Project # **S0101** Category: **Animal Biology - Sr**

Student: **Layan Mustafa** Grade: **10** G: **F**

School: **Institute of Knowledge High School**

Title: **It's About Bloody Time! Examining the Health Impacts of Conventional Pad Components on Women's Menstruation**

Problem/Question: The objective of this project is to investigate the potential effects of the components in conventional menstrual pads on menstrual cycles and overall health of women who use them.

Procedure: To conduct the study, a gynecologist was consulted to help design a survey questionnaire to collect data from participants. Awareness of the project was raised among potential participants through various online social media channels, and participants were asked to complete the survey and provide information on the symptoms they experience during their menstrual cycle and any other relevant factors. The data was analyzed to identify any possible correlations between symptoms and the type of menstrual pad used. Results were organized and presented using statistical graphs to facilitate interpretation.

Results: The findings of the study indicated a significant difference between the physiological and psychological symptoms experienced by the participants. This supports the hypothesis that there is a connection between the type of menstrual pad used and the symptoms experienced. Further research with a larger sample size and additional resources would likely lead to more pronounced differences and increased detectability.

Conclusion: While the differences between users of biodegradable and conventional pads were not pronounced, they were still present. In specific areas, such as cycle length, the variations in symptoms were more pronounced. This supports the hypothesis that biodegradable pads are a more favorable option compared to conventional pads. These findings demonstrate the relationship between the type of menstrual pad used and the symptoms experienced by women during their menstrual cycle.

Project # **S0102** Category: **Animal Biology - Sr**

Student: **Jordan Lari** Grade: **11** G: **M**

School: **Brentwood School - Senior Division**

Title: **The effect of caffeine on high school students' cardiovascular health and their genetic makeup**

The consumption of caffeine may affect the cardiovascular health of students at a private high school. A survey gathered information on caffeine consumption among the Brentwood Upper School student body, which was used to determine how much caffeine to expose the wildtype (N2) Caenorhabditis elegans (C. elegans) to. Moreover, we are using the model organism C. elegans to determine if the cardiovascular system of nematodes would decline if they are exposed to caffeine in a proportion that mirrors the consumption of this substance by human adolescents, as indicated by changes in the oviducts of the C. elegans' offspring. Data collected over two generations will determine if the next generation can inherit cardiovascular damage from caffeine exposure in the parental strain, thus resulting in epigenetic behavior.

Project # **S0103** Category: **Animal Biology - Sr**

Student: **Katharina Zirn** Grade: **11** G: **F**

School: **Flintridge Preparatory School**

Title: **The Percent Uptake of Polyethylene After Three Trophic Levels, From Rotifera to Artemia to Medusa**

An estimated 24 trillion particles of microplastics (MPs) live alongside seaborne organisms in the ocean. A previous study successfully transferred MPs from Copepods to Ephyra and found that MPs had no effect on the organisms' behavior. In our experiment, using Fluorescent Green Polyethylene Microspheres, we tracked the transfer of MPs through three trophic levels. We fed MPs to Rotifera; 20 hours later fed the Rotifera-MP to Artemia, and 6 hours later fed the Artemia-MP to Medusa. To quantify the number of MPs, we calculated organism and MP concentrations and crushed the larger organisms, to release the MP particles into the surrounding solution. We then used an ultraviolet microscope to photograph the solutions and used ImageJ to analyze the samples. Our results indicate that MPs will successfully transfer up the food chain. There was no statistical difference between the percent uptake of total MPs in the food chain in Rotifera and Artemia; however, the percent uptake significantly decreased in Medusa. Furthermore, we indirectly found that MPs caused Rotifera-MP and Artemia-MP to die >24 hours after the ingestion of MPs. However, the Medusae were able to expel the majority of the MPs from their system after three days and continued to have normal function. These findings demonstrate that MPs: can make their way up three trophic levels, have a detrimental effect on certain organisms, and at any stage of the food chain, the MPs will make their way back into the water, allowing for the perpetuation of this MP trophic transfer cycle.

Project # **S0104** Category: **Animal Biology - Sr**

Student: **William Boyd** Grade: **11** G: **M**

School: **Flintridge Preparatory School**

Title: **Chemical Sensing in Aurelia Aurita Studied by AI-Enhanced Image Analysis: Jellyfish Can Smell**

It is believed that jellyfish are opportunistic feeders, meaning they do not actively seek prey but capture and ingest food they encounter locally. Previously, I showed that Aurelia Aurita exhibits a strong neural response (pulsation) to live food (brine shrimp). I also observed a weaker response to dilute brine shrimp essence. Jellyfish are known to respond to a tactile stimulation, and it was not clear the part of tactile stimulation or chemical sensing in their response. Furthermore, a detailed analysis of chemical sensing was prevented by the natural movement of the jellies themselves. To overcome this issue, I developed AI-enhanced image analysis software to carefully track the position of the jellies, allowing analysis of their pulsing behavior with unprecedented precision. The software, jellyfish tracking and analysis (JeTA), was programed in Python. Using JeTA, the pulsation response of Aurelia was studied before and after the introduction of a chemical olfactory stimulus, concentrated brine shrimp extract. A significant increase in pulsation activity was observed after the introduction of the chemical stimulus, and the average pulse frequency was shown to increase by 31%. Additional behavior was also observed. A rotational propagation on their bell was seen for some of the jellyfish after the introduction of the chemical stimulus, which created a temporary suction force. These results suggest that Aurelia Aurita have the capacity to chemically sense food within their immediate vicinity and are not simple opportunistic feeders.

Project # **S0105** Category: **Animal Biology - Sr**

Student: **Justin Jeong** Grade: **11** G: **M**

School: **Crescenta Valley High School**

Title: **DETERMINING THE PHYLOGENETIC POSITION OF THE SAUNDERS'S GULL**

The genus Chroicocephalus consists of eleven small-sized gull species. Despite being an ecologically important group of birds, the evolutionary relationship among its species remains unresolved. Furthermore, some scientists speculate that the Saunders's Gull may not actually be a member of Chroicocephalus. In this study, cytochrome b and ATPase 6 nucleotide sequences of 19 different shorebird species were used to create an accurate phylogenetic tree that a) displays the evolutionary relationship among Chroicocephalus species and b) shows the phylogenetic position of the Saunders's Gull. Then, molecular clock software was used to visualize the divergence times of the 19 species. The results from the phylogenetic tree showed that out of the 11 Chroicocephalus species, only ten of them were classified into a clade. As the Saunders's Gull was not included in this clade, the constructed tree proves that the Saunders's gull is not as closely related to the other Chroicocephalus species as previously thought. Moreover, results from the molecular clock software show that the clade containing the 10 chroicocephalus species appeared quite recently, with the oldest divergence within this clade occurring only 2.64 million years ago. However, the Saunders's Gull appeared 7.7 million years ago, further proving that the Saunders's Gull is not closely related to Chroicocephalus. The methods used in this project to create an accurate phylogenetic tree can also be used for studies on the evolutionary relationship between other animal families and genera, giving us a greater understanding of the biodiversity of our natural world.

Project # **S0106** Category: **Animal Biology - Sr**

Student: **Rachel Lee** Grade: **10** G: **F**

School: **Crescenta Valley High School**

Title: **Decreasing the Excretion of Microplastics in Polystyrene-Consuming Mealworms**

In 2015, the discovery of polystyrene biodegradation through the digestive system of mealworms opened up new opportunities and ideas for solving the plastic pollution crisis. However, about 50% of the consumed polystyrene is released as microplastics through the excretions of the mealworms. The production of microplastics poses a greater risk on both the environment and human health, especially with the growing amount of research proving their hazardous effects. This research focuses on the gut bacteria of the mealworm, which is responsible for the biodegradation of polystyrene. It is hypothesized that the consumption of fermented bran will diversify the gut biome of the mealworms, further degrading polystyrene and reducing it altogether in the excretions. Mealworm excretions, also known as frass, will be analyzed using a scanning electron microscope (SEM) to image the changes in texture and size of the excreted microplastics that exist within the frass. After analysis using the SEM, it can be concluded that there is a continued presence of polystyrene microplastics within the frass, regardless of the consumption of fermented bran. However, the size has decreased, indicating an effect from the fermented bran (gut-microbiome improving food) in promoting greater biodegradation of polystyrene. Though the presence of microplastics implies that the use of mealworms for the biodegradation of polystyrene is not yet a practical solution for the growing quantities of plastic waste, the decrease in size shows that it has potential in reducing the existence of microplastics in the frass altogether.

Project # **S0107** Category: **Animal Biology - Sr**

Student: **Usman Salman** Grade: **9** G: **M**

School: **Institute of Knowledge High School**

Title: **Toxic Trespass: Assessing the Impact of Copper Sulfate Pentahydrate on Marine Ecosystems**

Objective: The objective of this project is to investigate and analyze the effects of copper sulfate pentahydrate on marine ecosystems.

Procedure: A stock solution of Copper Sulfate (CuSO4) was prepared by dissolving 1g of the compound in 2L of bottled water within a 3.79L milk container. Five experimental aquatic environments were established by adding 1L of water to each plastic container and introducing different concentrations of copper ions by adding varying amounts of the stock solution. The five environments were created with the following copper ion concentrations: 0ppm (0 drops added), 0.1ppm (4 drops added), 0.2ppm (8 drops added), 0.3ppm (12 drops added), and 0.4ppm (16 drops added). Snails and duckweeds were then introduced into each container, and observations were recorded for a period of 5 days, during which the number of live snails and duckweed leaves were documented daily.

Results: Three snails and ten duckweed plants were placed in each of five aquatic environments with varying concentrations of copper ions (0.0, 0.1, 0.2, 0.3, and 0.4ppm) created by adding Copper Sulfate stock solution. After five days of observation, the highest survival rate for duckweed was in the 0.1ppm environment (16 leaves remaining) and for snails in the 0.1 and 0.2ppm environments (2 snails remaining in each).

Conclusion: The hypothesis was supported by the outcome of the experiment, as the snails and duckweed plants experienced reduced survival rates in environments with higher concentrations of copper ions.

Project # **S0108** Category: **Animal Biology - Sr**

Student: **Hannah DeMerit** Grade: **10** G: **F**

School: **Flintridge Preparatory School**

Title: **In Vivo Study of Uptake and Accumulation of Polyethylene Microplastics in Artemia and A. Aurita**

Microplastic contamination is prevalent in various food chains, specifically marine ecosystems, where they are ingested and transferred up the food chain. This experiment aims to understand the role of microplastics in trophic transfer and how it affects Artemia and Aurelia Aurita. Artemia were placed in a 11 mg/L stock solution of polyethylene microbeads and allowed to homogenize. Video and pictorial data of Artemia were taken over time to see the effects of microplastics on activity and measure the residence times of the microplastics. Batches of Artemia with microplastics were filtered to remove free microplastics in the water, and fed to Aurelia Aurita ephyra. The process of measuring residence time was repeated with the Aurelia Aurita. The results show that microplastics can be transferred up the food chain through ingestion but, fortunately, will be transferred out of the organism's system after a period of time, which are different for the Artemia (2 days) and Aurelia Aurita (7 days). Image analysis also shows that there is an increase in activity in Artemia after ingestion of microplastics compared to their activity after ingestion of microalgae food.

Project # **S0201** Category: **Animal Physiology - Sr**

Student: **Angelina Lin** Grade: **10** G: **F**

School: **Brentwood School - Senior Division**

Title: **Are all controls interchangeable? (in Caenorhabditis elegans)**

In nematology, Caenorhabditis elegans (C. elegans) adopted a new strain as wildtype identified as PD1074, comparable to the original wildtype strain N2. Upon further literature investigation, no individual compared these two wild-type strains. This investigation identifies if the two strains, N2 and PD1074, are truly interchangeable as wild-type strains. The stains will undergo the following assays: longevity, metabolism, movement, and stimuli behaviors. Comparing these two wild-type strains will determine if scientists need to readjust their conclusions about C.elegans as they may not be interchangeable as previously assumed.

Project # **S0202** Category: **Animal Physiology - Sr**

Student: **Ashley Viveros** Grade: **10** G: **F**

School: **Discovery Charter Preparatory High School**

Title: **Lifespan Abbreviation Induced by Caffeine in Worms**

It is interesting to see how many energy drinks one can find in any food store. Do people think twice before buying and putting them in their bodies? The nutritional value, printed on the drinks, give the consumer what is inside the drink, but they do not elaborate on their harmful effects. An experiment was conducted to find the effects of caffeinated-energy drinks on worms and if the amount of caffeine in a drink would lead to different levels of harmful results. If caffeinated drinks hurt warms, those negative effects can also harm humans. This experiment was conducted on worms because it is easier to see the immediate effects on warms than on human subjects. In this experiment, six groups of 3 worms were put into a container filled with soil to be monitored. Of the six groups, one was set aside as the control group.
The other five groups were put into separate containers. Every other day each group (not including the control group) would be submerged in a different drink for thirty seconds. These drinks included Pure Leaf branded green tea, brewed coffee, classic Rockstar Energy Drink, Classic Monster Energy, and classic Red Bull Energy drinks. This experiment was conducted for two weeks. Both the Rockstar Energy group and the coffee group worms died during this time. However, the worms treated with Rockstar Energy perished first. Pure Leaf green tea, Classic Monster Energy, and Red Bull affected the worms by making them hyperactive, but they were not lethal.

Project # **S0203** Category: **Animal Physiology - Sr**

Student: **Nathaniel Madrid** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **Creating a Functioning Model of two Human Kidneys**

This project was designed to discover whether or not an efficient model of the human kidneys could be created using everyday materials. For this project, a working model of the human kidneys was constructed using coffee filters, modeling clay, two plastic water bottles as the kidneys, plastic tubing as the ureters, a funnel as the bladder, and a coffee grounds, and water solution as the toxins/waste . Tests of model efficiency were run by increasing the amount of coffee grounds in the solution with every test. In result, the solution became more and more yellow colored with each test, making sense as to a real human kidney. Less hydration equals darker urine. The hypothesis that the solution would become darker and darker with every test was strongly supported by the results. But even then, it may be more informative to make a more complex and accurate model, or perhaps using real STEM cells to see how it may affect the efficiency of the kidneys.

Project # **S0204** Category: **Animal Physiology - Sr**

Student: **Zimo Chen** Grade: **10** G: **M**

School: **Walnut High School**

Title: **Meta-Analysis on the Effects of Diet on Diabetes**

The purpose of this meta-analysis is to look into the effect of nutrition on diabetes control. To assess the impact of various diets, such as low-carbohydrate, low-fat, Mediterranean, and high-protein diets on diabetes, data from numerous research studies were synthesized. The findings revealed that a low-carb diet significantly reduced hemoglobin A1C levels, whereas a Mediterranean diet improved lipid profiles and weight loss. It has also been demonstrated that high-protein diets lower hemoglobin A1C levels, though further research is required to confirm these results. In conclusion, this meta-analysis investigates and contrasts various diets and how they impact diabetes treatment.

Project # **S0205** Category: **Animal Physiology - Sr**

Student: **Hania Kashif** Grade: **10** G: **F**

School: **Institute of Knowledge High School**

Title: **The Clairvoyants: Examining the Influence of Age on Brain Waves and Mental Prediction**

Objective: This study examines the effect of age on brain wave patterns related to mind reading and brain activity prediction. It was hypothesized that brain wave patterns will become increasingly complex with age, potentially resulting in decreased accuracy in thought prediction.

