated ants, this project aims to determine whether modifying the gut microbiome can restore normal activity and responsiveness, demonstrating a potential gut-brain connection in insects. Different probiotic strains could also be tested to see if specific types have stronger effects on behavior.

Ridgefield High School

Teacher: Ryan Gleason

Project # 123

Katz, Noa

<u>Intergenerational Effects of Isolation on Hsp70 Expression in Drosophila Melanogaster to Understand the Epigenetic Mechanisms of Stress Response</u>

01- Behavioral Research Proposal

Social isolation has become a global concern, a reality made increasingly evident during the COVID-19 pandemic due to social distancing measures and prolonged quarantine (Hwang, 2020). The heritability of trauma induced by isolation remains unknown. If left unaddressed this uncertainty could pose a significant threat to future populations. In Drosophila melanogaster, isolation-induced stress affects heat shock protein 70 (Hsp70) levels (Zlatković, 2013); however, it remains unclear whether this stress produces transgenerational effects via epigenetic inheritance. Addressing this knowledge gap is essential for developing interventions to mitigate the negative consequences of intergenerational trauma. To investigate the impact of isolation on Hsp70 expression, Drosophila with GFP-tagged Hsp70 will be exposed to varying social environments over a two-and-a-half-week period. Responses will be assessed through GFP-Hsp70 fluorescence levels, thermotolerance and heat-shock recovery, and behavioral assays measuring aggression and sleep. F2 progeny will be evaluated using the same assays over an equivalent timeframe. It is anticipated that the offspring of socially isolated parents will exhibit similar Hsp70 expression, increased thermotolerance, disrupted sleep, and heightened aggression, suggesting that stress-induced modifications can be inherited. This finding is significant, as overexpression of Hsp70 has been linked to the development of certain cancers and other long-term health issues, underscoring the need for future action to restore balanced Hsp70 levels in individuals affected by prolonged pandemic-related isolation (Feng, 2019).

Staples High School

Teacher: Amy Parent

Project # 124

Kennedy, Kleighton

<u>Potential Medications to Treat Concussion in D. melanogaster as a Model Organism</u>

01- Behavioral Research Proposal

In cases of concussion, following initial trauma, the neurometabolic cascade of concussion occurs. Many aspects of this neurometabolic cascade can serve as targets for pharmacological concussion treatments. Dantrolene, a ryanodine-sensitive calcium store blocker may be able to reduce the effects of calcium-induced calcium release that occurs following concussion. Fingolimod, promotes microglia M2 polarisation, which should be neuroprotective, as M2 tends to be anti-inflammatory (instead of pro-inflammatory like its M1 counterpart). Quinolinic acid, a product of tryptophan-metabolism in the brain is harmful in concussion, but deactivating the kynurenine-3-monooxygenase (KMO) enzyme that promotes quinolinic acid production may aid in concussion recovery; this would be done by KMO-Inhibitor II. The products of another part of the same (kynurenine) pathway is kynurenic acid, which tends to be neuroprotective in concussion (by modulating glutamate levels), so L-kynurenine will be used to promote the production of L-kynurenine. Tests will be preformed in D. melanogaster with the different drugs mixed in their food. The flies will be subjected to trauma using a high intensity trauma device. The medications (with the exception of KMO-Inhibitor II) will be placed in an emulsion to increase (oral) bioavailability. Preliminary tests (with low sample size) using fingolimod and dantrolene, have yielded somewhat promising results, though further experimentation is required to mark statistically significant results

King School

Teacher: Victoria Schulman

Project # 125

Kinyon, Katie

<u>Effects of Ozonated Water on the Growth of E-coli on Lactuca Sativa</u>

02-Environmental Research Proposal

From previous studies, ozonated water has prolonged the shelf life of lettuce because ozonated water contains O3 molecules, which kill bacteria, mold and fungi. These previous studies submerged Lactuca Sativa in a singular time to test this hypothesis. This project reveals the effectiveness of different concentrations of ozonated water in preventing the growth of e-coli on Lactuca Sativa. Lactuca Sativa can get e-coli from the contamination of fertilizer, feces and irrigation water while in the fields. In this experiment, samples of 3ppm, 5ppm, and 8ppm concentrations of ozonated water will be tested to see how it affects the growth of e-coli. Compared to other studies which have only submerged the Lactuca Sativa once and is not homegrown, this project will utilize the method of repeated short exposures to ozonated water and will be homegrown to prevent the intervention of pesticides. It is expected that higher concentrations of ozonated water will reduce the amount of e-coli growth on a sample of Lactuca Sativa. E-coli is very harmful when consumed by humans because it contains toxins which damage the small intestines and lead to infections. Producers commonly use chlorine to sanitize, so when chlorine is left in the environment, it can accumulate, enter waterways, expose aquatic life to toxic chemicals, and contaminate drinking water. Compared to chlorine, ozonated water, which is O3 dissolved into H2O, primarily decomposes back down into O2. In the near future, the use of chlorine sanitizers will lead to long-term damage to the human body and environment.

Joel Barlow High School

Teacher: Paul Testa

Project # 126

Kisakye, Siobhan-Cadence

<u>Maternal Undernutrition Induces Cognitive Deficits in Offspring</u>

03- Health Research Proposal

Up to 733 million people suffered from chronic undernourishment in 2023, a serious increase from 2019. The World Food Programme reports that about 318 million people are experiencing crisis-level hunger or worse. These numbers underscore why studying nutrition is so important. Diet plays a major role in overall health, especially during pregnancy, when proper nutrients are essential for brain development. Maternal undernutrition can negatively affect an offspring's cognitive abilities by interfering with normal brain growth and development. This can lead to long-term problems with learning, memory, and attention later in life. To study the effects of maternal undernutrition, researchers could use mice because testing on humans would be unethical. The mice would be divided into two groups. One group would receive a normal, balanced diet, while the other would receive limited nutrition during pregnancy. After the offspring are born and grow, they would be given several cognitive tests to measure mental abilities. Common tests include the Y-Maze, which measures memory, and the Morris water maze, which tests spatial awareness and learning. It is expected that the offspring from undernourished mothers would perform worse on these tests than those from properly nourished mothers. The data collected would be organized into graphs to clearly compare the two groups. Overall, this research helps show how important proper nutrition during pregnancy is and how undernutrition can have lasting effects on brain function and cognitive health.

Darien High School

Teacher: David Lewis

Project # 127

Kress, Emilia

<u>Optimization of First Aid Kits for Easier Use and Improved Emergency Response</u>

04-Physical Science Research Proposal

The survival chances of a person experiencing cardiac arrest decrease by ten percent for every minute that CPR and the use of an AED is delayed. Yet, only four in ten people know how to perform CPR on someone in cardiac arrest and less than a third know how to use a defibrillator. The objective of this project is to improve the first aid response of bystanders in emergency situations, by developing a highly effective first aid kit, designed to guide the user during duress. Existing studies will be used as a basis to analyze emergency response behaviour. The first aid kit will act as a primary guide providing instructions through a screen and speaker, that are based on a logic tree, allowing the responder to act calmly even without prior medical knowledge. Additionally, an emergency call through the device will allow the Emergency Communications Center to have direct access to the first aid kit alongside establishing communication to the bystander. The layout of the kit will be clearly labeled and adjusted in order for the user to have immediate access to the required emergency supplies. This will also be reflected in the instructions, showing which supplies are needed and how they are to be used. Lastly, studies will be conducted in order to secure positive effects of the first aid kit. Subsequently, adjustments will be made assuring an increase in the survival rate and proper treatment in people experiencing a medical emergency without access to immediate professional care.