Procedure: Participants (ranging in age from 10 to 80) were recruited and the EEG machine was set up and connected to the software. Participants were first instructed to alternately open and close their eyes, serving as a control condition. Then, they were presented with a series of images and asked to recall any associated thoughts. EEG recordings were made. After the imaging task, the participants were asked to recall as many images as possible and these results were recorded. The recorded EEG data was analyzed to predict the thoughts of the participants while they were viewing the images, based on their previous EEG recordings during the imaging task.

Results: The results showed that the young participants had an average recall of 7 images, while the middle-aged participants had an average recall of 8 images. The older participants had the lowest average recall of 5 images.

Conclusion: Ultimately, the results support the hypothesis that as individuals age, their cognitive functions decline, as evidenced by their reduced ability to recall images. The EEG predictions also reflected this trend, with the older participants having the lowest accuracy in thought prediction. These findings suggest that age should be considered as a factor in future experiments and applications to ensure consistency in results.

Project # **S0206** Category: **Animal Physiology - Sr**

Student: **Benjamin Woodward** Grade: **12** G: **M**

School: **Brentwood School - Senior Division**

Title: **Nematodes Dopamine Rush - The Effect of Different Concentrations of Glucose on Caenorhabditis elegans**

Is there a relationship between glucose consumption and attention-deficit hyperactivity disorder (ADHD) in young children? We are examining varying glucose concentrations on dopaminergic activity in the Caenorhabditis elegans (C. elegans) model organism. Egls-1 mutants express a green fluorescent protein (GFP) in the DA neurons (ADE and CEP) and are used to observe GFP expression changes resulting from glucose-enriched diets. Behavioral assays are also conducted to determine if glucose directly impacts the nematodes' behavior. Our study hypothesizes that increased glucose consumption will decrease dopamine signaling and lead to increased hyperactive behavior in C. elegans, potentially suggesting a link between glucose consumption and ADHD in children.

Project # **S0207** Category: **Animal Physiology - Sr**

Student: **Jonathan Chen** Grade: **9** G: **M**

School: **Diamond Bar High School**

Title: **The Effects of Plant-Based Diet on Prostate Cancer**

How can a plant-based diet affect prostate cancer? The most common cancer for males is prostate cancer, so finding a method to prevent or even cure it would be a life-saving event. It is not as simple as doing some tests, as there have been numerous studies regarding this. If someone switches from a regular diet to a vegetarian diet, then they will have a decrease in the chance of getting prostate cancer. To see if these two events have a correlation, first, data articles and analysis are collected. Then, they were looked over for any key information such as control and treatment groups with a vegetarian diet being the variable being tested.

After obtaining the useful information, the total number of human subjects for the 2 groups, one with a regular diet and one with a vegetarian diet, was noted. Also, the number of prostate cancer cases per group was noted. Then, calculations were made to find out the rate at which the human subjects were getting prostate cancer for both groups.

Then, it must be determined whether the difference in the rates between the 2 groups is statistically significant. Through a chi-squared calculation, it is determined that the p-value is less than 0.05, and therefore the difference in the rates between the 2 groups is statistically significant.

Based on the data collected and the statistical analysis performed, it can be concluded that a plant-based diet has significant effects on decreasing the chance of getting prostate cancer.

Project # **S0208** Category: **Animal Physiology - Sr**

Student: **Annika Gruettemann** Grade: **10** G: **F**

School: **Palos Verdes High School**

Title: **Examining Mytilus edulis' Filtration Capabilities Against Microplastics**

One of the many issues plaguing the world’s oceans today is pollution via microplastics, small, broken-down plastic particles less than five millimeters in size that are ingested by marine organisms and to an extent, humans. In past experiments, both marine and freshwater mussels have been utilized to remove excess sediments, toxins, and bacteria from large bodies of water. My experiment’s goal was to investigate the marine mussel Mytilus edulis’ abilities to filter out three specific sizes of particles to best determine the effectiveness of using them as natural filters against microplastics.
In this experiment, three small tanks were set up to house the mussels, filled halfway with aquarium seawater. 100 pieces of three biodegradable glitter types with sizes of 0.5, 1.5, and 2.3 millimeters were placed in each tank, along with one mussel each, in trials of 1, 12, and 24 hours. Additional measures were taken to ensure the well-being of the mussels at all stages of experimentation, including manually aerating the water and storing them correctly in the refrigerator.
Combining the data collected over nine trials, the mussels filtered a total of 142 pieces of 0.5 mm glitter, 68 pieces of 1.5 mm glitter, and 47 pieces of 2.3 mm glitter.
As depicted by the data, Mytilus edulis are most efficient in intaking smaller particles. If retested and expanded upon in the future, this data may have future applications when considering a natural, effective way of cleansing the ocean of harmful microplastics.

Project # **S0209** Category: **Animal Physiology - Sr**

Student: **Manon Iwata** Grade: **9** G: **F**

School: **Westridge School for Girls**

Title: **Effect of Paeonia Lactiflora Pall (White Peony) Roots on the Alleviation in Primary Dysmenorrhea**

Abstract (Limit: 250 words): Paeonia Lactiflora Pall (white peony) roots are a traditional herbal remedy with multiple medicinal benefits, for example: treating ailments and suppressing inflammatory disorders. The aim of this study was to determine the effects of white peony roots on pain relief in primary dysmenorrhea. This study was a double-blind randomized trial. The sample size included 100 subjects with primary dysmenorrhea. Subjects were randomly assigned to two equal groups, one for the Paeonia Lactiflora Pall root tea and the other for the placebo. The white peony root tea or placebo was given on the second and third day of the subjects' menstrual cycle. The severity of pain was assessed with a Visual Analog scale before and after the intake of the placebo or tea. The white peony root tea included 1 gram of Paeonia Lactiflora Pall root powder tea bag infused with 236 grams of water and a tablespoon of honey for 5 minutes. The placebo was 1 tablespoon of honey infused with 236 grams of water. Both the placebo and tea were premeasured beforehand. The study's results demonstrated statistically significant differences in the severity of pain between the two groups. T-test P-value: <0.05. Therefore, this study proves my hypothesis that the treatment of Paeonia Lactiflora Pall roots for females with Primary Dysmenorrhea had a significant effect on relieving the intensity of pain.

Project # **S0210** Category: **Animal Physiology - Sr**

Student: **Petrina Ong** Grade: **11** G: **F**

School: **The Webb Schools**

Title: **Effect of Neurotransmitters on Planarian Flatworm Regeneration**

My goal in this project was to investigate the regenerative capacities of planarian flatworm Dugesia Dorotocephala in the presence of two neurotransmitters, serotonin, and melatonin, to determine the effectiveness of these drugs on cell proliferation, growth, and regeneration. To identify the most effective neurotransmitter, I divided my experimental procedures into three main sections: 1) growing uncut and cut planaria in control, serotonin, and melatonin conditions and extracting proteins; 2) growing cut planaria in control and 0.0001M of serotonin conditions and extracting proteins; 3) growing uncut planaria in control and 0.0001M of serotonin conditions and extracting proteins. Results revealed that growing planaria in 0.0001M of serotonin solution yielded promising effects on regeneration, particularly in the formation of head and eyes; however, overall insignificant differences were observed in the regeneration rate of cut heads and tails between control groups and 0.0001M serotonin groups when analyzed under a 95% confidence interval. Furthermore, results reveal the lethal doses of serotonin and melatonin and changes in protein expression in response to 0.0001M of serotonin. In conclusion, my hypothesis that serotonin would increase the rate of regeneration in planaria, and that melatonin would hinder the rate of regeneration in planaria was somewhat supported by the results; even though melatonin did obstruct planaria growth, the direct effect of serotonin on planaria regeneration yielded inconclusive results and further research will need to determine its effect. Next time, it would be interesting to focus on the role of serotonin in the formation of eyes in Dugesia Dorotocephala.

Project # **S0211** Category: **Animal Physiology - Sr**

Student: **Lauren Cheng** Grade: **9** G: **F**

School: **Diamond Bar High School**

Title: **A Path to Scientific Discovery: The Interconnections Between a Plant-Based Diet and Stroke**

As stroke is the 2nd leading cause of death worldwide, its impact on humanity is profound. To be able to effectively lower the risks and even prevent stroke will save countless lives and further deepen the medical field's understanding of this health condition. Current studies have shown a strong correlation between plant-based diets and lower occurrences of stroke. A metal-analysis is done to analyze data from a series of original research papers which contributes to the extensive scientific literature on the effects a plant-based diet has on stroke. Each article is thoroughly studied, and only research that incorporates data on the rates of stroke among subjects who had plant-based diets versus those who had non-based plant diets containing meat, fish, eggs, and dairy are selected.

From the data collected and calculated, It was determined that the rate of stroke for people on a plant-based diet is twenty percent lower in contrast to people on a non-based diet.

The difference between the two rates are notably distinct. A null hypothesis is created, expressing the idea that there is no statistical difference between the rates of those who are and are not involved in a plant-based diet. A chi-square test is performed, presenting mathematical calculations which support that the p value is less than 0.05. Hence, the null hypothesis is rejected.

Based on the extensive analysis of scientific data regarding the relation between non-plant-based diet and plant-based diet, it is concluded that plant-based diets greatly contribute to lower rates of stroke.

Project # **S0212** Category: **Animal Physiology - Sr**

Student: **Javeria Kashif** Grade: **9** G: **F**

School: **Institute of Knowledge High School**

Title: **Robo Roach to the Rescue! Evaluating the Efficiency and Viability of Integrating Blaberus discoidalis and Technology in Rescue Operations**

Objective: The objective of this study is to assess the feasibility and effectiveness of using Blaberus Discoidalis in combination with technology as a tool to improve rescue operations during natural disasters.

Procedure: Cockroach #1 and #2 underwent surgery with electrodes inserted into their antennas and a "backpack" attached. Cockroach #1 was anesthetized for 6 minutes, with a 12-hour recovery time, while Cockroach #2 was anesthetized for 4 minutes with an 8-hour recovery. Both cockroaches' behavior in enclosed and open spaces was recorded and stimulation time was measured.

Results: The results showed a disparity in stimulation time between Cockroach #1 and Cockroach #2. Cockroach #1 displayed slow and cautious behavior in enclosed spaces but displayed fast and efficient behavior in open spaces. Conversely, Cockroach #2 demonstrated fast and efficient behavior in both enclosed and open spaces. Additionally, Cockroach #1 had a longer recovery time and spent more time in anesthesia water (6 minutes) compared to Cockroach #2 (4 minutes).

Conclusion: In conclusion, the hypothesis that a cyborg Blaberus Discoidalis could be a successful tool for enhancing rescue operations during natural disasters was supported by the results of the study. The findings showed a 3-day increase in stimulation time and a shorter time required to perform the entire surgical process, indicating the overall success of the cyborg Blaberus Discoidalis in this context. These results suggest that incorporating Blaberus Discoidalis with technology could lead to improved and more efficient rescue efforts during natural disasters.

Project # **S0213** Category: **Animal Physiology - Sr**

Student: **Ty Sorenson** Grade: **11** G: **M**

School: **Palos Verdes High School**

Title: **Emitting Sound Frequencies to Repel Euwallacea nr. fornicatus**

Invasive shot hole borers are very destructive to many tree species in California, including avocado trees, as they cause fusarium dieback. Over 90% of US produced avocados are grown in California, and protecting this industry is very important to our economy. Currently there are no control measures for ISHB, as insecticides are generally ineffective and only early detection of infestation helps reduce their population. Not only does the loss of product harm the environment and economy, but the loss of other trees due to ISHB-FD would be catastrophic. In an optimistic scenario, it is estimated the removal and replacement of ISHB-FD would cost $15.9 billion. Our hypothesis is that vibrations from certain sound frequencies would repel Euwallacea nr. Fornicatus and protect trees.
We used confused flour beetles and bean beetles in replacement of shot hole borers and put 20 of each type in their own glass terrarium. We studied their behavior before any sounds were played. We had a bluetooth speaker against the glass terrarium to optimize the vibrations felt and studied the reactions of the beetles at different frequencies, allowing them to return to normal activity before playing the following sound, but always between 40-50dB.
Both types of beetles' behavior is affected by vibrations sent out from frequencies between 60-1000Hz. Normal behavior continued when sound frequencies over 1000 Hz were played.
The change in behavior of bean beetles and confused flour beetles shows there is potential for a certain sound frequency to cause a state of retreat in ISHB.

Project # **S0214** Category: **Animal Physiology - Sr**

Student: **Justin Kung** Grade: **11** G: **M**

School: **Diamond Bar High School**

Title: **"Planting the Seeds of Prevention: The Impact of Plant-Based Diets on Diabetes Incidence"**

As diabetes is a leading cause of death, finding a way to prevent diabetes will save many lives.

Recently, plant-based diet has been shown to correlate with a lower incidence of diabetes. To test the hypothesis that plant-based diet decreases diabetes risk, an analysis is performed that combines the data from several original research articles. First, an extensive literature search yielded a large number of articles pertaining to the effects of diet on diabetes. Then, each article was carefully studied, and only articles that divided subjects into plant-based and non-plant-based groups and contain the number of subjects who developed diabetes during the research period are retained for analysis.

From this pool of data, the rate of subjects on a plant-based diet and the rate of subjects on a non-plant-based diet who developed diabetes are calculated. It was determined that the rate of diabetes for people on a non-plant-based diet is almost twice as high as the rate of diabetes for people on a plant-based diet.

Finally, the difference between the two rates is determined to be statistically significant. A null hypothesis is created stating that there is no statistical difference between the rates of diabetes of subjects on plant-based diets and those on non-plant-based diets. A chi-square calculation is performed to show that the p-value is less than 0.005, and therefore the null hypothesis is rejected.

Based on the analysis of the data, it is concluded that a plant-based diet does indeed contribute to a lower rate of diabetes.

Project # **S0301** Category: **Behavioral/Social Sciences - Sr**

Student: **Zeena Hajhamid** Grade: **9** G: **F**

School: **Institute of Knowledge High School**

Title: **Just Beat It: Examining the Gender Gap in Math-Induced Stress and Heart Rate Responses**

Objective: The objective of this study was to explore the differences in anxiety levels and physiological responses among different cis-gender groups during a standardized test.

Procedure: The study commenced by recruiting participants and obtaining their informed consent. The participants then completed a 4th grade level test while their heart rates were monitored one hour prior to the test, 5 minutes before the test, halfway through the test, and upon completion of the test.

Results: The results indicated that 7th-grade cisgender males achieved the highest scores in terms of timing, performance, HAM-A scale, and heart rate. On the other hand, 10th grade cisgender females demonstrated the lowest scores in these categories. During the experiment, 10th grade cisgender males displayed the lowest heart rate, while 7th grade cisgender females exhibited the highest heart rate.

Conclusion: This supports the hypothesis that higher levels of anxiety and cortisol during tests may result in higher heart rates, particularly among cis-female participants. These findings provide valuable insights into the potential factors contributing to differences in performance and heart rate among different cis-gender groups during tests.

Project # **S0302** Category: **Behavioral/Social Sciences - Sr**

Student: **Gabriel Morales** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **Big City Rats**

A rat maze was used as a psychological experiment where a city environment was simulated for the rats to determine the time it took for them to solve the maze and if a group setting would result in a faster solution compared to individuals, with the aim of assessing their ability to communicate effectively under stress. The hypothesis based on the conducted research would be the rats solving the maze in a group would be significantly faster than an individual rat. In the experiment, the rats were tested in groups of three, and alone, for five separate trials and their time(s) to complete the maze were recorded. The maze's exterior was constructed using wood, while cardboard was used for the interior to reduce expenses. The experiment was carried out in a darkened room with illuminated walls meant to imitate bright buildings in a bustling city.

Project # **S0303** Category: **Behavioral/Social Sciences - Sr**

Student: **Ashley Deng** Grade: **12** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **Modeling Depression and Antidepressant Treatment Accurately in Drosophila Melanogaster**

Over half of 37 million antidepressant users experience side effects that influence long-term antidepressant efficacy. However, their biological causes are still mostly unknown. By using animal models, these causes can be more effectively explored.

In particular, drosophila melanogaster, or the fruit fly, is lauded for its utility in studying human depression. Despite this, simulation of depression and antidepressant treatment in drosophila is minimally studied compared to its counterpart in mice. To close this gap, this research explored two methods of drosophila simulation: using food deprivation and sucrose treatment to mimic depression and antidepressant treatment, respectively. High/low locomotor activity was examined as a standard for non-depressed/depressed behavior.

This study used the Drosophila Activity Monitoring System (DAMS) to observe locomotor activity of 4 red-eyed wild-type adult flies through photobeam breaks. Flies were monitored through 3 stages: 1) baseline; 2) food deprivation; and 3) sucrose treatment (standard food mixed with 5% sucrose solution). All activity was analyzed using the DAMSystem3 Software in 3 categories: Rest (Rt), Position (Pn), and Counts Total (CT), with a Bin Time of 5 minutes.

Experimental results showed that food deprivation was not a successful simulation of depression; it increased locomotor activity rather than decreased. Similarly, while sucrose treatment succeeded in increasing activity, its immediate efficacy compared to slow-acting antidepressants disputes its validity in mimicking antidepressant response. Results also yielded uncertainty regarding locomotor activity as a behavioral standard.

Future studies should explore sucrose through the GAL-4/UAS system. If further developed, antidepressant drosophila studies could advance beyond basic testing into studying biological pathways.

Project # **S0304** Category: **Behavioral/Social Sciences - Sr**

Student: **Naomi Kao** Grade: **12** G: **F**

School: **Palos Verdes High School**

Title: **The Effect of a Simulation Game on Students' Handwashing Knowledge and Skills**

Although the spread of disease is neverending, many people lack knowledge of handwashing - the simplest method of protection from contracting illnesses - which may be due to the plethora of inaccurate sources on online platforms. But what if people were given the right information? The objective of this research project is to evaluate how effective a method of sharing correct handwashing knowledge is in improving elementary student’s public health. My hypothesis is that playing a handwashing simulation game will increase the number of proper steps 2nd grade students use when washing their hands.

A group of 21 student participants was used for this project. Using a fluorescent gel (to represent bacteria on the hands pre-wash) and a UV light box (to take fluorescence displaying pictures), a total of eight pictures were taken of each student’s hands - (1)Pre-Wash/Pre-Game, (2)Post-Wash/Pre-Game, (3)Pre-Wash/Post-Game, and (4)Post-Wash/Post-Game - (front and back). Between steps 1&2 and 3&4, students were recorded washing their hands for later analysis. And between steps 2&3, students played Bubble Beats, a handwashing simulation game, on Chromebooks for ~15 minutes. After experimentation, students were asked to fill out an online Google Form to evaluate their learning experience.

The results showed that on average, students improved their handwashing skills by +2.15 of the 18 World Health Organization steps after training with Bubble Beats.

This research provides essential knowledge to the public health sector through demonstrating that a handwashing simulation game can significantly improve student's handwashing.

Project # **S0305** Category: **Behavioral/Social Sciences - Sr**

Student: **Kimberly Liang** Grade: **10** G: **F**

School: **Diamond Bar High School**

Title: **Quantifying Happiness**

Happiness is one of the most elusive concepts. Most people respond that happiness is something they hope to achieve in their lifetimes, but the idea of happiness has become a catch-all for perceived success and contentment. However, the concept of happiness is somewhat abstract, with different definitions based on who you ask. In this project, I attempt to quantify happiness. Instead of using mechanical approaches such as measuring dopamine levels, I instead chose to examine happiness through a more sociology-based perspective, where I start by defining happiness as some function of reality minus expectations. That is happiness = f(reality - expectations). Using a survey based approach, I was able to show that there is a strong relationship between happiness and (reality - expectations), and that this relationship is somewhat linear in nature.

Project # **S0306** Category: **Behavioral/Social Sciences - Sr**

Student: **Rana Kapadia** Grade: **11** G: **M**

School: **Da Vinci Science High School**

Title: **Public Health Awareness Survey**

GOAL: The objective was to assess and gather data on the community's knowledge of diseases commonly vaccinated against in the USA: Measles, Mumps, Rubella, Polio, Varicella, Tetanus, Diphtheria, and Pertussis via a survey. The hypothesis was that 5/10 people in California would be unaware and uninformed about the diseases.

METHODS: The Google Forms survey was reviewed with healthcare specialists and pretested(n=10). Anonymous data was collected remotely online from January 22-February 2, 2023.

RESULTS: 308 people completed the 5 min survey. 64% were from California. Questions were grouped for each disease. Likert scale questions were reliable with Cronbach alpha Knowledge(.91) and Concern(.95). 76% reported having access to their vaccine records; however, 50% who answered "yes" to being immunized against measles reported "don't know" about being vaccinated against Rubella, even though the MMR vaccine provides immunity for both. For ages 15-30, 61% inconsistently reported being vaccinated for Tetanus, Diphtheria, or Pertussis, besides being a combined vaccine(Tdap). The correlation coefficient was low at 0.324 for knowledge of diseases vs. outbreaks. Participants were unaware of the outbreaks of Measles(51%), Mumps(87%), and Pertussis(96%), despite recent 2019 USA outbreaks of all three. There was also a lack of transmission knowledge for Measles(45%), Mumps(61%), and Pertussis(49%).

CONCLUSION: The data supports the hypothesis that there are significant gaps in knowledge of immunization status, outbreaks, and transmission. By identifying these gaps, educational tools like an app can be developed to improve awareness of the diseases surveyed.

Project # **S0307** Category: **Behavioral/Social Sciences - Sr**

Student: **Grace Cha** Grade: **11** G: **F**

School: **National Youth Community Center**

Title: **Effects of Magnesium on Fruit Fly Memory**

Drosophila Melanogaster, the common fruit fly, exhibits a form of orientation memory. Memory is retained for an average of four seconds for simple tasks. However, the memory capacity of Drosophila can be altered using a monosaccharide commonly found in diets, sugar. Sugar has an addictive quality, releasing levels of opioids and dopamine, a neurotransmitter that plays a role in the “reward circuit”. Drosophila sustained off of a high-sugar diet experienced an alteration in their taste cells, creating a molecular memory. In this experiment, the long-term and appetitive immediate memory of Drosophila was tested through an olfactory memory test composed of discs soaked with a sugar and 1% agar water solution. Each disc was placed on different ends of a T-shaped tube. All Drosophila a part of the experiment were starved for 24 hours prior to the training. Each was given the opportunity to choose their own tube path for different discs. Once the Drosophila successfully chose a disc and fed on the solution, all flies were starved for the same 24 hour period before being exposed to the same environment. However, the location of the discs were swapped from the previous positions of the first training in order to test the long-term memory of the same Drosophila. If the Drosophila are starved for a 24 hour period, then the addictive memory enhancing qualities of sugar will have a stronger effect, causing the Drosophila to memorize the sugar disc better than the water disc.

Project # **S0308** Category: **Behavioral/Social Sciences - Sr**

Student: **Chloe Chen** Grade: **9** G: **F**

School: **Brentwood School - Senior Division**

Title: **The Power of Music: Do frequencies impact nematodes with dementia?**

The proposed study uses nematodes (Caenorhabditis elegans, C. elegans) and frequency therapy as a potential treatment for Alzheimer's disease. The mutant strain Smg-1, which exhibits deficits in thermotaxis memory (used to represent an Alzheimer's patient), will be used in this study. The goal is to slow the progression of dementia, particularly Alzheimer's, in the cerebrum by using C. elegans as a model organism due to the similarity of its nervous system components to those in mammals. The study will involve exposing C. elegans hermaphrodites and the Smg-1 mutant strain to frequencies (2s, 1kHz, 80dB SPL) to observe changes in the phenotypes associated with dementia and potentially extend the sense of self and connections to loved ones. If the analysis yields positive results, the findings may have significant implications for the treatment of dementia.

Project # **S0309** Category: **Behavioral/Social Sciences - Sr**

Student: **Yaduo Zhang** Grade: **10** G: **F**

School: **Diamond Bar High School**

Title: **The Relative Importance of Nature and Nurture**

Personality traits include extroversion/introversion, sociability/shyness, openness/closeness, and many others. In our research, we are trying to determine the relative importance of genetic and environmental influences on personality traits. Our hypothesis is that personality traits are mainly shaped by genes rather than the environment.

The most promising research methodology in determining the relative importance of nature and nurture in shaping personality traits is twin studies. Comparing monozygotic twins and dizygotic twins can allow us to assess the importance of genes since monozygotic twins are genetically identical whereas dizygotic twins are only 50% related. Comparing monozygotic twins reared together and reared apart can allow us to determine the relative influence of different environments.

An extensive literature search is performed to look for original research articles on twin studies of personality traits. Only those articles that compare monozygotic twins and dizygotic twins, or that compare monozygotic twins reared together and reared apart, are retained for our analysis. A meta-analysis is performed on the combined data from these original research articles to arrive at a more valid and more widely applicable conclusion.

In our analysis, we found that monozygotic twins have high correlations in their personality traits regardless of whether they were raised together or apart, whereas dizygotic twins have much lower correlations regardless of whether they were raised together or apart. Furthermore, monozygotic twins raised together and apart have almost equally high correlations. These findings support our hypothesis that the genetic influence is greater than environmental influence in shaping personality traits.

Project # **S0310** Category: **Behavioral/Social Sciences - Sr**

Student: **Meera Mahidhara** Grade: **12** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Less Stress for the Homeless**

Homelessness in Los Angeles is a continually pervasive problem that affects a multitude of communities and families. Mental health is one of the three main reasons for eventual homelessness. This study aims to test whether HomeScreens, a local nonprofit that provides base-line mental health screening tests, can effectively screen and encourage subsequent therapy treatment to those who take the test. Ten tests were administered at three different locations of a pre-existing drop-in center, Hope of the Valley; Tyrone Avenue in Van Nuys, Sherman Way in Sherman Oaks, and Trebek in Northridge. Five volunteers were in charge of test-distribution and thirty-two people took the test. Tests were screened for anxiety disorders, and takers were given two therapy resources. A HomeScreens volunteer scheduled an appointment for the test-taker a week later. On average, more than half of test-takers were eligible for resources concerning an anxiety disorder, but less than half of them followed through with their appointments. Those who took tests at the Sherman Way center were more likely to find resources than the other two locations where less than 20% of eligible test-takers sought resources. The data concluded did not support my hypothesis since I thought there would be higher turnout from the Tyrone Center. I've realized how I need to improve HomeScreens' tests and subsequent methods so that there are more accessible and local resources for test-takers. Being able to administer resources at shelters or centers that are accessible is integral to provide sustainable therapy.

Project # **S0311** Category: **Behavioral/Social Sciences - Sr**

Student: **Hannah Cho** Grade: **12** G: **F**

School: **North Hollywood Senior High School**

Title: **Cortical Thicknesses of the Insula and Prefrontal Regions Are Significantly Correlated with Social-Emotional Processing**

The insula in cooperation with frontal cortices is known to be associated with the monitoring and regulation of internal body states and this information, in turn, is important for the subjective feeling of emotions, emotion regulation, and empathy (Uddin et al., 2017). This study explores correlations found between the use of emotion processing words when making sense of a complex emotional video and the cortical thicknesses of the insular cortex and frontal areas. Forty educators, ranging from 26 to 57 years of age ($M = 36.6$, $SD = 8.8$) in California who regularly exhibited strong social-emotional connection with students and utilized it in curriculum, underwent an MRI scan, followed by administration of the Wechsler Abbreviated Scale of Intelligence (WASI-II), and reflective interview after viewing a short video depicting an adolescent's educational growth through adversity. Interview transcripts were evaluated with the Linguistic Inquiry and Word Count (LIWC) analysis platform for the use of cognitive processing words and social processing words. Correlation between cortical thickness, IQ, age, and LIWC values were visualized and analyzed through Freesurfer, a brain imaging software. The thickness of the insular cortex was negatively correlated with age at $r(30)=-.52$, $p<.01$, social processing words at $r(30)=-0.64$, $p<.001$, and positively correlated with cognitive processing words, $r(30)=0.42$, $p<.05$. Additionally, anterior regions of the frontal lobe and the precentral gyrus showed similar correlations, regions associated with emotion regulation and empathy respectively. It is theorized that experience leads to a refinement of processing in these regions which is accompanied by synaptic pruning, thus decreasing cortical thickness. This knowledge further develops our knowledge of the relationship between the brain and emotion, and can be used in affective neuroscience, to understand how educators, people who are involved in heavy cognitive and social processing daily, are affected by their own teaching methodology and principles, before they enforce such practices on students.

Project # **S0312** Category: **Behavioral/Social Sciences - Sr**

Student: **Kaitlyn Sulivan-Pascual** Grade: **11** G: **F**

School: **Flintridge Preparatory School**

Title: **How the Placebo Effect Alters Cognitive Performance**

Prior research has been done to test how the placebo effect, a psychological phenomenon, could impact a student's cognitive, academic, and test-taking performance. The placebo effect is the effect caused by a fake drug or treatment and is contingent on a patient's expectancy and belief in the treatment. Placebos have mostly been used in a medical context to stimulate positive physical responses, but they do not have to be tangible substances. In a study by Weger, U. W., & Loughnan, S., it was found that the placebo effect can change the way students perform academically merely because they have established in their brain that a certain stimuli will help them succeed ("Using the placebo concept to enhance cognitive performance," 2013).

For the experiment, high school students ages 12-17 took a 6-minute general knowledge test. Before administering the test, I used bogus priming on one test group and asserted the false notion that the test would draw upon and assess strong skills and understanding in the subject math. I predicted results would be higher for those who identified as more confident in math because their primed expectancy would stimulate a positive response on their cognitive performance on the test. The results contribute to further research and discoveries that can be shared to benefit students in their academic journeys.

Project # **S0313** Category: **Behavioral/Social Sciences - Sr**

Student: **Sara Moshfeghi** Grade: **11** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **Combating the Spread of Deepfake Videos with Labels**

Deepfake videos are the latest frontier on misinformation. One approach to combating these is to label fake videos with warnings. It is, however, currently not possible to detect all fake videos. This project assessed how three video labeling methods affect the perception of the videos.