Westover School

Teacher: Ashley Bonet

Project # 128

Kwong, William

<u>The activation of SKN-1 via the RNAi knockdown of wdr-23 to reduce oxidative stress from microplastics in Caenorhabditis elegans.</u>

02-Environmental Research Proposal

Microplastic pollution is a significant issue due to increases in plastic production. Currently, there is no solution for microplastic damage in the body(Thompson2024). In humans, microplastics are associated with increased oxidative stress levels, resulting in inflammation, disease, and cancer(Liu2023). This research aims to knockdown the upstream repressor(WDR-23) of the antioxidant system(SKN-1) via RNA interference(RNAi) to increase C. elegans resistance to microplastic induced oxidative stress. Worm strains CL2166 and LD1, along with wild type(N2) will be exposed to 0.1mg/ml microplastics aged in H_2O_2 and HT115(DE3) to induce RNAi and knockdown wdr-23. CL2166 and LD1 express GFP due to SKN-1 expression, visible in vivo under a fluorescent microscope. CL2166 expresses GFP from SKN-1 downstream targets and will be utilized as a positive control. LD1 allows for direct visualization of SKN-1 protein localization because of SKN-1::GFP fusion protein expression.To study the effects, lifespan and reproduction and reactive oxygen species (ROS) levels will be measured using N2 worms. In lifespan assays, nematode survival of 30 worms will be evaluated daily until death. Brood size, counted daily, will be evaluated to assess reproduction. ROS will be measured via fluorescence with chloromethyl-H2DCFDA dye and a fluorescent spectrometer, and normalized via PierceBCA protein assay. It is hypothesized that wdr-23 knockdown will combat microplastic damage by increasing lifespan, reproductive rate, and GFP expression, as well as lowering ROS levels. This research could provide insight for a novel target to reduce oxidative stress caused by microplastics in humans.

Staples High School

Teacher: Amy Parent

Project # 129

Lee, Wonyoung

<u>The relationship between high glucose intake and sleep-inducing signals</u>

03- Health Research Proposal

In biology, sleep in defined as a state of reversible unresponsiveness characterized by a reduced responsiveness to sensory stimuli, the adoption of a specific posture, and a physiological changes in brain activity. In recent studies, it was found that sleep homeostasis is essential for an organism to maintain its mitochondrial and cellular health by preventing the oxidative stress resulted from operating oxidative phosphorylation to harm the organelles and cells. However, it is still unclear how much an external factor can affect the sleep homeostasis mechanism. Since this homeostatic system is deeply related to oxidative phosphorylation which demands electrons from glucose, this study hypothesizes if a Drosophila organism intakes a high amount of glucose, the length of the organism's wake bouts will decrease because it increases the imbalance between the energy availability and the energy demand of the dFB neurons. To measure the difference between the length of the sleep bouts, this study utilizes 3 Drosophila melanogaster groups consist of 32 fly organisms and modifies each group's diet to normal, high glucose, and high sucralose. The Drosophila Monitor System will measure the lengths of the sleep bouts, and the lengths will be compared to other groups. The expected results of the experiment is that the Drosophila group with a higher glucose diet will have shorter wake bouts than the other two groups because of the greater energy imbalance. The study will suggest a deeper understanding of sleep through explaining the specific relationship between the inevitable metabolic process and sleep.

Ridgefield High School

Teacher: Patrick Hughes

Project # 130

Lenich, Lily

<u>Laser Interstitial Thermal Therapy: A Minimally Invasive Approach for Deep-Seated Brain Tumor</u>

03- Health Research Proposal

Pediatric low-grade gliomas (pLGGs) are the most common brain tumors in children and are often located in deep or eloquent regions where open surgical resection carries significant neurological risk. Laser interstitial thermal therapy (LITT) has emerged as a minimally invasive alternative, but data on its safety and clinical effectiveness in pediatric populations remain limited. This study evaluates the safety, feasibility, and clinical outcomes of LITT for pediatric low-grade gliomas through a retrospective review of pediatric patients treated with MRI-guided LITT. Data were collected on tumor location, procedural complications, radiographic tumor response, and clinical outcomes across multiple follow-up intervals. Results indicate that LITT was generally well tolerated, with minimal perioperative complications and no permanent neurological deficits. Radiographic analysis demonstrated meaningful tumor volume reduction in most cases, particularly when staged or repeat LITT procedures were employed. These findings suggest that LITT can provide effective local tumor control while preserving neurological function, especially for tumors in surgically challenging locations. Overall, LITT represents a promising therapeutic option for select pediatric patients with low-grade gliomas, offering reduced morbidity and shorter recovery times compared to traditional open surgery. Further prospective studies with larger sample sizes are needed to better define long-term outcomes and optimal patient selection.

Darien High School

Teacher: Guy Pratt

Project # 131

Liu, Josh

<u>Higher Pressure over Shorter Duration during Hyperbaric Oxygen Therapy</u>

03- Health Research Proposal

Hyperbaric oxygen therapy (HBOT) is used to treat conditions such as ulcers and other chronic wounds by increasing tissue oxygen availability. Standard protocols emphasize moderate pressure exposures over longer durations to maximize efficiency but also safety. This proposal examines whether higher pressure for a shorter duration during HBOT could maintain precautions while reducing total treatment time. Exposures at higher pressures for shorter periods of time could achieve therapeutic oxygen thresholds sufficient to stimulate angiogenesis and suppress inflammation further. A comparison would first be made between conventional HBOT protocols and higher-pressure, time-restricted exposures, assessing outcomes such as tissue oxygenation and inflammatory cell recruitment. Safety endpoints would include evidence of oxygen toxicity and barotrauma. Analytical methods include hypoxia and histological assessment of tissue injury. It is expected that higher-pressure, shorter-duration HBOT may reproduce select oxygen-dependent signaling effects while demonstrating increased risk profiles if pressure thresholds exceed physical tolerance. The findings would clarify whether pressure and duration are biologically interchangeable or whether therapeutic benefit requires sustained exposure. This study would provide critical mechanistic insight into HBOT dosing parameters and inform future optimization of hyperbaric treatment protocols, emphasizing whether limited-duration, high-pressure strategies could be feasible under tightly controlled conditions in carefully monitored clinical research settings only.

Darien High School
Teacher: David Lewis

Project # 132

Lockwood, Nate

<u>Improving treatment of Asthma through the use of Peptides</u>

03- Health Research Proposal

The main goal of this experiment is to find better ways to help people living with T2 severe asthma, a very serious version of the disease that doesn't always respond to normal inhalers. We want to target specific white blood cells—the "soldiers" of our immune system—to stop them from causing too much swelling in the lungs. By improving how medicine is delivered through the air (aerosol treatments), we can make sure the help gets exactly where it needs to go. To do this without testing on humans, Im planning on using Lung Organoids. These are "mini-lungs" grown in a lab that act just like real human lung tissue, allowing us to see how the disease works in a controlled setting. We keep these mini-lungs in cell culture incubators that mimic the inside of a human body, keeping the cells alive and healthy so we can be able to study them. In our tests, we are looking at two specific types of white blood cells: eosinophils and neutrophils. In severe asthma, these cells get confused and attack the lungs, making it hard to breathe. We are testing AMPS (special molecules) and new spray-on medicines to see if we can calm these cells down more effectively. By taking many samples and recording what happens, we hope to find a way to make medicine work faster and be easier to access for everyone, regardless of where they live. Ultimately, this research is about helping millions of people breathe easier and live better lives.

Ridgefield High School

Teacher: Patrick Hughes

Project # 133

Losic, Ana

<u>Evaluating the Neurobiological Effects Of Stevia in an Amyloid-β Based Drosophila model of Alzheimer's Disease</u>

01- Behavioral Research Proposal

Alzheimer's disease (AD) stands as one of the most prevalent neurodegenerative disorders, marked by worsening memory loss and cognitive decline and still lacking any effective cure. Pathologically, AD is characterized by amyloid beta (Aβ) plaques and neurofibrillary tangles of hyperphosphorylated tau (Fernandez-Funez 2015). Emerging research indicates that dietary habits- especially consumption in high glycemic foods- may contribute to the Aβ deposition and influence disease progression (Taylor 2021). Artificial sweeteners (AS), very commonly used as low calorie sugar substitutes, may have an effect on neurodegenerative processes (Sylvetsky 2018). Despite their prevalence, their specific role in AD-mechanisms remains unclear. This study will investigate how AS consumption impacts an AD model: Drosophila Melanogaster GAL4/UAS model engineered to express human APP and BACE-1 (Adedayo 2023). Survival, locomotor performance, and reactive oxygen species(ROS) levels will be evaluated in flies fed stevia versus sucrose to determine whether AS has any effect in AD-like neurotoxicity. By clarifying this relationship, research may gain deeper insight into how artificial sweeteners shape AD pathogenesis, ultimately informing nutritional strategies for prevention. Uncovering whether AS worsen or protect against AD-like pathology could further pinpoint a dietary risk factor that is potentially modifiable.