A group of 167 survey volunteers were recruited to rate 24 videos as real or fake, 12 of which were fake face-swap videos. Each volunteer was randomly assigned to one of four surveys. Survey 1 was the control with no video labels. Survey 2 had fake warning labels on half the fake videos. Survey 3 had fake warning labels on half the fake videos and verified labels on half the real videos. Survey 4 had the same labels as survey 3 but also added unverified labels on all the remaining unverified videos.

A staggering 50% of volunteers in control survey 1 on average rated the fake videos as real. This perception inaccuracy was not correlated with age, gender, education level, or social media familiarity. The most accurate perception results were obtained with survey 4's labeling, where believability of fake videos with fake labels and unverified labels were on average reduced by 19% and 6% respectively, but believability of real videos with verified labels and unverified labels were on average increased by 8% and 10% respectively.

These results suggest that social media platforms can slow the spread of fake video misinformation by labeling checked fake videos, checked real videos, and unchecked videos.

Project # **S0401** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Mariyah Ahmed** Grade: **9** G: **F**

School: **Institute of Knowledge High School**

Title: **That's a Wrap! Investigating Plastic Wrap Brands to Determine their Effectiveness in Preventing Oxidation**

Objective: The goal of this project is to determine which brand is most effective in preventing oxidation.

Procedure: The project began by selecting three brands of plastic wrap for testing: Great Value plastic wrap, Glad cling wrap, and Reynolds plastic wrap. Three avocados and three apples were each cut into four pieces. A piece of each fruit was covered with a different brand of plastic wrap and placed in a bowl. The covered fruit was left for 8 hours and then the level of browning was measured using a color scale. The color scale was placed next to the fruit for comparison. The process was repeated for the avocado and was conducted three times in total to ensure accuracy of the results.

Results: Upon collecting and analyzing the data, it was found that the slices wrapped in Great Value plastic wrap had the most discoloration. On the other hand, the slices wrapped in Reynolds and Glad wrap were in better condition, with the Glad wrap appearing to be the most effective in preventing oxidation.

Conclusion: The hypothesis was supported by the results, as Glad wrap was found to be the most effective in preventing oxidation. This was because oxidation requires the presence of oxygen, and Glad wrap was able to do this. On the other hand, the other brands, Great Value and Reynolds, were less effective in preventing oxygen from reaching the fruit and therefore did not prevent oxidation as well as Glad did.

Project # **S0402** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Anna Peti-Peterdi** Grade: **11** G: **F**

School: **Palos Verdes High School**

Title: **The Development of the C2F Seawater to Freshwater Converting Bioplant**

Recent changes in climate, increased energy production, overpopulation, and inadequate water use and infrastructure led to freshwater shortage globally. There is an urgent need to develop new technology to produce freshwater due to the inadequacy of currently used methods. Biomimicry is a method which can use ideas found in nature to create long-term, eco-friendly, and sustainable solutions to human challenges. Key ideas from salt transporting organs such as the kidney and the fish gill may be used to remove salt from a solution thus converting seawater into freshwater. In this study we addressed the hypothesis that fish gill cells grown in a filter scaffold system can be used to develop a seawater-to-freshwater (C2F) converting bioplant prototype. We aimed to demonstrate proof of principle that the C2F bioplant can reduce NaCl concentration ([NaCl]) of seawater test solution (3.6% [NaCl]).
RTgill-W1 fish gill cells grown on permeable support in a transwell culturing system were used to form a confluent cell monolayer. Fluorescence microscopy with a green sodium sensitive fluorescent dye CoroNA was used to measure changes in [NaCl] of the luminal fluid compartment.
Our C2F prototype significantly reduced [NaCl] in the luminal compartment from 3.6% to 0.3% in 45 minutes ($n=4$, $p<0.0001$). The integrity of the cell monolayer was preserved throughout the experiment confirmed by confocal fluorescence microscopy.
In conclusion, our study provided proof of concept that cell-based strategies can be used to efficiently convert seawater to freshwater. Our C2F prototype may be further developed to build eco-friendly and sustainable solutions to our global fresh water problem.

Project # **S0403** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Danny Wang** Grade: **10** G: **M**

School: **The Webb Schools**

Title: **Pinpointing Drug Targets on Influenza by Analyzing RNA Sequencing Data**

Human influenza remains a serious public health problem. This research project aimed to pinpoint suitable cellular drug targets that could effectively treat influenza by analyzing RNA sequencing data and drug screening data. Raw data of RNA-Seq included four cell types. Human lung fibroblasts (MRC-5, WI-38 VA -13) and epithelial cell (A549) acted as representatives of infected cell lines, whereas human kidney epithelial cell (HEK293FT) served as a control. The genes were first filtered, only leaving the ones that were likely to be affected by the virus (p-adjacent value < 0.05 and absolute value of log2(foldchange) > 1). Two enrichment analyses—Gene Ontology(GO) and Gene Set Enrichment Analysis(GSEA)—were then applied to the refined data, demonstrating that the cell types are showing similar transcriptional responses after the infection. Two leading-edge analyses were performed by selecting the top or lowest 20 gene sets, generating two charts of genes with numerical data. The String Database was also used to visualize the relationships between possible drug targets and the proteins related to them. The drug targets contributing to cytokines were eliminated because of their risk of leading to cytokine storms. Eventually, a heat map was created, including 8 potential drug targets and their foldchanges respectively of four cell types. Some of the genes made enzymes helping to acidify intracellular compartments and catalyze geranylgeranyl transformation, while others produced channels for RNA, organelles, and chemicals. Together, these analyses produced 8 potential drug targets for influenza infection.

Project # **S0404** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Josette White** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Plastic Eating PETase (Year 2 with Procedure Modifications)**

Objectives
My objective was to see if the enzyme PETase (found naturally in the bacteria Ideonella Sakaiensis) could break down PET plastic over 4 or 8 weeks. The purpose of my project is to find a method to reduce plastic pollution.

Methods
I used an E. Coli bacteria transformed with the gene that produces the enzyme PETase (created by Beckham and Johnson at Addgene). The transformed E. Coli was exposed to a 2cm x 1cm rectangle of PET plastic. In my experiment, I had 3 groups. Experimental groups 1+2 contain PET plastic exposed to the transformed E. Coli in LB broth: group 1 with lysed cells and protease cocktail applied, group 2 with neither procedures. The control contains PET plastic and LB broth. After the 3 groups were set up, half of each group were incubated for 4 weeks, half for 8 weeks.

Results
The results are the average change in mass of each rectangle and if bubbles/holes formed in the plastics' surface. Results: after 4 weeks, both experimental groups decreased -0.0003g, and control decreased -0.0005g. After 8 weeks, experimental 1 (lysed) decreased -0.0006g, experimental 2 (not lysed) decreased -0.0001g, and the control decreased -0.0002g. Bubbles/holes were formed on both experimental groups after 8 weeks, minimal bubbles were formed on the control.

Conclusion
In conclusion, my results support my hypothesis of experimental 1 (lysed) after 8 weeks reducing the most, however all groups reduced in mass, so I reject my hypothesis.

Project # **S0405** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Kate Chiang** Grade: **12** G: **F**

School: **Whitney High School**

Title: **Protective effects of omega-3 fatty acids against oxidative stress-induced collagen degradation of Tilapia fish scales**

Background:

Aging-associated oxidative stress and free radical generation leads to collagen degradation and subsequent reduced skin elasticity, bone degeneration and organ dysfunction. Omega-3 fatty acids are potent free radical scavengers and exhibit anti-inflammatory properties in numerous pathologies. However, the protective role of omega-3 fatty acids against oxidative stress-induced collagen degradation during aging remains to be established.

Materials and Methods:

Collagen samples were isolated from tilapia fish scales sourced from a local 99 Ranch Market, Artesia, CA, USA. Samples were treated with hydroxyl free radicals generated with Fenton reaction and were subjected to eicosapentaenoic (EPA) acid, docosahexaenoic acid (DHA), EPA:DHA (1:4) or oil tablets (320 mg EPA: 200 mg DHA). SDS-PAGE electrophoresis (Bio-Rad Laboratories, Inc., Hercules, CA) was carried out with or without dithiothreitol or chloroacetamide at Gretchen Whitney High School, Cerritos, CA.

Results:

Hydroxyl-treated collagen samples exhibited increased electrophoretic mobility compared to non-treated controls in both the chloroacetamide and non-chloroacetamide groups. Control samples run with or without DTT did not noticeably differ. In the non-chloroacetamide group, electrophoretic mobility of collagen samples pretreated with EPA or DHA was comparable to hydroxyl-treated samples, but was noticeably reduced in EPA:DHA- and oil-treated samples similar to controls. In samples run in chloroacetamide, hydroxyl-induced increase in electrophoretic mobility was further promoted by pretreatment with EPA, DHA, EPA:DHA or oil.

Conclusion/Discussion:

A combination of DHA and EPA protects against hydroxyl-induced collagen damage, suggesting the potential benefit of prophylactic fatty acid supplementation to preserve collagen integrity during aging.

Project # **S0406** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Brianna Rivera** Grade: **10** G: **F**

School: **Pomona Unified School District Senior Division**

Title: **Milk into plastic**

The goal of this project was to see how something you drink in the morning could turn into a plastic and which amount of vinegar produces the most amount of plastic. We did them in the lab and the first time we notice that the vinegar made it very clumpy so then we though the amount of vinegar affected the texture so then we decided to do 30 milliliters but then notice it was a little bit of a mixture so then again we added 15 militersand got the best texture. The reason we chose it was because we didn't think that something you drink could turn into something like plastic. So are thing is too fond the better option of vinegar.

Project # **S0407** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Ray Chung** Grade: **9** G: **M**

School: **Institute for Educational Advancement**

Title: **A new design for photovoltaic proteins in biohybrids with an aim to improve thermal stability and electric output**

Solar cells have an efficiency problem. Traditional solar cells have an efficiency below 24%. A new biohybrid design (protein-pigment complex) has achieved efficiencies 2.6x of a photosensitizer like eosin alone. My goal is to improve the design of a newly developed biocatalyst by supercharging it (optimizing the net surface charge), to make solar cells more thermally stable. This would increase the energy output of the solar cell, therefore increasing its efficiency in light-energy conversion.
I am using a new protein published by Bunzel et.al. (2022). Then, I use the Rosetta supercharging method, developed by Lawrence et.al.(2007) and Der et.al.(2013) I will use ESMFold (which is an artificial intelligence method for predicting protein structures) to visualize the redesigned proteins and Pymol, which is a molecular visualization system, to look at and align protein structures.
The new proteins will fit the following design characteristics:
They will be thermally stable
They will fold in a similar structure to the original protein as analyzed using Pymol.
The next steps are to test this experimentally to confirm computational predictions.
There are two possible outcomes of this supercharging re-design:
If successful:
The current model for supercharging, folding, and aligning proteins is good enough to enable rational design for improving proteins. While these remain to be experimentally validated, the models provide a critical de-risking of our design strategy.
If not successful:
The models, while individually informative, have trouble integrating to produce designs that satisfy all constraints.

Project # **S0408** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Zachary Jones** Grade: **11** G: **M**

School: **Hart High School**

Title: **Recombinant Synthesis of Ovomucoid Protein, an Allergen in Eggs**

Food allergies impact the lives of millions of people worldwide, leading to negative health outcomes, including death. Many allergies, such as those caused by pollen, allow for immunotherapy, which involves exposure to controlled doses of the allergen. Unfortunately, the propensity for food allergies to result in anaphylaxis often makes exposure therapy too dangerous as the number and allergenicity of the allergens are difficult to precisely control. Recombinant technology has the potential to solve this problem. We designed a recombinant plasmid that expresses the ovomucoid (Gal d 1) protein, a key allergen in eggs. We used Benchling software to modify a plasmid from Addgene's library that already expressed mClover3 and ampicillin resistance proteins so that it also expressed ovomucoid. We then used the company GenScript to build the plasmid. We transformed Escherichia coli (E. coli) using the plasmid sent to us from GenScript and incubated them for 72 hours on an LB agar plate with ampicillin added. When grown, the transformed bacterial culture turned yellowish-green, indicating that both proteins were expressed. We made several more plates of the transformed bacteria for extraction and incubated them for 48 hours. After extraction and filtration, we further verified the presence of ovomucoid with an Elisa Systems test. The test showed negative in controls but positive in culture with the recombinant DNA. This project can help to generate specific proteins for use in customizable allergen serums that could potentially be safer for immunotherapy.

Project # **S0409** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Ava Simpson** Grade: **11** G: **F**

School: **Palos Verdes High School**

Title: **Determining the Collagen Content and Concentration of Nanofat and Microfat Using SDS-PAGE and Sirius Red Dye Assay Analysis**

My objective is to determine the concentration of Microfat and Nanofat using SDS-PAGE and Sirius Red Dye (SRD) assay analysis. Microfat is small clumps of fat that are derived from lipoaspirate. Nanofat is lipoaspirate broken down into a thin liquid that has no adipose cells and is the stromal vascular fraction of the lipoaspirate. My hypothesis for this experiment is that Nanofat will contain a higher concentration of collagen since the adipocytes have been removed.
Collagen identification through SDS-PAGE allows proteins in a solution to be separated and compared to controls and molecular weight markers. In the Sirius Red Dye assay, the dye is added to a sample, shaken by hand, then centrifuged to separate the solid bound collagen-dye material from the remaining dye solution. Then, the UV absorbance of the remaining dye solution is measured and the lower the UV absorbance of the solution means the more collagen in the sample.
Although the microfat samples came up inconsistent and faint in the gel, the SDS PAGE results ultimately showed that Microfat contains a more concentrated amount of collagen than Nanofat. Also, the Sirius Red Dye assay proved that Microfat contained more collagen than Nanofat. Microfat had an average absorbance level of 0.09921 and Nanofat had an average absorbance level of 0.56112.
My hypothesis was null because the SDS-PAGE and SRD assay analysis proved that Microfat contains a higher content and concentration of collagen than Nanofat. Ultimately, I hope my experiment will help forward studies on Nanofat and Microfat as it helps treat burn victims, victims of domestic violence, and aging.

Project # **S0410** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Claire Dokko** Grade: **11** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **Comparing the Cancer-Inhibiting Abilities of Photosynthetic Pigments in Algae on Breast and Testicular Cancer Cell Lines**

Cancer is a leading cause of death worldwide. Photosynthetic pigments in algae are on the rise as novel methods to treat cancer. The objective of this research was to determine which type of pigment would have the strongest cancer-inhibiting abilities and if their efficacies varied on different cancer cell lines.

The 3 chemicals (Chlorophyll a, C-Phycocyanin, and Zeaxanthin) were prepared as treatments and applied to MDA breast cancer & C4 testicular cancer cells. The cells were observed and re-fed for 3 days. The second and third trials were repeated with increased concentrations. After, the cells were fixed and checked for differentiation through OCT4 staining. A Caspase-3/7 assay was performed on the cells to determine the apoptotic abilities of the cells.

It is concluded that C4 cells underwent differentiation, possibly leading to drug resistance. Cell death was observed among increased concentrations and Zeaxanthin-treated MDA cells displayed signs of apoptosis. It can be deduced that greater concentrations of treatment resulted in more significant cell death, MDA cells responded to the treatment to a greater extent compared to the C4 cells, Chlorophyll a-treated cells resulted in cell death, and Zeaxanthin-treated cells induced apoptosis.