Staples High School

Teacher: Amy Parent

Project # 134

Lowman, Lucy

<u>Effects of Golf Course Fertilizer Runoff on Nutrient Enrichment and Growth of Local Invasive Aquatic Species</u>

02-Environmental Research Proposal

Nutrient runoff from managed landscapes such as golf courses is a potential source of nutrient pollution in adjacent freshwater ecosystems and may promote the proliferation of invasive aquatic plant species. This study will investigate the effects of fertilizer runoff from a golf course on water nutrient concentrations and the growth of a common invasive aquatic plant, water hyacinth (Eichhornia crassipes). Water samples will be collected from a local stream at sites upstream of the golf course, within the golf course boundaries, and downstream of the course to represent varying levels of potential nutrient exposure. Water hyacinth plants will be grown under controlled laboratory or greenhouse conditions using water from each sampling location while maintaining consistent light, temperature, and starting biomass across treatments. Plant growth will be measured over a three week period using metrics such as biomass change, leaf number, and growth rate. Growth responses among treatment groups will be compared to assess the influence of nutrient enrichment associated with golf course runoff. It is expected that plants grown in midstream and downstream water will exhibit significantly greater growth than those grown in upstream water due to elevated nutrient availability. Results from this study will contribute to understanding how anthropogenic nutrient inputs influence invasive species success and freshwater ecosystem health.

Ridgefield High School

Teacher: Ryan Gleason

Project # 135

Madson, Kelsey

<u>Calcification intensity and Sr/Ca ratios of coccoliths influenced by mineralogical composition of dust deposits in the Northeast Pacific.</u>

02-Environmental Research Proposal

Coccolith shells containing calcium carbonate vary in intensity and thickness of plates and the strontium-to-calcium ratio of coccoliths. The mineralogical composition of dust that deposits into oceans with coccoliths can affect coccoliths. A two-year time series analysis of coccoliths collected by a sediment trap mooring in the Channel Islands area would be conducted. The two source regions of windblown dust are the Central Valley and the Mojave Desert in California, US. Bulk sediment collected would be refined, and data would be collected via ICP-OES spectrometry. Due to nutrient composition, dust deposition from the Central Valley is predicted to cause a decrease in calcification mass and a higher Sr/Ca ratio in coccolith shells due to accelerated growth rates. Dust deposition from the Mojave Desert is predicted to diminish calcification mass and lower the Sr/Ca ratio. Further research could explore how other calcified plankton, such as foraminifers, react to dust deposition.

Darien High School

Teacher: Guy Pratt

Project # 136

Mao, Terry

<u>Structural Redesign of Single-Emitter Configurations for Improved Efficiency in Atmospheric Ionic Wind Thrusters</u>

04-Physical Science Research Proposal

Electroaerodynamic propulsion is a reliable alternative for traditional UAV propellers, offering advantages such as being silent, easily maintainable, and cheap cost. However, at a low energy efficiency, which is not ideal for commercial use. In this study, a combined mathematical model with Bayesian optimization is used to automatically search for the best geometric design. The geometry is updated in each simulation based on the results. After each simulation, the model evaluates the output and adjusts the input parameters. This forms a positive feedback loop like gradient descent, where in each iteration, the input is improved. The simulation was written in C++ to get fast performance and be able to run many cycles. The simulation results show that after optimization geometry has up to an 11% increase in total thrust while reducing simulated power loss by 14%. The model was able to perform more than 120 simulation runs per hour, and generate 2–3 unique solutions in a 24-hour period. Future investigation on this study will focus on using GPU acceleration and 64-bit floating-point precision to improve computational speed and outcome accuracy. Techniques such as mini-batch training can be used to reduce the chance of simulation reaching false optimization. Also integrated, a trained AI model can be used to detect and filter out potentially faulty results.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 137

Marti, Nicholas

<u>Assessing the Effects of GLP-1 Receptor Agonists on Digestion in Drosophila
Melanogaster</u>

03- Health Research Proposal

Glucagon-like peptide-1 (GLP-1) is a hormone that helps regulate digestion by
stimulating the pancreas to release insulin and other digestive enzymes and by slowing
down muscle contractions in the gut to prevent food from moving too quickly. GLP-1
Receptor Agonist drugs are FDA-approved drugs used to mimic this hormone. These
GLP-1 drugs may be an effective treatment for patients with other digestive issues; they
would help increase nutrient absorption in patients by reducing muscle contractions in
the digestive system, a potential benefit for people who's gastrointestinal tract struggle
to absorb nutrients properly. To test this hypothesis, I used drosophila melanogaster,
the common fruit fly, as an invertebrate example of the effects of these drugs. Taking
flies with various genetic makeups, including flies with no mutations and flies with
mutations in the dRET gene (which causes Hirschsprung's disease, a disease that
causes short bowel syndrome, in humans), I medicated each group with either
semaglutide (a once-weekly GLP-1 drug used by companies such as Ozempic),
liraglutide (a once-daily GLP-1 drug used by companies such as Saxenda), or no drug
as a control, then observed each drug's effect on digestion. I found that GLP-1s did
slow digestion in d. melanogaster, and I also found that dRet mutated flies had a
surprisingly low digestive rate, meaning GLP-1 treatment might affect patients with
mutations similar to this differently. The potential for patients with digestive issues to
use GLP-1s as a potential treatment could mean significant improvements in nutritional
health and quality of life.

King School

Teacher: Victoria Schulman

Project # 138

Masone, Grace

<u>Salinity and Degradation of Cosmetic Glitter Microplastics (PET and PVC)</u>

02-Environmental Research Proposal

Glitter microplastics, primarily composed of polyethylene terephthalate (PET) and polyvinyl chloride (PVC) with metallic coatings, are widely used and frequently enter aquatic environments. Due to their chemical stability, these plastics persist in freshwater and marine systems. Previous research has shown that environmental factors such as salinity influence microplastic behavior, aging, and surface interactions, while PET-based glitter has been shown to promote mineral formation that may affect marine ecosystems. This study investigates how varying salinity levels affect the physical and chemical degradation of PET and PVC cosmetic glitter. Equal masses of PET and PVC glitter will be exposed to freshwater (0 ppt), brackish water (1.5 ppt), and seawater (35 ppt) under continuous light at room temperature for 14 days with daily stirring to simulate water movement. Degradation will be evaluated using visual observations, compound microscopy, scanning electron microscopy (SEM) to assess surface damage, and infrared spectroscopy (FTIR) to detect chemical changes. Pre- and post-experiment mass measurements will be recorded only if reliable. Data will be analyzed by comparing surface changes, spectral changes, and visible aging across salinity treatments and between plastic types. Results are expected to show increased surface deterioration and chemical weathering at higher salinity levels. Understanding how salinity influences glitter microplastic degradation provides insight into where these particles persist or accumulate in aquatic environments and whether degradation reduces pollution or produces smaller, potentially more harmful particles. This research contributes to ongoing efforts to evaluate microplastic persistence and may inform environmental policy and safer cosmetic material design.

Joel Barlow High School

Teacher: Paul Testa

Project # 139

Medina, Sam

<u>Determining the effect of implementing an MCED (Multi-Cancer Early Detection) genomic blood test among other screenings on Cancer diagnosis rates</u>

03- Health Research Proposal

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Cancer, a worldwide issue, has ruined the lives of millions and taken the lives of thousands of others. In 2020, only 6 years ago, over 20 million people were diagnosed with some form of cancer (Sung et al., 2021) and over 9 million people died from the disease worldwide. On a global scale, Cancer is a leading cause of death for millions. Cancer, defined as a disease in which some of the body's cells begin to grow abnormally fast, presents itself in many ways—it can affect the lungs, the heart, the blood, and essentially any part of your body. However, there have only been a handful of screening tests available to the public, ones made specifically for only a few types of Cancer. And thus, the MCD (Multi-Cancer Detection) test was born. The MCD test, also known as the MCED (Multi-Cancer Early Detection) test, is very recently developed technology that could prove beneficial if taken alongside the regular screenings. The goal of this proposal is to determine whether the MCED (Multi-Cancer Early Detection) blood test could potentially aid in spotting different types of cancer before it becomes fatal, and reducing worldwide mortality rates if available to the public for usage alongside the regular screening tests.