The results rejected the initial hypothesis that C-Phycocyanin would have the strongest cancer-inhibiting abilities, and reflects the potential of Carotenoids, Chlorophylls, as well as Chlorophyll derivatives, in the treatment of cancer. Further studies of marine microalgae can improve molecular-based cancer therapies and advance their application in real-world cancer treatments.

Project # **S0411** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Derick Ghadimi** Grade: **10** G: **M**

School: **Crescenta Valley High School**

Title: **Path To Understand and Cure the Mechanics of Phantom Limb Pain**

Approximately 80% of amputees experience Phantom Limb Pain (PLP), characterized by perceived pain in a missing limb. Historically considered psychological, recent research suggests physical mechanisms play a role. This project synthesizes current knowledge on PLP mechanisms. The project is a part of a broader study that aims to model Phantom Limb Pain. This is a literature review that was conducted by searching information from Google Scholar, NCBI, and Pubmed. By using keywords of Phantom Limb Pain, Phantom Limb Syndrome, Residual Limb Pain, and amputees, information significant to the topic was extracted. There are two key mechanisms that cause the basis of PLP. Central sensitization is a spinal reaction caused by trauma that releases P tachykinins which are neurotransmitters found in the peripheral nervous system that create extra sensitivity in the nerve and surrounding tissue. Cortical Reorganization is a psychological process that reroutes a certain stimulus, like pain, from one part of the body into another. Central sensitization causes the pain, while cortical reorganization reroutes the pain onto the phantom limb. Using these connections of the mechanisms, a hypothesis was generated. Is PLP caused by a specific nerve that is channeling P-Tachykinins which causes pain which is relocated to the phantom limb by cortical reorganization? Central sensitization and cortical reorganization together cause PLP. Since they support each other, if one of the mechanisms is solved, the other one would also be solved. Understanding these two mechanisms and their relationship will support future research creating new pharmaceuticals designed for amputees with PLP.

Project # **S0412** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Elyse Hwang** Grade: **12** G: **F**

School: **La Canada High School**

Title: **Investigating the Open-Closed Transition of cpSRP43 Using NMR Spectroscopy and a DE3NQ Mutant**

cpSRP43 is a key chaperone protein found in plants. The protein is known to chaperone light-harvesting chlorophyll-binding proteins (LHCP) in its closed (ordered) state and tetrapyrrole biosynthesis proteins (TBS proteins) in its open (disordered) state. Previous studies have ascertained that the shift between these two states is caused by changes in temperature, with the open state of cpSRP43 being favored at high temperatures (the open state prevents TBS proteins from heat-induced aggregation). How changes in temperature exactly cause the protein structure to switch between these two states is further investigated in this project. cpSRP43 has a closely spaced stack of negatively charged amino acids within its ankyrin repeat domain, which is potentially destabilizing. Mutants of cpSRP43 that replace these negatively charged amino acids with their polar amino acid counterparts (ie exchanging aspartic acid for asparagine and glutamic acid for glutamine) have been shown to stabilize what seems to be the closed (ordered) form of the chaperone protein. In this project, DE3NQ, one of the mutant forms of cpSRP43, is expressed and compared via NMR spectroscopy with the wildtype form of cpSRP43 to determine if the DE3NQ mutant cpSRP43 maintains the same closed state as its wildtype form. This high-resolution comparison of the protein's molecular structures will help further deduce whether or not this negatively charged stack of amino acids is a key factor in the transition between the closed and open form of cpSRP43.

Project # **S0413** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Long Hei (Ryan) Ho** Grade: **10** G: **M**

School: **The Webb Schools**

Title: **Identifying the Pollen Composition of Local Honeys by DNA Barcoding**

This project was designed to identify the flowers bees pollinate to produce honey using DNA extraction and sequencing.

Six honey samples were collected from apiaries across California and diluted. The samples were incubated and centrifuged with EDTA extraction buffer, DTT, and proteinase K. The solution was ground, and phenol-chloroform-isoamyl alcohol and CTAB extraction buffer were added. With the supernatant extracted after centrifugation, isopropanol, sodium acetate, and ethanol were added for precipitation and centrifuged. The pellet was extracted and dried, then resuspended in water. PCR was performed to amplify the rbcL gene and samples were analyzed using gel electrophoresis, returning clean bands. PCR products were sent to a lab for purification and Sanger Sequencing.

Orange blossom honey and sage blossom honey returned the cleanest results. The UniProt BLAST program suggested that both honeys were 99.4% and 98.7% similar to Spinacia oleracea (Spinach). Despite being only 95% similar, both BLAST runs respectively returned Salvia splendens (Scarlet sage) and Citrus sinensis (Sweet orange), matching the honey types provided by the apiaries.

A possible reason for Spinacia oleracea's repeated appearance could be the rbcL gene's similarity between plants. Future experiments could be repeated with more unique primers for more reliable species identification. Because honeybees could pollinate multiple flowers, Sanger sequencing may be less reliable since it only sequences one fragment of DNA. Instead, next-generation sequencing could be utilized to identify every species in my sample. In any case, this project proves that it is indeed possible to extract and sequence DNA from honey.

Project # **S0414** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Matteo Ornelas** Grade: **11** G: **M**

School: **Institute for Educational Advancement**

Title: **Investigating the Hybridization of Phage Tail Proteins for use in the Treatment of Multi-Antibiotic-Resistant Bacteria**

A problem of recent decades has been the overuse of antibiotics. This has led to a much higher prevalence of multi-antibiotic-resistant bacteria. The aim of this project is to hybridize the tail proteins of bacteriophages for the transduction of DNA into multiple species of bacteria. Its intended use is for the treatment of multidrug-resistant bacteria, as phages are the natural predator of bacteria. With this, we are able to have one phage which can be produced on demand to match whatever bacteria needs to be targeted. Initially, two bacteria were chosen for their similarity to each other. Then two phages were selected from each bacterial host for hybridization. The tail proteins from each were searched for on Uniprot, and the amino acid sequence for each was found. Next, the PDB file from it was isolated and entered into PyMOL. After this, each receptor site was searched on Uniprot, and the PDB files were isolated and matched to their corresponding tail proteins. Finally, The end of the tail protein from the phage that infected the target bacteria was isolated. Next, the top half of the phage that infected the original host was separated and pieced together. The final protein could now be used for future research into transduction using hybridized proteins. The result of the experiment was the DNA sequence to a hybridized phage tail protein for infecting the target host bacterium. It also makes a framework for future hybridizations.

Project # **S0415** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Rama Takleh** Grade: **10** G: **F**

School: **Institute of Knowledge High School**

Title: **Sweetening the Deal: Examining the Effects of Sucrose, Fructose, and Glucose on Hypoglycemic Recovery**

Problem/Question: The objective of this project is to determine which type of sugars have the greatest impact on individuals with diabetes and to assess the effects of these sugars on their blood glucose levels.

Procedure: To conduct this experiment, the glucose levels of various fruits were tested using glucose strips. The fruits tested were oranges, bananas, carrots, tomatoes, apples, and onions. The process consisted of placing a glucose strip on each fruit and observing the change in color of the strip, which indicated the glucose level. This process was repeated for each of the fruits in the study.

Results/Data: The results of the experiment showed that fruits high in fructose had higher sugar levels. Apples and onions were found to have the highest fructose levels; and, based on the results, they may have the greatest impact on individuals with diabetes.

Conclusion: The results supported the hypothesis that fructose has the worst effect on individuals with diabetes. According to research, fructose causes insulin resistance in the body making it challenging for the body to maintain stable insulin levels. In conclusion, based on the results of this experiment, of the three types of sugar (sucrose, fructose, and glucose), fructose has the most detrimental effect on people suffering from diabetes.

Project # **S0416** Category: **Biochemistry & Molecular Biology - Sr**

Student: **Muhammad Junaid** Grade: **9** G: **M**

School: **Institute of Knowledge High School**

Title: **Slow Your Flow: Examining the Effects of Sodium Citrate on Coagulation in the Human Body**

Objective: This project seeks to explore the effect of sodium citrate on blood coagulation in humans.

Procedure: The project began by cutting graph paper into appropriate dimensions to measure the formed clots. Subsequently, a sodium alginate solution was prepared to represent the blood coagulation. Three labeled bowls, control, 1%, and 1.5% sodium citrate, were then placed in the work area. 1.3g of calcium chloride was added to each of the three bowls. 2.4g of sodium citrate was added to the bowl labeled 1% sodium citrate, and 3.6g of sodium citrate was added to the bowl labeled 1.5% sodium citrate. The sodium alginate solution was then introduced into each of the three bowls. After the clots formed, they were placed on the prepared graph paper to measure their height and diameter.

Results: From the results of my experiment, the average height for the control was 4.8mm, and for the diameter, it was 9.6mm. The average for the 1% sodium citrate was 2.6mm in height and 8.4mm in diameter, and for the 1.5% sodium citrate, it was 2mm in height and 6.4mm in diameter.

Conclusion: The results demonstrate that sodium citrate effectively lowers the coagulation of blood by acting as an anticoagulant, specifically trisodium citrate. Additionally, it highlights the potential dangers of excessive blood clots, as a large clot can obstruct the lungs and lead to severe consequences including illness, disability, and even death within a short period of time.

Project # **S0501** Category: **Chemistry - Sr**

Student: **Marcel Contreras** Grade: **9** G: **M**

School: **Pioneer High School**

Title: **Kevlar's against water**

The purpose of our project is to research the effects of water on the material Kevlar. The methods that were used to observe this reaction included soaking the Kevlar for different periods of time (1 hour, 1 day, and 1 week) to compare with the control that was not soaked in water. The Kevlar was draped over a razor blade and weight added slowly until a tear was observed. The results displayed the 1 hour soak required 800 g of mass while the 1 week soak required 300 g of mass. After all data was collected the results proved that the longer the Kevlar was submerged in water the less force/pressure was needed to cause a tear. It can be concluded, that water causes the Kevlar to weaken and be unable to withstand the forces it took to normally cut dry Kevlar.

Project # **S0502** Category: **Chemistry - Sr**

Student: **Paul Rivera** Grade: **11** G: **M**

School: **Schurr High School**

Title: **Colors and their relationship with heat and light**

The question is what are the effects of different colors and their relationship of heating an object through the absorption of light. Based on the electromagnetic spectrum I want to know if there would be any change in temperature through the different amounts of radiant energy being emitted from the light. The procedure was getting 9 glass jars and wrapping them around with different colors of construction paper and filling them with water. I put a heat lamp facing the jar, wait 1 hour and check the temperature change of the water in the jar. I discovered that the information I gathered based on the electromagnetic spectrum is correct, that darker colors tend to retain heat more than lighter colors. The control temperature was around room temperature water it was at 77 degrees fahrenheit. Colors with darker shades had trials of them having an average of a 15 temperature increase sometimes even 20. While lighter colors had an average temperature increase of 8 -12 degrees fahrenheit. My hypothesis was validated because based on our research we made the hypothesis that darker colors will absorb more heat because the wavelengths are shorter and when we conducted our experiment we found that our hypothesis was correct.

Project # **S0503** Category: **Chemistry - Sr**

Student: **Daekyu Im** Grade: **11** G: **M**

School: **National Youth Community Center**

Title: **Kimchi Chemistry**

Kimchi is a traditional fermented cabbage dish from Korea. Koreans eat kimchi all year, loving the spicy taste that it offers and the fact that it contains loads of vitamins B and C. In this science fair project, I will make kimchi from scratch and measure the changes in pH and glucose as the kimchi ferments. I will create kimchi with 2 cabbages and divide them into 4 and make some changes to them. I will add more sugar to 2 of the 4, put 2 types of kimchi, the one with more sugar and the normal one, into the fridge, and leave the rest at room temperature. I will measure the pH and glucose levels of the kimchi at a set time for 3 days and create a graph based on the results. Towards the end, I will be making observations about what the fermentation process actually does, how to speed up the fermentation process, and how sugar and temperature affect the fermentation process. Since probiotics are created mostly by a fermentation process, I created this experiment to see which process is most effective for fermentation.

Project # **S0504** Category: **Chemistry - Sr**

Student: **Jonah Nazarian** Grade: **10** G: **M**

School: **Brentwood School - Senior Division**

Title: **Flex Charge**

The production of traditional batteries, such as Lithium, Alkaline, Carbon Zinc, Silver Oxide, and Zinc Air, consumes a significant amount of energy and results in the contamination of groundwater and surface water (Meng and Chung 2010). In this study, we propose a sustainable and environmentally friendly solution by creating a rechargeable, moldable battery that utilizes mechanical energy. Through testing various concentrations of salts in a PVA and Borax slime, we were able to determine the optimal voltage to light up an LED and recharge our moldable battery. Our findings have the potential to replace current battery pollutants and reduce our carbon footprint.

Project # **S0505** Category: **Chemistry - Sr**

Student: **Karen Marin** Grade: **10** G: **F**

School: **Pioneer High School**

Title: **How do different variations of additives to coffee affect its acidity?**

There are many different types of coffee, each with its own combination of additives. In our experiment, we used a pH meter to determine the acidity of different types of coffee. Each coffee was exactly one shot of espresso (about an ounce), filled up to eight ounces with differing combinations of water, milk, and milk-based foam. Materials used were the Oakton Ecotestr, a pH meter with built-in automatic temperature compensation, and seven different types of coffee: flat white, americano, cappuccino, macchiato, latte, and espresso. For the experiment, a single shot of espresso was the control, with it having an acidity of 5.0. When we mixed in different combinations of additives, we noticed that our results showed a radical change in the pH of the coffee drinks, towards a neutral side. This is due to water having a pH level of 7.0 and milk and milk-based foam sharing a 6.7 pH level. The point of this experiment was to see how much the ph level would change and based on our results, using the coffee listed, the pH levels of the coffee ranged from 5.0 to 6.1. In order from most to least acidic: espresso with 5.0, americano with 5.4, flat white with 5.9, and cappuccino, macchiato, and latte tying for a 6.1 acidic level. Something interesting was how americano, a shot of espresso combined with water, had a higher acidity than any of the coffees with milk or milk-based foam.

Project # **S0506** Category: **Chemistry - Sr**

Student: **Lori Terjimanian** Grade: **11** G: **F**

School: **Schurr High School**

Title: **Tooth Decay Eggs-periment**

In this experiment, we are going to examine how acids in certain drinks affect the eggshell more since it is similar to a tooth's enamel. Based off this experimental project, we are going to determine which drinks cause the most tooth decay from the ingredients it holds. If the coca-cola melts the eggshell then the tooth decay will occur fastest with the coca-cola. There were four trials of this experiment and were done by placing the eggs in the liquids and changing it every three days until it was changed four times. After we completed the experiment, we noticed that the results for the egg measurements were very similar for each trial by being decimals apart. In the end, both of our hypotheses were incorrect. Our hypotheses were invalidated because we believed that the amount of stain that the coffee and coca-cola would cause would result in tooth decay, however the vinegar had a stronger effect and completely got rid of the shell making it weight the least.