Newtown High School

Teacher: Timothy DeJulio

Project # 140

Mihopoulos, Luke

<u>Towards the Application of PSCs for SmallSats in LEO</u>

04-Physical Science Research Proposal

Perovskite solar cells (PSCs) have emerged as a promising alternative to traditional silicon solar cells due to their high power conversion efficiencies(PCEs) and comparatively low manufacturing costs. These advantages are particularly desirable for space application, where mass at launch (which is critical) can be minimized by using fewer, higher-efficiency solar cells. Despite these benefits, though, the relatively low durability towards humidity and temperature of these PSCs has remained a major obstacle in their development. While this is more manageable on earth, extreme temperatures in space can cause major problems. Because of this, research is needed to determine how close PSCs are to reaching a level in which they are fit for use in space. This research aims to address this issue, determining specifically how close PSCs are for application on SmallSats in low earth orbit (LEO). Test cells will be exposed to simulated LEO conditions, analyzing the degradation in PCE over time, which can then be compared to degradation in typical silicon cells to perform a gap analysis. It is expected that there will be a significant gap between PSC sample performance and performance of prior silicon cells when exposed to LEO conditions. Regardless, the results will still be significant in driving more interest into research and development for PSCs in SmallSats, which will be crucial in the future.

Darien High School

Teacher: Christine Leventhal

Project # 141

Mitev, Alina

<u>Efficacy of PMT Interventions vs. Implementation Intention Strategies in Eliciting Behavior Change Directed Toward Mitigating Climate Change in Adults Who Believe in Climate Change</u>

01- Behavioral Research Proposal

Although many are aware that climate change is occurring, there are slightly fewer who are motivated to take action, and there are very few who actually take action against climate change. This is an issue, as the majority of greenhouse gas emissions can be attributed to the everyday behaviors of citizens (such as meat consumption and energy use). There has been extensive research on how to increase motivation to mitigate climate change. One theory which has been tested is the Protection Motivation Theory, postulating that threat appraisal and efficacy appraisal determines motivation to take action against a threat (in this case, climate change). However, there has been less research on how to actually increase implementation of protective behaviors, and how habit can act as both an obstacle and a strategy in implementing protective behaviors (at least in the context of climate change mitigation). Implementation Intention is a goal-setting strategy which helps correlate the goal behavior with situational cues, similar to how habitual behaviors function. I'm planning to test how effective PMT interventions (messages) and Implementation Intentions are in eliciting climate change mitigation behavior in adult participants, as opposed to PMT interventions alone. I will measure change in motivation and change in behavior through digital surveys. Ultimately, I expect PMT interventions utilized together with Implementation Intentions will be more effective than PMT interventions. This research will help to improve interventions outside organizations use to elicit climate change mitigation in people, and add more insight into the roles which motivation and habit play in behavior change.

Ridgefield High School

Teacher: Ryan Gleason

Project # 142

Nafde, Rohan

<u>Species Boundaries of Caviomorph Rodents.</u>

02-Environmental Research Proposal

South America includes major natural barriers like the Andes Mountains and enormous river systems such as the Amazon. Large geographic features such as rivers and mountain ranges play a clear role in separating different kinds of South American animals from one another. This can often cause a split of a population of animals into two species. Caviomorphs, a group of rodents, include familiar animals such as guinea pigs, capybaras, chinchillas, and pacas. This group may be especially affected by these geographic features. This study will see whether populations of the same species on either side of a large natural barrier are actually different species or the same. To prove this, I would find genetic sequence data from GenBank or the IUCN on either side of a large geographic barrier. Then I would see the differences between the genetic code using a software algorithm, and then determine if this correlates to different species or just one. The hypothesis of the study is that populations on either side of a geographic barrier would be distinct and could be classified as a separate species, supporting a relationship between geographic barriers and species boundaries.

Darien High School

Teacher: David Lewis

Project # 143

Nehro, Marin

<u>Clinical Efficacy of Ibogaine for Opioid Detoxification and Withdrawal Symptom Reduction: A Systematic Review and Meta-Analysis of COWS, OWS, and SOWS Outcomes</u>

01- Behavioral Research Proposal

Ibogaine is a psychoactive, hallucinogenic substance derived from the bark of the Iboga plant. It interacts with multiple neurotransmitter systems, including opioid receptors, and is being researched as a treatment for opioid addiction. It is classified as a Schedule 1 controlled substance in the United States and is not approved for medical use. It is legally regulated in New Zealand, Australia, Mexico, and other areas globally. Ibogaine has shown strong results in treating opioid dependence and withdrawal symptoms. This study aims to analyze the efficacy of Ibogaine throughout multiple studies in an effort to produce a standardized estimate of effect size across studies.

Darien High School

Teacher: Christine Leventhal

Project # 144

Niass, Abdallah

<u>Comparative Effects of Nicotinamide Riboside and Propranolol on Caenorhabditis Elegans Expressing Amyloid-Beta Toxicity</u>

03- Health Research Proposal

Alzheimer's disease (AD) is a form of dementia and a type of metabolic disorder. Symptoms include memory loss, confusion, and personality changes. Biological characteristics include amyloid-beta (AB) toxicity in the brain, oxidative stress, and motor dysfunction. AD is currently recognized as irreversible, as a cure has yet to be found. Most current treatments are therapies that focus on relieving symptoms, and fail to fix the biological characteristics of AD. This experiment is going to compare the effects of nicotinamide riboside (NR), a form of vitamin B3, and propranolol, a beta-blocker, on a Caenorhabditis elegans (C. elegans) model. The model uses transgenic strains that mimic AD. The worms are going to be grown on nematode growth medium, and both NR and propranolol will be added to each experimental group's food (E. coli OP95). NR and propranolol will be diluted using DSMO, and the control group will have only DSMO added to their food. The results should show that NR had a higher performance at preventing/slowing down the three dependent variables measured: AB aggregation, motor dysfunction, and oxidative stress. Propranolol will be able to perform, but at a lower extent than NR. The negative control group, with non-transgenic worms, will not show any AD characteristics.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 145

O'Malley, Eliza

<u>The Effect of High Salinity on Coral's Acclimation to Climate Change</u>

02-Environmental Research Proposal

There are many ways that corals help the ecosystem, whether it's for the environment, the land, or the fisheries, corals have a great impact. Corals dying have many problems in the world, such as population decreases in fish 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 a 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 the 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 14 days, the corals will be fully adapted. In the research, the Montipora corals will adjust to the temperature in the tanks similar to global warming temperatures to see if they will be able to adapt. The Corals will be photographed pre and post-experiment to check for growth, so that it will be seen if they were thriving.

Ridgefield High School

Teacher: Ryan Gleason

Project # 146

Palicha, Rishi

<u>The effect of mouthguards on frequency of concussions in student athletes</u>

03- Health Research Proposal

Concussions, like any other common injury, are very frequent in sports, especially student athlete's sports, and contact sports. When athletes take a heart hit, their jaw quickly clenches, and delivers force up into the skull, and the brain in extension. A mouthguard can be used to soften this blow, however there are different types of mouthguards that can be used, all delivering different levels of safety. Using an impact force gauge, a mouth mold, a weight and the three main types of mouthguards, I will attempt to measure the difference in these types of mouthguards, stock mouthguards, mouth fitted mouthguards, and custom mouthguards. I believe that the custom fitted mouthguard will perform the best due to its tight fit that allows it to absorb more energy. Once the experiment is completed, I will be able to definitively tell which type of mouthguard is able to prevent concussions the best, and plan on educating the various contact sports teams in my school on which mouthguard is best.

Ridgefield High School

Teacher: Patrick Hughes

Project # 147

Pasham, Ishan

<u>Effect of innovative design using additive manufacturing on discreet body armor to improve EMS safety and cost efficiency</u>

04-Physical Science Research Proposal

EMS personnel do not have access to comfortable, low-profile stab/impact protective gear (Ritchie2023). Additive manufacturing can be used to create breathable, flexible, elastic, and impact-absorbent spacer panels using low-cost materials and desktop printers(Halbrecht2023). The optimal design has not been established. This study aims to use additive manufacturing and innovative design of 3d printed lattices combined with moisture-wicking nylon, Kevlar, and Hot-Press TPU film, to create affordable, comfortable, and effective low-profile protective gear for EMS personnel. 4x4inch sheets of Kevlar will be modified and layered using 3D printed spacer textiles. 3D printing parameters will vary thickness, and the width or girth of each fiber within the structure. Modifications will be done iteratively to optimize design. Data will be collected using tests to observe breathability, and impact/puncture resistance. Impact and puncture resistance will be determined using a weighted striker with a blunt and sharp striker with added weights at 10lbs 20lbs, 30lbs dropped from 6 ft high the force will be calculated using a photogate and a videotimer to measure the velocity and impulse. The breathability test will use a small dish filled ⅓ with water sealed to the breathable side of the panel. The change in the water level over time and the weight of the water indicates the level of evaporation i/e breathability. (ASTME96) .If EMS personnel have gear that is both comfortable and effective enough to wear 24/7, they can maintain a level of protection while not being impeded in their movement or comfort.