Project # **S0507** Category: **Chemistry - Sr**

Student: **Victoria Adams** Grade: **12** G: **F**

School: **Institute for Educational Advancement**

Title: **The Effects of Various Chemicals such as Capsaicin and Caffeine on the Energy Production of Microbial Fuel Cells**

The purpose of this project is to determine whether concentration of capsaicin, caffeine, etc. in soil affects the energy production of microbial fuel cells. Materials: MudWatt Microbial Fuel Cell (MFC),?Tabasco Scorpion Pepper Hot Sauce, caffeine powder, garden soil, water, multimeter. Soil was collected from a local garden. It was separated into 350ml portions for each MFC. Increasing amounts of Tabasco sauce containing capsaicin were added to each soil sample. Similarly, 200 and 1000 mg of caffeine were added to soil samples. A soil sample without additives served as the control. MFCs were assembled and electrical output was measured after 1 day and then 1x week. After 1 day, the MFC control produced an average of 43 mV. The MFCs with 1, 5, 10, and 20 ml of hot sauce each produced an average of 4, 195, 115, 191 mV, respectively. The MFCs with 200 and 1000 mg of caffeine each produced an average of 159 and 136 mV respectively. After 1 week, the MFC control produced an average of 377 mV. The fuel cells with 1, 5, 10, and 20 ml of hot sauce produced an average of 364, 424, 24, 168 mV, respectively. Note: Tabasco sauce is not pure capsaicin. This sauce contains added sugar, vinegar, fruit and salt, which could affect the energy production. The measurements after one week for the caffeine MFCs have not been taken but preliminary results indicate that both high amounts of caffeine and capsaicin appear to benefit the energy production of MFCs. Other chemicals are also tested.

Project # **S0508** Category: **Chemistry - Sr**

Student: **Sarah Zhang** Grade: **10** G: **F**

School: **Beverly Hills High School**

Title: **Fading Famines: Reducing world hunger by innovating upon ancient meat preservation techniques**

With Hurricane Harvey, COVID-19, the war in Ukraine, and many other global disasters, millions of people are struggling to obtain fresh and nutritional food, so we set out to discover the most healthy and efficient preservation method. In the process, we stumbled across an ancient Native American meat preservation technique called pemmican. We compared pemmican and jerky, a more modern technique, and measured their pH and swabbed for bacteria every five and ten days respectively. We hypothesized that pemmican would spoil slower than jerky because it does a better job of reducing oxidation and exposure to water, which are necessary for bacteria growth. Ultimately, we discovered that our hypothesis was correct, and pemmican could have stayed fresh for over half a year, significantly longer than jerky, which only lasted about 31 days. The jerky spoiled about 13 times faster, with its pH going from 5.25 to 6.73 in about a month, whereas the pemmican went from a pH of 6.04 to a pH of 6.15 in the same time span. This is due to the incorporation of saturated fats that prevent any contact of oxygen or water with the meat.

Project # **S0509** Category: **Chemistry - Sr**

Student: **Anthony Picos** Grade: **12** G: **M**

School: **Schurr High School**

Title: **Tenderized Meats**

We will be testing how tender the meats are from different stores after being cooked the same way. When buying the meats we will cook them thoroughly and see the results once everything is done and compare their tenderness and flavor. We think the store with the most tenderness meat is La Poblana because it is very famous for their meats. It may be the most expensive one as well. At the end we discovered that the meat from La Poblana was the most tasty of all the meats. It was the most tender and soft to chew.

Project # **S0510** Category: **Chemistry - Sr**

Student: **Isabella Contreras** Grade: **12** G: **F**

School: **Schurr High School**

Title: **Look no further for a grease stain remover**

The project that we will be doing is to find what stain remover will completely get kid of a grease stain. We will be using 5 fabrics (silk, cotton, cow fur, denim, polyester) We are using these different types of fabric to find out how stain remover brands react upon different fabrics. For example, each stain remover will erase a silk grease stain better on cotton material.

Project # **S0511** Category: **Chemistry - Sr**

Student: **Sehoon Kang** Grade: **11** G: **M**

School: **The Webb Schools**

Title: **Conversion of Carbon Dioxide into a Versatile Green Solvent with Isoreticular Metal-Organic Frameworks**

Human activities since the industrial revolution have generated large amounts of greenhouse gases, with CO2 being the most prevalent. Recent advances in CO2 capture and fixation allowed the transformation of atmospheric CO2 into useful organic molecules, but they are limited by extreme reaction conditions and the absence of optimal catalysts. Herein, we synthesized, using the solvothermal method, two series (zinc and zirconium) of isoreticular metal-organic frameworks (IRMOFs), functionalized porous materials with abundant Lewis-acid sites, in varying pore sizes and nitrogen sites, as heterogeneous catalysts for the cycloaddition of CO2 and epoxides to cyclic carbonates. Cyclic carbonates are a useful group of chemicals, including green solvents for organic synthesis, electrolytes for Li-ion batteries, and pharmaceutical ingredients. The catalytic efficiencies of Zr- and Zn-IRMOFs in this reaction were tested by transforming CO2 and styrene oxide into styrene carbonate under mild conditions (80C, 1atm). Notably, the catalytic performances of Zr-IRMOFs with high retention properties due to their structural stability exceeded those of Zn-IRMOFs. In addition, comparing the BPDC and BDC ligands demonstrates that the optimal pore size for catalysis was 12-16 Å. Besides, nitrogen sites of the BPyDC ligand were exhibited to play a crucial role in providing additional binding sites for CO2. Our research adds important insight to the systematic understanding of different physical and chemical properties of MOFs that influence CO2 conversion. Additionally, this work provides a promising clue about which type of MOF with variations in metals and functionalized ligands is more effective in CO2 capture and fixation.

Project # **S0512** Category: **Chemistry - Sr**

Student: **Christine Kim** Grade: **11** G: **F**

School: **Crescenta Valley High School**

Title: **Understanding the Relative Efficiency of Antibodies Generated in Response to Infection by Covid Variants**

Since its initial emergence in the year 2019, COVID-19 has affected the lives of millions of people throughout the world. Accordingly, many vaccines have been produced to solve this global crisis and yet this disease has, alternatively, mutated rapidly, creating a number of variants such as the Alpha, Beta, Gamma, or Delta variants. However, one specific variant, the Omega variant, is less compatible with vaccines as a whole. Initially, it was theorized that this occurred because of evident changes in its spike protein. However, the authentic reason behind this phenomenon remains unknown. Consequently, a project idea emerged: comparing the efficacy of antibody sequences when used in correlation with a number of differing COVID-19 variants. Now, upon the completion of background research, it was hypothesized that such sequences would be most compatible with itself. Unsurprisingly, this hypothesis was confirmed through the use of a number of software such as AutoDock Vina and Windows PowerShell. These software successfully produced an array of binding affinities that displayed the relationship between antibodies and variants. One such successful result includes the discovery of a binding affinity of -46.633 kcal/mol when describing the interaction between an Alpha antibody and an Alpha variant. Such results remained relatively consistent throughout the duration of this experiment as all results were within the ideal range of -50 kcal/mol. In the end, these results will undoubtedly serve as a gateway to a more comprehensive research project that will further current knowledge and understanding of COVID-19 as a whole.

Project # **S0513** Category: **Chemistry - Sr**

Student: **Jeffery Yu** Grade: **12** G: **M**

School: **Granada Hills Charter High School**

Title: **How To Eliminate The "Swimming Pool Smell"**

Swimming pools always have a bad and annoying smell. The goals of this research are to identify the compound responsible for the bad smell and finding the best chemical to erase the bad smell. During the experiment Calcium Hypochlorite solution and MonoChloramine solution are made to compare the smell and Carbonate Water, acetic acid and citric acid are tested to determine the effect on erasing the bad smell. In conclusion the compound responsible for the bad smell was identified as both Calcium Hypochlorite and Monochloramine(depending on the amount of the calcium hypochlorite they used during disinfectant). And through the test, the carbonate water is proved to be the optimal solution for erasing the bad smell.

Project # **S0514** Category: **Chemistry - Sr**

Student: **Katelyn Mak** Grade: **11** G: **F**

School: **Whitney High School**

Title: **Comparing the Influences of Stevia Rebaudiana Extract and Butylated Hydroxytoluene on the Degradation of Biodiesel Derived from Brassica napus L. Oil**

As the prices of fossil fuels rise, many energy industries are looking for alternative energy sources such as biodiesel. However, since biodiesel is biodegradable, biodiesel will degrade in a month making it less efficient and hard to implement. As a result, my project focuses on developing a natural preservative, Stevia Rebaudiana Extract (stevia soaked in ethanol), and comparing it to an industry standard preservative, Butylated Hydroxytoluene (BHT). I first made biodiesel from canola oil by heating up Sodium Methoxide with canola oil in a round bottom flask attached to a condenser. It was then washed with distilled water in a separatory funnel and dried under the fume hood. Then I mixed 0.1,0.2,0.3 grams BHT and a 25,50,75% mixture of biodiesel and stevia extract in 10 mL samples. I tested each mixture by dripping 0.3 grams on a cotton ball and lighting it on fire under the fume hood. I used a timer to see how long the flame lasted and repeated it. The stevia extract had an average of 2 minutes, pure biodiesel had 1 minute 42 seconds, and BHT had 2 minutes 36 seconds. Overall, my research showed that Stevia Extract worked as a natural preservative for biodiesel as the burn time was greater than pure biodiesel. However, it was not as effective as BHT. I hope to continue this research in the future and find a way to make it as effective as BHT.

Project # **S0515** Category: **Chemistry - Sr**

Student: **shaun Ortega** Grade: **12** G: **M**

School: **Schurr High School**

Title: **Sweet Tooth**

The Sweet Tooth Project is a project that gives you information about what drinks can damage the Tooth enamel on your teeth. Tooth enamel is the thin outer covering of a tooth. Instead of actual teeth, I will be using eggs. The hard outer shell of the egg is the closest to representing your tooth enamel. I let the eggs sit in Black Coffee, Watermelon Juice, Squirt Soda, and water. In a total of 3 trials I got different results revealing that black coffee damages the tooth enamel more then the other 3

Project # **S0516** Category: **Chemistry - Sr**

Student: **Sana Rajesh** Grade: **11** G: **F**

School: **Whitney High School**

Title: **Improving the Ductility and Overall Usability of Milk Based Plastic Through the Implementation of a Plasticizer**

This project is aimed to explore the properties of casein plastic, a biodegradable alternative to traditional petroleum-based plastics. While using raw casein provides the tensile strength needed of a plastic, its rigid nature narrows its uses to jagged objects. To overcome this, this project performs a multi-factor research to explore the properties of casein plastic and evaluate the efficiency of a new version of this material made from liquid milk. It was hypothesized that the supplementation of a plasticizer that acts as a lubricator to the original formula of the plastic would easen the process of curating the casein, allowing for a more pliable material. Multiple tests such as testing the tensile strength, ease of biodegradability, and durability to different extreme conditions strongly affirmed the newly formulated casein's superiority over the original plastic. The results showed that the new casein plastic has promising properties with a tensile strength comparable to that of some traditional plastics, a strong ability to maintain form, and a good resistance to bending and tearing. Furthermore, the material can be easily molded into different shapes and is biodegradable, making it a viable alternative to traditional plastics for a range of applications. The study provides valuable insights into the potential of casein plastic as a sustainable solution for plastic production and use. Overall, the contributions of this project help further the development and implementation of casein plastic, proving that it can be used for varying commercial purposes and be produced using household resources.

Project # **S0601** Category: **Earth / Space Sciences - Sr**

Student: **Oscar Zhou** Grade: **11** G: **M**

School: **Diamond Bar High School**

Title: **Correlation between Climate Change and Natural Disasters**

Climate change is caused by an increase in greenhouse gas emissions leading to a gradual rise in global temperatures. Although the rise in global temperatures is well-documented and indisputable, the serious consequences of global warming have not yet been universally accepted, especially not by those living in relatively affluent countries who are sheltered from the worst effects of climate change. In my research, I tried to demonstrate that a rise in global temperatures actually corresponds to an increase in both the frequency and the severity of natural disasters around the world. These natural disasters include heat waves, severe winter storms, flooding, wildfires, etc.
The warmest 8 years on record were the last 8 years, from 2015 to 2022. I began collecting my data from the year 2000, when the average global temperature was much cooler, only 0.4C above pre industrial levels, compared to >1C now. I relied on online news reports and summary articles for information about the natural disasters, defined as ones that caused significant damage and deaths, that occurred each year. I also recorded the damage and death toll where information was available.
I analyzed the data and found that the frequency and severity of natural disasters were significantly greater for the last decade compared to the previous decade, and in general there was indeed a trend of increasing frequency and severity of natural disasters as temperature rose because of climate change. Through my research, I hope to convince more people of the harmfulness of climate change.

Project # **S0602** Category: **Earth / Space Sciences - Sr**

Student: **Julia Budano** Grade: **12** G: **F**

School: **Schurr High School**

Title: **Water Consumption in Los Angeles and Tucson**

The problem I am focusing on in my project is how water consumption in Los Angeles is less compared to water consumption in Tucson, during 1980, 1990, 2000, 2010, and 2020, despite one city having larger population growth than the other. To solve this problem I need to find the amount of water consumed in both cities from 1980 through 2020, along with the population of both cities, to find comparisons and get my answer. My data can be found and analyzed from each cities water and power website which publishes annual consumption.

Project # **S0603** Category: **Earth / Space Sciences - Sr**

Student: **David Agekyan** Grade: **12** G: **M**

School: **Anderson Clark Magnet High School**

Title: **Investigating Methane Emissions in Local Communities**

In 2015, the Aliso Canyon Gas Leak occurred, releasing thousands of tons of methane into the atmosphere into the local Porter Ranch community. This disaster took months to resolve and raised serious concerns with regard to the effects of methane in the atmosphere. Studies have established that Methane is 25% more potent than carbon dioxide at trapping heat in the atmosphere. While that leak occurred 7 years ago, it is still necessary to analyze methane in the Aliso Canyon to ensure that no gas leaks occur. To address this problem, two payloads were designed. A high-altitude balloon payload for analysis of the upper atmosphere on NASA's Raven Aerostar balloon and a low-altitude payload for low-altitude drone flights. Both loads were built using microcontrollers as well as methane and gas sensors. Using designing, building, and programming skills, the payloads were tested to meet the requirements for the missions. The high-altitude balloon payload is currently awaiting flight but several low-altitude drone flights have been conducted in school and residential areas. Results have shown that there may be issues with gas grills emitting methane in school areas. Results have been obtained from analysis using ArcGIS maps. Around Aliso Canyon, results have indicated that there are no active gas leaks occurring. The proposed solution for the local payload was validated as the payload worked as required. The high-altitude balloon has not yet flown and its results are not yet determined.

Project # **S0701** Category: **Ecology - Sr**

Student: **Alexander Tapia** Grade: **10** G: **M**

School: **John Muir High School Early College Magnet**

Title: **Water Desalination**

Access to clean, fresh water is a major problem facing the world today. In countries neighboring the ocean, seawater desalination is sometimes used to provide the country with drinkable water. Distillation is one of the main methods used to purify ocean water and works well since salt, microorganisms, and other components of seawater are non-volatile. The main disadvantage of distilling water is that the process requires a lot of energy, and unless engineered creatively, the economics can be a major deterrent to using the method (3). If water is placed in a sealed container and allowed to evaporate, it will eventually reach an equilibrium such that the water vapor is condensing just as fast as the water is evaporating. The pressure of the vapor at this equilibrium is called vapor pressure. Vapor pressure is different for different substances and varies with temperature. In a mixture of two liquids with different boiling points, the vapor will have more of the liquid that is more volatile, i.e., evaporates more readily. In simple distillation, the liquid mixture is heated and the vapor rises through a tube and is collected and re-condensed. The re-condensed liquid will have a higher concentration of the more volatile component than the original mix. If the two liquids in the original mix have widely different boiling points, a one-step evaporation and re-condensation process is all that is necessary. This process is called simple distillation (2).

Project # **S0702** Category: **Ecology - Sr**

Student: **Ann Huang** Grade: **10** G: **F**

School: **Whitney High School**

Title: **The Effect of Different Fertilizers on Levels of Dissolved Oxygen**

Excess fertilizer causes eutrophication, which leads to increased algae growth. This results in algal blooms and a decrease in dissolved oxygen. This research project was designed to discover the effects of different types of fertilizer on dissolved oxygen levels by monitoring the growth of algae and algal blooms. I wanted to explore which types of fertilizers of the same NPK(Nitrogen, Phosphorous, and Potassium ratio) would create the greatest algae growth and lowest dissolved oxygen levels. I hypothesized that the sample with liquid fertilizer would have the lowest dissolved oxygen. To test this, I put hair algae, or Bryopsis, in four beakers: one control beaker with no fertilizer and three others with liquid, granular, and spike fertilizers. I made observations over the course of three weeks with the Vernier Dissolved Oxygen Probe to measure the dissolved oxygen levels for each sample. Finally, I compared the graphs of dissolved oxygen to reach a conclusion. The control group had an average of 0.645 mg/L of dissolved oxygen. The liquid fertilizer sample had an average of 0.746 mg/L of dissolved oxygen. The granular fertilizer sample had an average of 0.807 mg/L of dissolved oxygen. The spike fertilizer sample had an average of 0.696 mg/L of dissolved oxygen. I rejected my hypothesis because, among the fertilizer samples, the spike fertilizer had the lowest dissolved oxygen. In the future, I would like to test when the algal blooms are at their peaks and and also test how temperature affects algae growth.

Project # **S0703** Category: **Ecology - Sr**

Student: **Madeleine Lundberg** Grade: **11** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Farmers Say Thank You: Finding an Alternative Farming Method Using Electromagnetic Fields**

My objective was to see if the addition of magnets would aid in the growth of radish seeds. To do this I planted radish seeds in three different pots with varying amount of magnets in each.

Pot #1 had no magnets, pot #2 had 9 total magnets and pot #3 had 15 total magnets. First, I placed ¾ of the soil in the pot and then the magnets. When placing them, I set them apart to create a uniform magnetic field. Once setting up the amount of soil and magnetic fields, I then placed a group of three seeds in six different divots that are 1 inch deep. I lightly tapped soil over the radish seeds to secure them. I watered the plants every other day with about 2 ounces of water at 3 pm. This experiment ran over the course of 30 days.

Results were based on the plant's height over the course of 30 days. Pot #1 grew the most in the beginning, but towards the end when the plants started decreasing in height, all groups were about the same heights. In the end, many plants died but the only one left standing was in fact living in pot #3 being 6.5 cm.

My experiment found that the addition of magnets stunts the growth of radish seeds. Therefore my hypothesis was not supported by the results of my experiment. I learned that magnets may not be an alternative to farming methods during drought season.

Project # **S0704** Category: **Ecology - Sr**

Student: **Efren Rangel** Grade: **10** G: **M**

School: **John Muir High School Early College Magnet**

Title: **Exploring the Greenhouse Effect**

The amounts of heat-trapping atmospheric gasses, called greenhouse gasses, have increased since the mid -1800's, when modern industry became widespread. Since that time, the average temperature of Earth's surface has also risen (1). The greenhouse effect occurs when the atmosphere of a planet acts much like the glass in a greenhouse. Like the greenhouse glass, the atmosphere allows visible solar energy to pass through, but it also prevents some energy from radiating back out into space (2). The greenhouse effect ensures that the surface of a planet is much warmer than interplanetary space because the atmosphere traps heat in the same way a greenhouse traps heat (3). The Earth's average temperature increased about 1 degree Fahrenheit during the 20th century. The Intergovernmental Panel on Climate Change warns that continuing increases could have serious effects on crops, glaciers, the spread of disease, rising sea levels and other changes (4). The increase in these atmospheric gasses could raise the average temperature of Earth. During the last 100 years, the temperature has risen by approximately 0.5 degrees Celsius. That could triple by the year 2030 and quadruple by the year 2050 (5). In this experiment, students built a simple model of earth using a cup, soil, a light and plastic wrap. Students observed the cup without plastic wrap, simulating the earth without greenhouse gasses. Then, the students produced an identical cup covered with plastic wrap, simulating the earth with a greenhouse layer in the atmosphere.

Project # **S0705** Category: **Ecology - Sr**

Student: **Haik Isaiants** Grade: **11** G: **M**

School: **Crescenta Valley High School**

Title: **Lowering the Harmful Impact of Invasive Species**

Invasive species pose a major problem for the environment and the biodiversity of ecosystems, causing 58% of all mammal, reptile, and bird extinctions. To determine a possible method to significantly reduce the harmful impacts of well-integrated invasive species, the validity of amplifying aggression through genetic modification was tested. This solution aimed to collectively harm an invasive species without significantly harming the native inhabitants of the environment. To test this possible method, a simulator on Unity was built to accurately represent the differences in interactions between native organisms, passive invasive organisms, and aggressive invasive organisms. This simulator used randomization and multiple equations to simulate the chances of death and reproduction for each type of organism during each generation. 16 trials of 120 generations were run through the simulator, starting with the growth and stabilization of a native species, the introduction of an invasive species, and the implementation of aggression into the invasive species through genetic modification. The results showed that aggressive behavior was beneficial to the individual invasive organism, allowing the behavior to become predominant in the population via natural selection. Furthermore, aggressive behavior also decreased the invasive population by 49.6%, which allowed the native species population to recover to roughly 34.7% of the original population at which it stabilized. Further research utilizing real-world genetic modification along with living organisms in a functioning ecosystem is needed for more reliable data. Promising results can then be applied to real situations involving well-integrated invasive species.

Project # **S0706** Category: **Ecology - Sr**

Student: **Mia Moore-Walker** Grade: **11** G: **F**

School: **Flintridge Preparatory School**

Title: **Assessing the nutritional impact of decomposers(isopods) on soil fertility**

Fertilizer accessibility is decreasing rapidly. Africa is already lacking 2 million metric tons of fertilizer and in India, 55 percent of the country’s soil is deficient in nitrogen. Though fertilizer is available, it is not accessible since prices have risen nearly 30 percent since the beginning of 2022. Several studies have assessed that soil fauna, like isopods, have a positive effect on the total nitrogen(TN) and total potassium(TP) content of soil(Xi Yang, Ming'an Shao, Tongchuan Li). Anything that could possibly help increase TP and TN levels in soil and act as a pseudo-natural fertilizer is beneficial. Here, over a period of three weeks, I kept track of 12 different soil terrariums separated into 4 groups, each with a different concentration of isopods. The concentration of TN and TP, PH level, and Germination rate of pea plants were measured periodically throughout the 3 weeks. Moreover, the resulting data showed that the higher concentration of Isopods had a higher concentration of TN and TP, an ideal PH, and a higher germination rate. Discovering accessible ways to increase soil fitness is a necessity in spearheading a successful future for everyone in agriculture.

Project # **S0707** Category: **Ecology - Sr**

Student: **Stella Leland** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Global Worm-ing: Climate Change and Lumbriculus Variegatus**

Objectives:
My objective was to explore the effects of climate change. I did this by keeping 10 California blackworms in 8 different temperatures (16, 18, 20, 22, 24, 26, 28, and 30 degrees celsius) in a water bath for 20 minutes before finding their pulses to see if the worms' pulses would increase with the temperature. These temperatures were used to simulate the temperatures of water now and in the future where blackworms live, based on the effect of climate change.

Methods:
To achieve the temperatures (16, 18, 20, 22, 24, 26, 28, and 30 degrees Celsius), blackworms were put in capillary tubes in petri dishes placed in a water bath. After 20 minutes, they were taken out of the bath and viewed with a digital microscope to see their pulse rates.

Results:
The worms in temperatures 16, 18, 20, 22, 24, 26, 28, and 30 degrees Celsius had average pulses (bpm) of 6.1, 7.7, 6.4, 6.6, 7.2, 9.4, 11, and 10.5, respectively. The worms in 16 and 18 degrees moved significantly less than those in temperatures 28 and 30. Although the worms' pulses did not increase with heat linearly, they did generally increase.

Conclusion:
This information is relevant as it provides more information about the effect of heat increase on aquatic organisms, as well as how pulse rate correlates to movement; more experiments highlighting the effects of global warming may encourage others to create more change to help the environment.

Project # **S0801** Category: **Engineering Applications - Sr**

Student: **Shreyas Kulkarni** Grade: **10** G: **M**

School: **Whitney High School**

Title: **The Affordable Lockbox**

Many people want to keep their valuables and other items secure, but do not want to invest a large amount of money into a safe. The Affordable Lockbox seeks to solve this problem by utilizing an Arduino Uno to have a low-cost alternative, with a high level of personalized security. The Arduino board itself, in addition to a fingerprint sensor, Infrared receiver and remote, and an LCD are all part of the design. The components were connected to the board via jumper cables, and the code that I wrote was used to control the functionality of the above mentioned components. This code was transmitted to the Arduino from a standard computer with the Arduino IDE installed on it. An ideal safe must be both quick to open, and accurately and consistently open when called to do so. The median time for the fingerprint sensor to validate a fingerprint was 3.5 seconds. It also correctly identified the fingerprint on the first try 90% of the time, and almost 100% of the time within two tries. It also had a 100% accuracy rate during the trials; it never opened with an unauthorized or unregistered fingerprint. In conclusion, this safe can be a viable alternative to existing safes, as it is not very expensive, and meets the necessary parameters for a product of its kind.

Project # **S0802** Category: **Engineering Applications - Sr**

Student: **Vela Benedicto** Grade: **10** G: **F**

School: **Crescenta Valley High School**

Title: **Designing A C.A.S.E. Air Quality Monitor (cost-efficient, accurate, self-sustaining, easy-to-use)**

Air quality monitors can range from $240-1300, an expensive price many people are unable to purchase. To fill the gap among the lack of air quality data for developing countries, the project focused on designing a consumer-friendly air quality monitor that embodies four characteristics – cost efficiency, accuracy equivalent or better than existing monitors, self-sustaining power through renewable resources (sunlight), and lastly, be easy to set up and monitor no technical assistance needed (for simplicity, C.A.S.E. characteristics). This is accomplished through an Arduino Mega, a microcontroller that utilized the following sensors of DHT11 (temperature and humidity), PSM5003 (particulate matter size quantifier of 1.0, 2.5, and 10.0 microns), and the MQ2 smoke sensor. The information collected from the sensors is transmitted to the cloud using the ESP8266 wifi shield every 30-60 minutes, and can be displayed on the corresponding student-made app in addition to the LCD screen mounted on the monitor itself. Testing was conducted in the Philippines, and displayed high values of temperature and humidity (87 Fahrenheit and 78% respectively). To ensure it updates accordingly, a “breathing test” was done (exhaled carbon dioxide was focused on the DHT11 and MQ2 smoke sensor). The values were able to increase as expected due to the presence of carbon dioxide detected (157 to 350 ppm). The finished device accomplishes cost efficiency and easy consumer implementation, and will be undergoing further testing at the San Diego State University laboratory as a potential product for developing countries in the future.

Project # **S0803** Category: **Engineering Applications - Sr**

Student: **William Huang** Grade: **12** G: **M**

School: **Palos Verdes Peninsula High School**

Title: **SuperVision: A Novel Integrated Sensing and Computational Framework to Enable Superhuman Epiretinal Prostheses**

The current gold standard to restore vision to patients suffering from retinal degenerative diseases is through retinal prostheses. However, these FDA-approved implants are limited to low-resolution grayscale images, making object identification and prosthesis adaptation difficult for patients. Furthermore, current studies focus on vision recovery and do not fully leverage state-of-the-art sensing and computational advancements.

For the first time, this study develops a paradigm that creates visual capabilities superseding the standard visual acuity. The framework aims to turn patient disadvantages to advantages, effectively creating superhuman vision. It consists of four integral components: 1) a modular plug-and-play (PnP) system to enable the adoption of advanced visual schemes; 2) a tunable optimal transportation theory (OT)-based virtual magnifier to localize and enlarge regions of interest (ROIs) while preserving important features and curvatures; 3) a real-time image optimization framework to encode the maximum amount of spatial and color information to patients; and 4) an autoencoder-OT model to augment the optimized images.

The PnP system provides patients with optimized images at any visual angle. Computational experiments through distortion maps showed that the magnifier enlarged the ROIs with minimal area and angle distortion. Further, users can select important features and optimize ROI densities through a “digital knob” user interface. In contrast to current schemes, the image optimization framework demonstrated better visual quality and allowed for optimal color mapping through comparison studies. The AE-OT model augmented images from 6 datasets while avoiding mode collapse to generate an image library for patient training.

Project # **S0804** Category: **Engineering Applications - Sr**

Student: **Elan Lonstein** Grade: **11** G: **M**

School: **Delphi Academy of Los Angeles (Senior Division)**

Title: **Alternate Center Airbag Gas Release System**

Objective

Create an alternate center airbag gas release system that reduces exposure to high concentrations of nitrogen gas.

Methods and Materials

Research was conducted on different airbags and their respective inflation systems. The most common inflator was found to be the pyrotechnic inflator. After studying how air bag systems are mounted in cars, three possible designs were created using computer-aided design (CAD) to redirect gases away from the driver. Each design went through a computer simulation to determine possible outcomes. Then each outcome was evaluated for feasibility.

Results

It took three designs to create a possible product that had a workable outcome. The final version was designed as an attachment to the pyrotechnic inflator. It uses a pressure release cap that is designed to release gases after the pressure exceeds 20-30 kPa, the highest pressure during the air bag inflation. The gas would then exit through four different passages running through both sides of the car, the hood, and the bottom of the car.

Conclusion

The alternate center airbag gas release system can be designed so that gases are not expelled on vehicle occupants. The implementation of this system would add costs to the manufacturer because it would be an additional part to the center airbag ignitor but could mitigate the effects of exposure to high concentrations of nitrogen gas.

Project # **S0805** Category: **Engineering Applications - Sr**

Student: **Eric Gu** Grade: **9** G: **M**

School: **Brentwood School - Senior Division**

Title: **The Circuit Shower**

Americans have an annual consumption of 1.7 trillion gallons of water from showering alone. The purpose of this invention is to lessen the burden of drought and climate change. The Circuit Shower aims to operate as a self-sustaining system that is capable of reusing its own water. By conserving water within individual homes, there would be a lower demand for the transportation of usable water, resulting in less fossil fuel consumption. Our system works by collecting the water that goes down the drain, using a distiller to purify it, and then collecting the water in a storage tank, ready to be used again for showering or even drinking.