Staples High School

Teacher: Amy Parent

Project # 148

Pereyra, Asher

<u>Experimental Maturation of Pinus Strobus Resin in a Laboratory Setting</u>

04-Physical Science Research Proposal

Fossils are one of the most important factors and ways we have learned about and studied ancient life, as well as evolution. In nature, fossils are fairly rare, only forming in specific environments and in sedimentary rock. However, in the lab, there have been many studies about recreating and reproducing fossilization, including in time frames of only around 24 hours. This same principle has then been extended to amber, a hardened and preserved version of resin from trees such as species of Pinus, which undergoes many of the same or similar processes which fossils undergo. This research attempts to turn resin from the tree species Pinus Strobus into amber or an amber-like state, through use of compaction in sediment and high temperature. This research varies from previous work in the field by using more commonly available tools, which are available in most labs and schools. Resin will be collected from living P. Strobus trees, and compacted into Bentonitic clay through the use of an arbor press. Once compacted, the samples will be put into a steam autoclave, exposing them to temperatures exceeding 100°C, and 2 atm of pressure. These samples will be run for periods of time up to 24 hours, then removed and cut open. The finished samples will be inspected via use of an electric microscope, which will compare them to each other and resin that has not gone through the maturation process. The expected results are that the resin will undergo significant change, becoming similar to amber, hardening from its initial state, and displaying deeper colors.

Ridgefield High School

Teacher: Patrick Hughes

Project # 149

Punia, Vani

<u>Evaluating Toxicity of Natural and Synthetic Dyes in Caenorhabditis elegans: Identifying Safer Options for Consumables</u>

03- Health Research Proposal

Synthetic dyes are used more than natural dyes by food manufacturers. Synthetic dyes have been associated with severe health problems such as cancers, reduced hemoglobin concentrations, and allergic reactions (Dey & Nagabulu, 2022) A study evaluating natural and synthetic red dye in zebrafish showed that natural dyes are less toxic (Fogliano,2025) but no one has compared Blue Dye #1 to a natural product to evaluate toxicity; Blue Dye #1 is used in 24.2% of all processed foods.(Batada,2016) This study will compare the effects of Blue#1 and Blue Spirulina (a natural blue dye) in C. elegans in terms of neurotoxicity, lifespan, and reactive oxygen species to determine which one is the safer option for consumption. Because this study is focused on consumption, the dye will be fed to the C. elegans through e coli and the treated worms will be analyzed either in terms of neurotoxicity, lifespan, or reactive oxygen species .It is anticipated that Blue Dye #1s will lead to greater neurological decline compared to Blue Spirulina making natural dyes the safer alternative in consumables. If the hypothesis is true, the dye industry could consider alternative strategies to color food products.

Staples High School

Teacher: Amy Parent

Project # 150

Rael, Lilyanna

<u>DNA Barcoding as a Tool to Assess Biodiversity in Similar-Looking Species</u>

02-Environmental Research Proposal

It is expected that DNA barcoding will reveal clear genetic differences between species that appear visually similar, allowing for accurate species identification using short, standardized DNA sequences even when traditional morphological methods are unreliable. The analysis may also uncover cryptic species that were previously misclassified due to their similar physical appearance, suggesting that biodiversity is often underestimated when based solely on visual traits. Overall, the results are anticipated to demonstrate that DNA barcoding is a reliable and effective tool for assessing biodiversity, providing a more precise understanding of species diversity and supporting conservation and ecological research. However, DNA barcoding also has limitations, as closely related species may share similar barcodes, reference databases may be incomplete or inaccurate, and degraded DNA samples can reduce identification accuracy. Additionally, DNA barcoding alone does not provide information about an organism's behavior or ecological role. To address these limitations, DNA barcoding can be combined with other approaches such as multi-gene barcoding, environmental DNA (eDNA) analysis, morphological identification, and genomic sequencing, allowing for a more comprehensive and accurate assessment of biodiversity.

Darien High School

Teacher: Guy Pratt

Project # 151

Rivera, Randy

<u>Novel Approach for Viewing Quantum Superposition</u>

04-Physical Science Research Proposal

Quantum superposition is a core principle of quantum mechanics. Interestingly, while superposition is so important to quantum mechanics is a topic that people usually struggle to visualize. This is because of superpositions, abstract nature and the complexity of traditional experimental setups. Classic experiments such as Young's double slit and Wheeler's delayed choice experiments demonstrate light's wave-like and particle-like behavior separately, but not simultaneously within a single, accessible system. The paper proposes a low cost optical apparatus that combines beam slitters, mirrors, and delayed-choice elements to provide a visual demonstration of both wave-like and particle-like behaviors at the same time. A 15mW laser is divided and recombined using photon splitters and mirrors arranged at 45 degree angles to create multiple optical paths. By selectively inserting or removing photon splitters at when beams recombine, it is expected that these findings demonstrate wave-like and particle-like behavior. The anticipated outcome is a simplified, classroom accessible demonstration of quantum superposition that improves conceptual understanding of wave-particle duality.

Joel Barlow High School

Teacher: Paul Testa

Project # 152

Schwartz, Sienna

<u>Can Your Diet Protect Against Microplastics? Discovering the Impact of Probiotic E. coli Strains on Microplastic-Induced Toxicity in C. elegans</u>

03- Health Research Proposal

Microplastics are an emerging environmental pollutant which threaten human health by accumulating in the gut and altering microbial balance (Dehaut,2016) (Schwabl,2019). Evidence from several studies demonstrates that exposure to polystyrene microplastics significantly disrupts gut microbiota and metabolic function (Jin, 2019), yet little is known about whether improving gut health can reduce this toxicity. This study investigates whether probiotics in the gut microbiota can improve behavioral and physical responses to microplastic-induced stress in C. elegans due to their genetic similarity to humans and well-characterized gut responses to bacterial diets (Cabreiro,2013). Synchronized L1 N2 wild-type C. elegans will be fed one of three bacterial diets: E. coli OP50 (control), E. coli Nissle 1917 (probiotic), or heat-killed E. coli K-12 (dysbiotic), then exposed to 100 µg/mL fluorescent 1 µm polystyrene microplastics for 100 h. Toxicity will be measured in four assays: lifespan (Kaplan–Meier survival), brood size (reproductive output), locomotion (body bends/min), and oxidative stress measured via the fluorescent dye CM-H_2DCFDA (chloromethyl-2′,7′-dichlorodihydrofluorescein diacetate) (ROS fluorescence)(Yu,2021)(Sarasija,2018). It is hypothesized that probiotic-fed worms will exhibit longer lifespan, greater brood size, improved movement, and lower oxidative stress while exposed to microplastic-induced toxicity (Poupet,2020)(Kim,2019). If supported, these findings would provide groundbreaking evidence that gut microbial composition influences an organism's resilience to environmental pollutants and may suggest dietary probiotics as a potential tool to mitigate microplastic toxicity in humans.

Staples High School

Teacher: Amy Parent

Project # 153

Shah, Derek

<u>Development of A Novel Lateral Flow Assay Using Dual Sensitivity-Increasing Factors to Decrease Limit of Detection of Human IgG</u>

03- Health Research Proposal

Early detection of Alzheimer's disease is limited by the lack of low-cost diagnostic tools capable of identifying biomarkers at very low concentrations. Phosphorylated tau 217 (pTau217) is a promising early indicator of disease progression, but its levels fall below the sensitivity range of most conventional lateral flow assays (LFAs). This project explores a dual-enhancement strategy to improve LFA sensitivity using gold nanoshell reporters combined with post-assay silver enhancement. Preliminary work focused on optimizing antibody–gold conjugation conditions and constructing both standard and amplified LFA prototypes. Optimization demonstrated that lower gold-to-antibody ratios minimized excess nanoparticle precipitation, improving conjugate quality for downstream applications. Although full sensitivity testing could not be completed, an experimental framework was developed to evaluate assay performance through planned limit-of-detection analysis. Expected results suggest that combining nanoshell-based reporters with silver enhancement will substantially lower the detection threshold of LFAs, potentially enabling early-stage screening for Alzheimer's disease using a simple, scalable testing format.

King School

Teacher: Victoria Schulman

Project # 154

Shrivastava, Aanya

<u>Supporting Strategies to Reduce Blood Supply Requirements by Studying the Effect of Batch Emulsion Speed on Hyaluronic Acid Methacrylate Hydrogel Microparticle Size to Influence Bovine Serum Albumin Release Kinetics in a Simulated Bloodstream</u>

03- Health Research Proposal

Anemia, a hemoglobin deficiency typically treated through transfusion, has become a focus of alternative treatment research due to blood supply shortages (Jacobs et al.,2022). Injectable drug-loaded hydrogel microparticles are one such alternative; however, issues such as initial burst release and limited data on size-dependent release kinetics hinder further development. (Daly et al.,2019). This study investigates how batch emulsion speed will influence hydrogel particle size, impacting the release of Bovine Serum Albumin (BSA), a hemoglobin model protein, in a simulated bloodstream. 4μm, 8μm, and 12μm BSA-loaded microparticles will be formed by varying batch emulsion speeds, and their release profiles will be measured over 7 days (Daly et al.,2019). Drug loading, encapsulation efficiency, initial burst release, and cumulative release will be quantified using UV-Vis Spectrophotometry on either the supernatant after particle formation or a 1 mL aliquot of the simulated bloodstream to determine the concentration of BSA (Daly et al.,2019)(Sabaa et al.,2019). In vivo conditions will be modeled through warmed, agitated, pH7.4 phosphate-buffered saline (Vigata et al.,2020). It is hypothesized that 4μm particles will exhibit higher burst release caused by large surface area to volume ratio, 12μm particles will exhibit slow cumulative release due to the opposite, and 8μm particles will optimize the majority of test factors (Daly et al.,2019). If supported, these findings will address the limitation of burst release in the application of loaded hydrogel microparticle drug delivery and contribute to alleviating blood shortages through alternate treatments for anemia patients.

Staples High School

Teacher: Amy Parent

Project # 155

Sokhi, Naunidh

Applications of Geometric Brownian Motion to Fluid Dynamics

04-Physical Science Research Proposal

Fluid flow in such microchannels is often unpredictable and non-continuous, owing to random changes in the flow. Such random changes have a significant impact on the flow of particles. The project aims to evaluate the possibility of fluid velocity changes using Geometric Brownian Motion (GBM), where the hypothesis is that the fluid velocity changes in a random manner, as expected by GBM, and the changes will be more pronounced with higher pressure changes. To evaluate the changes, fluid will be passed through a microfluidics device with random pressure changes, and the changes in the particles will be monitored using high-resolution imaging techniques to evaluate the instantaneous velocity of the particles. The variables will be the pressure changes and the velocity changes, and the results will be compared with the expected changes using GBM. It is expected that the velocity changes will be random, as expected by GBM, and the changes will be more pronounced with higher pressure changes. Proving the relevance of stochastic models to micro-scale flows may help to increase the accuracy of predictions related to the transport of particles in micro-fluidic systems, which can be used to develop more efficient devices. Moreover, this study can serve as a basis for developing a method for using stochastic models to describe other phenomena of micro-scale fluid flows, which can help to understand the underlying behavior of fluids under random excitations.

Darien High School

Teacher: David Lewis

Project # 156

Spitz, Josephine

<u>Associations between Diet, Mental Health and the Gut Microbiota</u>

03- Health Research Proposal

Background: The gut microbiome influences human health through immune, metabolic, and neurological pathways, including the gut–brain axis. Growing evidence suggests that disruptions in gut bacteria may be linked to mental health disorders, but large population-based studies remain limited. This proposed study aims to investigate cross-sectional associations between gut microbiota composition and common mental health conditions. Methods (Proposed): Fecal microbiota samples will be analyzed using 16S rRNA gene amplicon sequencing to determine bacterial composition. Latent Dirichlet allocation (LDA) will be used to identify distinct microbial subgroups, allowing each participant's microbiome to be represented as a mixture of these groups. Mental health status—including symptoms of depression, anxiety, and stress-related conditions—will be assessed using validated psychological questionnaires and medical history. Associations between microbial subgroups and mental health outcomes will be evaluated using multivariate-adjusted Dirichlet regression models controlling for age, sex, BMI, diet, medication use, and lifestyle factors. Statistical correction for multiple testing will be applied to reduce false-positive findings. Expected Outcomes & Significance: It is anticipated that certain microbial subgroups, particularly those enriched in short-chain fatty acid–producing genera such as Faecalibacterium and Roseburia, will be associated with lower levels of depressive and anxiety symptoms, while subgroups characterized by dysbiosis-associated taxa may show positive associations with reported mental health conditions. This study may help clarify links between gut microbiome composition and mental health and demonstrate the usefulness of LDA for identifying complex microbial patterns. Longitudinal studies would still be needed to determine causality.

Darien High School

Teacher: David Lewis

Project # 157

Steneken, Alivia

<u>Culturing Lactobacillus Exposed to Fragrance Chemicals Found in Tampons</u>

03- Health Research Proposal

Aproxamitly 26% of the population menstruates regularly, and the vast majority of those people use products like tampons and sanitary pads. Many of the products used monthly have synthetic musks, man-made chemicals that aren't digested by the body. One of the ways the musk could harm the body is by attacking the lactobacillus in the vaginal cavity. Lactobacillus is the vagina's main defense against infections that could lead to things like infertility. By culturing Lactobacillus Crispatus in an incubator while exposing it to the musk, we will be able to learn about the adverse effects of these chemicals while also finding a safe amount of time for exposure.

Ridgefield High School

Teacher: Patrick Hughes

Project # 158

Tam, Kacee

<u>Determining How the Perception of Dissonance in Just Intonation Versus Equal Temperament Differs Between Individuals With and Without Absolute Pitch, and How this Relationship is Modulated by Age</u>

01- Behavioral Research Proposal

Absolute pitch (AP) is the ability to identify or produce any pitch without a reference note. There are two tuning systems that exist: just intonation (JI), and equal temperament (ET), which is more commonly used in Western music. It was hypothesized that AP possessors and non-AP possessors will perceive the same level of dissonance, and the purpose of this study was to determine how the perception of dissonance in the two tuning systems of music differs between individuals with and without absolute pitch. Participants completed a digital survey which included a test for the AP ability, and two versions of the same melody: one version using the JI tuning system, and the second version using the ET tuning system. Participants rated the level of dissonance for each version. The results suggest that the hypothesis was supported as AP possessors and non-AP possessors alike rated both versions . It was also found that JI was perceived as less dissonant than ET, even though ET is more commonly used in Western music. The implications of this study were to determine a universal perception of dissonance, and to better understand how AP and non-AP possessors perceive dissonance differently.

Amity High School

Teacher: Sarah Reeves

Project # 159

Thompson, John

<u>Effects of Marine Antifouling Paints on Copepod Tigriopus Californicus through multi-biomarker determination</u>

02-Environmental Research Proposal

Marine antifouling paints (MAPs) are widely used to prevent organisms from fouling vessel hulls. The majority are copper-based, and when scraped during cleaning, copper particles are discharged into the seawater and affect non-target organisms such as fish and crustaceans. Copepods are small plankton found in nearly every body of water, and are critical to the health of marine ecosystems. They act as a critical transfer of energy from microscopic phytoplankton to larger tertiary predators. This research looks to determine "eco-friendly" marketed, silicone-based MAPs' ecological impact on copepods and help determine if boaters should use silicone-based paints for their hulls. The experiment will research the impact of three MAPs on copepod health: copper-based, solely silicone-based, and silicone-based with a biocide, using two biomarkers, survival and feeding rate, to assess the MAP's effect on copepod health. An acute toxicity test will be used to find the minimum dosage of the MAP that causes 100% fatality within a copepod population. The copepods will be fed, and the food mass remaining will be measured and compared to the control to determine the MAPs' effect on their feeding behavior. The research hopes to determine if these silicone-based MAPs are better for the environment. It is projected that silicone-based MAPs with and without a biocide will have a higher copepod survival rate and feeding rate than traditional copper-based MAPs. Future research, then, must be done to determine the environmental impacts of different MAP formulations along with their effectiveness in preventing fouling.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 160

Turey, Nathan

<u>Behavioral and Vocal Responses of Male White's Tree Frogs to Conspecific
Advertisement Calls</u>

01- Behavioral Research Proposal

This study plans to examine in detail how male White's tree frogs respond behaviorally and vocally to playback of rival male advertisement calls. This research focuses on frog responses to specific stimuli and whether these responses represent fixed action patterns, which are innate, genetically hardwired behaviors triggered by particular signals and performed without prior learning. The guiding research question of this experiment is: How do male White's tree frogs respond behaviorally and vocally to rival male advertisement calls? This question is important to the field of ethology because, while advertisement calls are well documented, fewer studies have examined whether male responses to rival calls are innate or learned. During the planned experiment, each frog will be moved to a separate enclosure to ensure accurate data collection and prevent overlapping calls. A speaker positioned 15 cm in front of the enclosure will play a recorded conspecific advertisement call. Vocal variables such as latency to first call, pitch, and frequency will be recorded using audio equipment, while frog movement will be documented through video recording. Control trials will consist of identical conditions without sound playback or environmental changes. Because the frogs used in this study are captive-bred with limited exposure to conspecific calls, their responses can help distinguish between innate and learned behaviors. Increased vocalization or noticeable movement changes during playback trials compared to controls would suggest innate behavior, whereas no significant differences would suggest learned behavior. Understanding these responses may also aid conservation efforts by improving knowledge of reproductive communication and increasing successful breeding outcomes in captivity.

Weston High School

Teacher: Stacey Greenberg

Project # 161

Ufier, Abigail

<u>The Effect of Hearing Loss on Cognitive Function in Seniors</u>

03- Health Research Proposal

Roughly 40-50% of adults over 75 suffer from hearing loss, however the cognitive effects that come with this is commonly overlooked. This study explores the rate of cognitive decline amongst three testing groups: seniors with untreated hearing loss, seniors with treated loss through auditory intervention (hearing aids), as well as seniors with no notable hearing loss. Cognitive functions such as processing, attention span, and loss of memory will be tested to determine the effects of hearing impairment on cognitive ability. This study will administer cognitive assessments of the three different testing groups over a three month period of time. It is anticipated that the final results of the mental competency exam will reveal those with treated hearing loss to show greater cognitive function over the group with untreated hearing loss. The goal of this study is to enlighten people with hearing loss about the positive outcomes of hearing devices. It is far too often that elders dismiss the symptoms associated with hearing loss as a result of the aging process. With this information, people suffering from hearing loss can make an informed decision to pursue a path of acquiring hearing aids and receiving the support for maximizing the function of the device to enhance their remaining years of life.

Ridgefield High School

Teacher: Ryan Gleason

Project # 162

Ungerer, Roger

<u>Comparison of Water Absorption in PE, PLA, PVC Plastic Wraps</u>

02-Environmental Research Proposal

This study compares water absorption in polyethylene (PE), polyvinyl chloride (PVC), and polylactic acid (PLA) plastic wraps. PE is widely used for its general food storage due to its moisture resistance. PVC is utilized in more commercial settings for its clinging properties. PLA serves as a biodegradable alternative. Previous studies have shown that differences in polarity can lead to distinctions in the hydrolysis process. These differences result in comparative data that can be utilized to promote their purpose and usage. Equal-mass samples of PE, PVC, and PLA plastic wraps are submerged in room-temperature distilled water. Every eight hours, one sample of each will be removed and observed based on its mass and appearance. This will occur up until the forty-eighth hour. Water absorption is calculated through the differences between the initial and final mass of each sample. It is expected that PE wrap will show no change in its appearance or mass due to its nonpolar structure. Contrarily, PVC wrap is expected to absorb slightly more water molecules due to the presence of the chlorine atom, making it slightly polar. The PLA wrap will attract the polar water molecules due to the oxygen atoms. Respectively, in this order, it is expected that the more polar the molecule is, the more it will attract the water molecules, thus promoting the process of hydrolysis. Understanding how each polymer promotes/diminishes the breakdown cycle leads to a better understanding of the possible uses of plastic wraps.

Joel Barlow High School

Teacher: Paul Testa

Project # 163

Vaidheeswaran, Anika

Influence of Chitosan-Based Coatings on Staphylococcus epidermidis Biofilm Formation Across Peritoneal Dialysis Catheter Materials and Geometries

03- Health Research Proposal

Peritoneal dialysis is a life-sustaining treatment for kidney failure patients, but catheter-related infections such as peritonitis remain a major complication due to bacterial biofilm formation on plastic catheter surfaces, often leading to persistent infections and catheter failure. Current catheter materials lack effective long-term antibacterial properties. This study investigates whether a chitosan coating can reduce biofilm formation on catheter-like plastic materials commonly used in peritoneal dialysis. Polyethylene and silicone plastic samples of varying shapes, both uncoated and coated with a chitosan solution, will be exposed to identical cultures of Staphylococcus epidermidis under controlled laboratory conditions. Biofilm biomass will be quantified using a crystal violet assay, with absorbance measured via spectrophotometry at 590 nm to assess bacterial adhesion on each surface. Uncoated samples are expected to exhibit moderate to high biofilm formation, reflected in optical density values, with some variation depending on surface shape and material properties. In contrast, chitosan-coated samples are projected to show substantially lower optical density values, indicating a significant inhibition in biofilm biomass compared to uncoated controls. These results may demonstrate the effectiveness of chitosan-coated surfaces in limiting biofilm formation on peritoneal catheter materials, potentially lowering the risk of catheter-related infections. Future proposed work will include testing multiple chitosan concentrations, extending incubation times to model long-term catheter use, and using scanning electron microscopy (SEM) to evaluate surface morphology and biofilm structure under simulated body fluid conditions.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 164

Walder, Payton

<u>Effects of Sunscreen on Coral Health</u>

02-Environmental Research Proposal

This proposal is meant to show how sunscreen- specifically Oxybenzone, affects coral reefs and even anemones. If this problem continues then coral reefs will start to get sick or even die. A significant amount of fish and even us would suffer greatly if coral reefs- their homes, died. This will collapse the food chain and many creatures would suffer. Studies showing experiments of chemical sunscreens against corals provide the information you need to know to understand how oxybenzone/chemical sunscreens harm coral reefs and our world.

Newtown High School

Teacher: Timothy DeJulio

Project # 165

Webb, Jae

<u>Emotion Recognition of Animals Through the Use of Natural Language Processing</u>

01- Behavioral Research Proposal

This experiment will be focused on testing how Natural Language Processing techniques can be used to analyze vocalizations and observational data to determine certain emotional states with parrots as the model organism. These similarities and differences found between vocalizations can then be used to organize/map groups of vocalizations based on frequency, amplitude, rhythm, and behavior at that time. The organization of the parrot vocalization groups can then be evaluated and analyzed to discover displayed traits of certain emotions based on their placement on the emotional map. The information gathered from this experiment will then be used to compare and contrast to human behavior in hopes of enlightenment towards the complexity and capacity that certain animals display.

Ridgefield High School

Teacher: Patrick Hughes

Project # 166

Willis, Jessica

<u>Classifying Cataclysmic Variable Candidates Through a Multi-Time Scale Analysis of AAVSO Photometric Light Curves</u>

04-Physical Science Research Proposal

Cataclysmic variables (CVs) are close binary star systems that consist of a white dwarf (WD) star and a companion star. These binaries are important models to test many astrophysical concepts, like accretion physics (Inight et al., 2023). Moreover, varying gravitational forces and outbursts allow us to learn and test physical theories and magnetohydrodynamics that can't otherwise be reproduced in a lab (Ju, 2016). Primarily, these systems are vital for gravitational theory research. Contributions to archives such as the International Variable Star Index (VSX) from the American Association of Variable Star Observers (AAVSO) validates the capability of citizen astronomers to make reliable contributions to science (AAVSO, n.d.). Photometric light curves of varying time scales will be taken from the VSX of a control CV and 3-10 CV candidates. These varying time scales can have varying characteristics, like humps and dips in magnitude, pointing to the CVs period (Porb), outburst, magnetic field strength (B), inclination, and accretion rate (ṁ) (Abrahams et al., 2022). The control CV is SS Cygni (SS Cyg). SS Cyg is extensively documented in thousands of scientific papers. Analysis of UGem is intended to demonstrate the ability to correctly analyze future unclassified candidates. With the unclassified CVs from the VSX, the goal is to confirm the existence of an accretion disk, magnetic field strength, and their orbital parameters of the control and candidates based on the ellipses and outbursts observed in the light curves with the goal to categorize the CVs into specific magnetic, intermediate, or non-magnetic types.

Staples High School

Teacher: Amy Parent

Project # 167

Yan, Elise

<u>Enhancing Superoxide Dismutase (SOD) Stability Through Synthesis With Mesoporous Silica Nanoparticles (MSNs) Tested in C. elegans to Determine Its Potential Role in Breast Cancer Treatments</u>

03- Health Research Proposal

Breast cancer is the most commonly diagnosed cancer in women, accounting for one in ten new diagnoses(Menon,2024). Elevated reactive oxygen species(ROS) levels are linked to tumor growth(Shah,2015). Although Superoxide Dismutase(SOD) is an established antioxidant, its use is marked by poor pharmacokinetics(Yang,2022). Mesoporous Silica Nanoparticles (MSNs), which are highly customizable and nontoxic, have been proven to effectively deliver SOD to wild-type C. elegans without altering their lifespan and even increase the lifespan of C. elegans by approximately six days when combined with SOD(Yang,2022). These promising results support investigation of previously unexplored SOD-MSN treatments in breast cancer models. This study utilizes two C. elegans cancer models: YF15, which carries a mutation in the brap-2 gene homologous to the BCRA1 gene in humans(Koon,2010); and MT2124 which has a mutation to the Ras-ERK signaling pathway, a homolog of mammalian Ras, and is associated with 20-30% all cancers(Gimple,2019) resulting in a multivulva(MUV) phenotype(Medina,2021). In this study, MT2124 and YF15 will be fed SOD ± MSNs or MSNs alone and evaluated for lifespan, retention of SOD, a multivulva reduction bioassay (MT2124 only), and oxidative stress. This study hypothesizes that SOD-MSN will help stabilize SOD delivery, prolong lifespan of the YF15 strain, and decrease the MUV phenotype in the MT2124 strain. Confirming these effects will help justify SOD-MSN as a feasible stable drug delivery method and effective adjuvant treatment for breast cancer and possibly other cancer treatments.

Staples High School

Teacher: Amy Parent

Project # 168

Yang, Charlotte

<u>Freshwater Produce Machine</u>

02-Environmental Research Proposal

Clean freshwater is essential for human health, supporting nutrient delivery, waste removal, and body temperature regulation. However, only 3% of the world's water is freshwater, and two-thirds of that is frozen or unavailable. Millions of people, especially those in rural and low-income areas, lack consistent access to safe drinking water, leading to illness and inequity. This project proposes a low-cost, sensor-controlled, and solar-powered freshwater produce system to address global water scarcity. The system is designed to collect, filter, and pasteurize rainwater into clean, drinkable water using renewable solar energy. From an environmental research perspective, this project explores how rainwater harvesting and solar pasteurization can reduce the overuse of limited freshwater resources and decrease dependence on non-renewable energy. The main evaluation will center on environmental impact, including water safety, energy efficiency, resource conservation, and long-term sustainability. Potentially, it offers an affordable and sustainable freshwater resource for everyone, especially rural communities and low-income areas with limited freshwater, reducing overuse of scarce freshwater which is better for the environment, and keeping them healthy by killing harmful bacteria—making life safer and more sustainable. Overall, this environmental research proposal prioritizes both human health and equity, showing how simple, sustainable design can address two urgent global challenges: freshwater scarcity and overreliance on non-renewable energy.

Westover School

Teacher: Ashley Bonet

Project # 169

Yazbeck, Nicholas

<u>Evaluation of Tween 20 and Tween 80 on Bacteriophage Purification</u>

03- Health Research Proposal

In the twentieth and twenty-first centuries, antimicrobial resistance has been on the surge with bacteriophage therapy being one of the most viable options. Phage therapy is a crucial area of research because bacteria cannot mutate fast enough to counteract phages like they can with antibiotics. So when phages are prepared to be used in therapy, large amounts of harmful endotoxins are released and then purified. However, this doesn't stop the phages from sticking to surfaces that they come into contact with, rendering some amount of phages useless and lost. In order to prevent the phage loss, a regular detergent-assisted centrifugation technique can be used. During this process, when phages are kept for long times in centrifugation test tubes and in petri dishes when stored, small amounts of either Tween 20 or Tween 80 can be added. These substances act as a non-stick solution, so phages don't unnecessarily bind to tiny microscopic cracks, imperfections, and other waste in their containers. After the procedure is done, Tween 80 might retain more phages than Tween 20 due to its more hydrophobic properties, but it is harsher on the phages and might destabilize some. Tween 20 could retain comparable amounts, and would probably be better to use on more fragile phages. To analyze the data, a Wilcoxon signed-rank test can be used. Learning from this experiment could yield better phage storage solutions during transportation, or more advanced hydrophobic substances that can be gentle and effective, which positively affect phage treatment.

Darien High School

Teacher: Guy Pratt

Project # 170

Yi, Stella

<u>The Effect of Caffeine on the Sleep of Drosophila Melanogaster</u>

01- Behavioral Research Proposal

Sleep is a vital biological process that supports proper neurological and physiological function in living organisms. Disruptions to sleep can negatively affect behavior, metabolism, and overall health. Caffeine is a common drug that works by interfering with neural signaling associated with sleep, often resulting in delayed sleep and reduced sleep duration. Due to its widespread consumption, understanding the biological effects of caffeine is important. Fruit flies (Drosophila Melanogaster) are frequently used as model organisms in scientific research due to their short life cycle and genetic similarities to humans. Their sleep patterns can be easily observed, making them ideal for studying the effects of stimulants such as caffeine. The purpose of this experiment is to determine how increasing concentrations of caffeine affect the time it takes to fall asleep and sleep duration in fruit flies. This study will focus on how Drosophila Melanogaster responds to caffeine and how its Circadian Rhythm is affected. The results will be analyzed to identify trends between caffeine concentration and changes in sleep behavior. This study will help model how stimulants influence biological rhythms and provide insight into the neurological effects of caffeine using fruit flies as a model organism. It becomes evident that high doses of caffeine will lead to later sleep times, disrupting the sleep cycles, while smaller doses allow the 24-hour clock to run relatively smoothly.

Ridgefield High School

Teacher: Ryan Gleason

Project # 171

Zezula, Lily

<u>The Productivity of The Fungi Filter</u>

02-Environmental Research Proposal

This study evaluates the functional efficacy of the Fungi Filter, a patent-pending storm drain insert designed to address urban stormwater pollution through mycoremediation. Developed over a three-year period, the system utilizes blue oyster mycelium (Pleurotus ostreatus) to biologically filter and degrade contaminants within runoff. In collaboration with environmental specialists in Westchester, NY, this experiment involves installing the filter within active catch basins for a 3–4 week duration to monitor its impact on water quality. The research methodology focuses on comparing baseline runoff clarity and microplastic concentrations against filtered samples to determine the system's filtration capacity. It is hypothesized that the mycelium matrix will significantly reduce or eliminate microplastics, providing a sustainable and scalable solution for state-level stormwater management. To ensure the credibility of the data, multiple trials will be conducted to validate the filter's performance and structural integrity under field conditions.

Ridgefield High School

Teacher: Ryan Gleason

Project # 172

Zwynenburg, Cole

<u>Placeholder</u>

03- Health Research Proposal

Sleep is essential for healthy cognitive functioning, yet rising screen use exposes all groups, specifically teenagers, to artificial light that can disrupt the brain's natural sleep processes. Other research shows that blue-light exposure before bedtime may interfere with melatonin production, and thus impact sleep time and quality. This study aims to investigate how different wavelengths of light (including blue light and possible red light alternatives) affect sleep-dependent cognitive performance using Drosophila melanogaster (fruit flies) as a model. Fruit fly larvae will receive odor training and will be kept in a stable 12:12 white-light–dark cycle. Later, during the last 2 hours of their white light cycle the flies will be exposed to different light conditions—blue light, red light, or the control white light—before sleep. After they wake, their morning feeding is skipped, and they are placed in a T-maze where their choice between the two familiar odors indicates how well they remember which one was paired with food. Projected results suggest white-light larvae would show the strongest memory performance, red-light larvae moderately lower, and blue-light larvae the weakest due to greater sleep disruption. Future work includes similar experimentation with more complex organisms like monkeys and dogs. Later further experimentation could be done with humans, especially teenagers. A blue light vs. red light vs. white light trial before bed followed by cognitive tests (depending on test subject) in the morning could provide a clearer link to how nighttime screen habits affect the cognitive abilities of teenagers post-sleep.

Greens Farm Academy

Teacher: Mathieu Freeman