Project # **S0806** Category: **Engineering Applications - Sr**

Student: **Lachlan McDermott** Grade: **11** G: **M**

School: **Geffen Academy at UCLA**

Title: **Carbon Can:A Novel Hand-Held Carbon Capture Device**

Climate change is the single biggest problem that humanity faces. Industries are emerging and groups are slowly starting efforts to become carbon neutral. While this strategy is effective, it is very limiting. Every current carbon sequestration operation costs hundreds of millions of dollars, this causes people to feel useless against this problem. That uselessness can often lead to hopelessness. This means we are neglecting the largest possible group of helpers in the fight against climate change. My goal is to produce a device that every person, aged 4 to 94, will be able to use to help capture carbon. I will develop an easy-to-use mass-market carbon capture device that utilizes human strength to capture and gamify carbon capture to appeal to both a younger and older audience.

Project # **S0807** Category: **Engineering Applications - Sr**

Student: **Chengyu Fu** Grade: **11** G: **M**

School: **The Webb Schools**

Title: **Two-Degree-of-Freedom Transformable Wheels**

Transportation has always been crucial to urban development. In the future, in “smart cities” where automated robots become highly involved with urban living by taking on laborious tasks for humans, the ability to adapt to complicated urban terrains becomes crucial for automated machines. However, any obstacles with vertical elevation can impede the traditional platform that moves on wheels. The transformable wheel provides a possible solution to the problem as they adapt to different landscapes by changing their form.

This study introduces an improved design for modular transformable wheels that can overcome vertical obstacles. These transformable wheels can adapt to city landscapes such as stairs and thresholds on sidewalks. They can be applied to service robots, wheelchairs, and transportation, therefore playing essential roles in the IoT and future city care systems. The researcher presents the mechanism of the transformable wheel and builds a model chassis incorporating the design. Each modular wheel has a Two-Degree-Of-Freedom transformation mechanism, composed of a 7-bar linkage with six rotational joints and one prismatic joint. A related study improving the efficiency in overcoming obstacles by changing the conditions of the contact surfaces is presented together with complementary field experiments, which conclude that the transformable wheels succeed in overcoming common obstacles such as stairs, curbs, and sidewalks in real-life scenarios. However, the design of the model chassis still requires further improvement to achieve the function of climbing multiple stairs continuously.

Project # **S0808** Category: **Engineering Applications - Sr**

Student: **Dohyun Ju** Grade: **12** G: **M**

School: **Palisades Charter High School**

Title: **The Development of an Automated, Modular Method for Medical Image Registration in the Creation of a Volumetric Prostate Atlas**

Prostate cancer is one of the most prominent types of cancer affecting American men, accounting for over 250,000 cases and 30,000 deaths in 2022. There has been extensive research done on prostate cancer treatment, but existing pathways have various setbacks, including restrictive sampling methods in biopsies. This study aimed to improve biopsy accuracy and efficiency by developing an automated, modular method of medical image registration and prostate atlas creation. Using deidentified patient images from the publicly available PROSTATEx dataset, the algorithm presented in this paper primarily centers around an efficient method of image registration that aligns images around the prostate's centroid. These slices are aggregated into volumetric prostate atlases, which highlight the most common areas of cancer formation based on pixel intensity values.

This method of registration and atlas formation proved to be promising, requiring minimal user input and providing a variety of visualization options that encourages versatility (specifically regarding the frequencies and locations of lesion masks in the atlas). In addition, this modularity facilitates scalability, which is significant because the use of a greater amounts of data can strengthen the statistical value of the atlases, as observed in the differences of the 20, 40, and 60-image atlases (as the number of images increased, the atlases highlighted more representative regions of cancer). In the future, this registration algorithm can be integrated into fully automated methods for prostate atlas generation. With enough patient data representing the general population, it can help physicians better understand prostate tumor locations and improve diagnosis mechanisms.

Project # **S0809** Category: **Engineering Applications - Sr**

Student: **Roshini Muppana** Grade: **11** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **The Discrepancy Between Pebbles and Lava Rock in the Growth of Mint Within an Aquaponic System**

An aquaponic system is an integrated farming technique relying on fish to produce plant food. This project specifically focuses on finding the best growth medium for mint plants. The growth media compared were lava rock and pebbles.
The materials used for this project are four adult feeder-sized single-tailed goldfish, a 5-gallon fish tank, a 24" x 18" growth bed, a water pump, goldfish food, fresh water, pH stabilizer, a ruler, lava rock, pebbles, an on-off electric timer, chlorine remover liquid, tank stabilization liquid. The aquaponics system was completely handmade and set up outdoors. The growth bed is a 24" x 18" plastic container; holes were drilled to fit the drain and the water pump, a divider was inserted, the growth substrates were added, and the mint was planted. The water pump was programmed to water the plants for 30-minute periods at 8:00 AM, 12:00 PM, 5:00 PM, and 12:00 AM daily. To collect data, the plants were measured weekly.
The collected data shows that the lava rocks were a better growth medium for mint plants during the winter. The results of this experiment suggest that outdoor aquaponic systems work if the right growth medium is chosen for a given species of plant.

Project # **S0810** Category: **Engineering Applications - Sr**

Student: **Russell Miller** Grade: **11** G: **M**

School: **Sherman Oaks Center For Enriched Studies**

Title: **Injury Detection Early Warning System**

Unreported physical injuries can prove detrimental, and in some cases fatal. From motorcyclists unable to move after an accident to football players ignoring concussion-causing injuries, the speed and accuracy with which an injury can be detected and reported could be vital in preventing a minor incident from becoming a long-term injury. To combat this: we designed a wearable accident-detection system entitled the Injury Detection Early Warning System (IDEWS). A central Raspberry Pi computer transmits the information gathered from external accelerometers and the internal positioning system to a separate device. This secondary device runs a Python program that can make sense of the data and send a detailed report to the appropriate authorities. The information sent to the authorities includes; the individual's inputted personal information (name, age, disabilities), inferred details of the injury, and their location. In experimental trials we ran drop and ramp acceleration tests, comparing the measured data to calculated ideal numbers to find accuracy. On average, drop testing showed ±1.5%, and ramp testing showed ±8.5% off of the ideal. These larger deviations from predicted values are likely due to unaccounted factors such as friction or air resistance. Then the recorded positioning data was compared to the accurate position, with a maximum deviation of ±0.015%. Although these can be improved, our prototype's small deviations allowed us to conclude that the IDEWS could be a viable option for injury detection.

Project # **S0811** Category: **Engineering Applications - Sr**

Student: **Shreyas Sakharkar** Grade: **11** G: **M**

School: **West Ranch High School**

Title: **Alzheimer's Disease Patient Chatbot**

Alzheimer's disease is a form of dementia that affects over 55 million people worldwide. Due to the deterioration of cognitive function and memory loss, one everyday challenge that patients face is difficulty communicating. To address this issue, this project trains a chatbot model to lead a conversation that engages patients in daily discussions and verbal exercises. The AI-powered chatbot utilizes natural language processing and machine learning techniques to understand and respond to the patient's queries and concerns in a conversational manner. To underscore usefulness in the patient population, this chatbot will have disability accommodations including a phone to text system, similar to Voice Assistant platforms such as Google Assistant. Given the heavy caretaker burden of Alzheimer's patients can severely impact mental and physical health, lightening the burden of the looped and repetitive speech syndromes that Alzheimer's patients present with is important [1]. This chat bot will be able to sympathize with the patients in conversations that would be challenging for humans to have. Conversely, Alzheimer's patients' perception of self-control over daily activities often translates to better clinical outcomes and slower cognitive decline, a large part of which is consistent mental exercise and engagement which this model can provide in a data-driven manner [2].

[1] Koca, E., Ta?kapilio?lu, Ö., & Bakar, M. (2017, March). Caregiver burden in different stages of alzheimer's disease. Noro psikiyatri arsivi. Retrieved February 5, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5439478/

[2] Yates, L., Csipke, E., Moniz-Cook, E., Leung, P., Walton, H., Charlesworth, G., ... & Orrell, M. (2019). The development of the Promoting Independence in Dementia (PRIDE) intervention to enhance independence in dementia. Clinical interventions in aging, 1615-1630.

Project # **S0812** Category: **Engineering Applications - Sr**

Student: **Rohan Sampath** Grade: **11** G: **M**

School: **Geffen Academy at UCLA**

Title: **Piezoresistive Graphene-Based Biosensor for Measuring Biomaterial Conductivity**

Biomaterial use to help regenerate lost tissue in patients has become popular in biomedical engineering. A variety of biomaterials can be used to replace different tissues within the body from blood vessels to bone marrow, or pieces of the lungs. These materials must undergo strict testing to ensure they support the designed function while being benign to patients. One property of biomaterials is conductivity, whose characterization is critical to define due to the flow of charge in neural tissues and muscles, and organs of the body whose electrical properties change with contraction. Currently, no portable, laboratory-grade sensor exists to measure material properties. I created a sensor that takes in a nano-fiber or other material and coats it in graphene to define the path of electrical flow. The material is stretched thin to create a criterion size so that electrical flow per unit area can be measured. Using electrodes, a voltage divider circuit, and a microcontroller, the sensor reads out the percent voltage loss across the material, allowing the calculation of conductivity. This allows the user to gauge how conductive the material is and whether it meets the limits permissible for patient implantation. My sensor will work on materials as small as 100 microns in diameter. The sensor runs on an Arduino Nano microcontroller, sends outputs to the computer via the HC-05 Bluetooth module, and prints output on the Serial Port stream. Future directions will include adding functionality to measure the same material's mechanical properties, such as stress and strain.

Project # **S0813** Category: **Engineering Applications - Sr**

Student: **Sid Shah** Grade: **11** G: **M**

School: **Whitney High School**

Title: **The Haptic Metroband**

Deaf musicians aren't common, but aren't unheard of either. Even Beethoven was deaf in the later parts of his life. But deafness can raise problems, especially for those playing with others at the same time. Keeping time is essential for an ensemble, and without a conductor, musicians that are hard-of-hearing may find it hard to stay in time with their peers. The Haptic Metroband was made as a solution for this. It used a single vibration motor and Bluetooth to send pulses to the wearer, allowing them to feel the beat, without needing to hear a metronome, which is especially useful during performances. The physical component was made using an Arduino Uno microcontroller, and the accompanying mobile application to control the microcontroller was made using Meta's React Native framework for building cross platform native mobile applications. After 5000 beats for each of 60, 120, and 240 beats per minute, T-tests were conducted which showed that the data we collected consistently found the experimental means to be higher than expected. Between all 3 of the selected tempos, there was a standard deviation of less than 20, which means the Metroband was accurate to about 20 milliseconds, which is nearly imperceptible to most humans. This means that the Haptic Metroband is a valid solution for our specified problem, but with further improvement to the hardware and software, it can be made to be more accurate.

Project # **S0814** Category: **Engineering Applications - Sr**

Student: **Mathew Gonzalez** Grade: **9** G: **M**

School: **Pomona Unified School District Senior Division**

Title: **Cable Management**

The problem I was aiming to solve was to make a device that would prevent my guitar from detaching from the strap; therefore making it safer to play. The idea was to make a device to hold the guitar's cable without running through the strap. The initial prototype was made out of cardboard. The final testable prototype was used in the guitar. The device when attached to the cable was able to be moved and reduced the chance of the guitar to fall from the player's arm. My hypothesis and the design were correct.

Project # **S0815** Category: **Engineering Applications - Sr**

Student: **maryjane sosa** Grade: **10** G: **F**

School: **BELL GARDENS HIGH SCHOOL**

Title: **electric motorboat**

Our project consists of a small foam battery powered boat.It will contain small propellers,batteries,and a small motor.It will also be tested in a small bucket or tub of water.

Project # **S0816** Category: **Engineering Applications - Sr**

Student: **Galilea Gonzalez** Grade: **11** G: **F**

School: **Pioneer High School**

Title: **Automatic Pet Feeder**

For pets to be fed automatically, this project requires an understanding of Arduino coding and the engineering of an efficient dispenser. Initially, this project was to encompass three different coding methods: Bluetooth, buttons, and timers, with the purpose of selecting the most beneficial coding method for owners. Unfortunately, between November 13th and 20th, the first dispenser design made of plastic was insubstantial and the coding for each method became not only expensive but time-consuming and uncooperative. Around December 3rd, utilizing resources from Paul McWhorter and NoLi led to a cheaper modification where through a press of a button food would be automatically dispensed. Data was collected at the dog owner's house on the time required to fill different serving sizes based on motor speed. One person measured the time through a stopwatch on iPhone, another person observed any errors within the design, and the last person monitored the button and movement of the dispenser. Trial #1 had no flaps and dispensed little food in long times. Trail 2 had one flap attached to the first “V” of the design where as a result food was being dispensed at an average of 39 seconds. The third trial had a flap on both the first “V” and the rotating design, which showed much faster results: an average of 15.18 seconds. With three trials, it then became clear that no matter the serving size, the pet food will be efficiently dispensed through the utilization of duct tape flaps and high speeds.

Project # **S0817** Category: **Engineering Applications - Sr**

Student: **Joaquin Resendez** Grade: **10** G: **M**

School: **Pomona Unified School District Senior Division**

Title: **Piezoelectric Pick-Up**

Our objective is to explain the piezoelectric effect by assembling a homemade piezoelectric guitar pickup. Our hypothesis is that the piezoelectric pickup will be able to pick up and amplify sound from anything as long as it vibrates. We also believe that if the piezoelectric pickup is placed on an area that vibrates more then the clarity will increase compared to an area that vibrates less. The materials are a Guitar amp (with wires), Soldering iron, Piezoelectric transducer, 1/4 inch guitar jack, and decibel meter. Our procedure was Soldier the wires of the piezoelectric transducer to the guitar jack, Attach the pick-up onto the guitar, Plug the amps wire into the guitar pick-up, and Test amplification. The results are made up of the testing of a short and long pickup placed in different places of a guitar and kalimba to see which pickup amplifies the best in different levels of vibration. The results were that the short pick-up worked better on the back of the guitar's saddle.

Project # **S0818** Category: **Engineering Applications - Sr**

Student: **Jiselle Rivas** Grade: **11** G: **F**

School: **Pioneer High School**

Title: **Hydraulic Robotic Arm**

Our study demonstrates to engineers how to use biodegradable materials in place of several environmentally damaging elements, such as corrosive chemicals, lubricants, metals, etc. We additionally hope to demonstrate to toy manufacturers how to build toys using biodegradable materials rather than so much plastic with the development of our hydraulic arm. Using biodegradable materials rather than all those horrible plastics, it would not only benefit our environment but also teach youngsters how to create. Cardboard, syringes, pipes, popsicle sticks, skewers, batteries, zip ties, and hot glue are the materials we used. We constructed our hydraulic robotic arm over the course of five days using these essential items. Our project's output is the development of our hydraulic robotic arm and the capacity to use biodegradable materials rather than damaging ones that will affect the environment. We learned the importance of employing biodegradable materials to build something strong and long-lasting through our successes and failures in the early stages of actually developing our project. Finding out more about this issue and potential solutions It was found that recycled cardboard can save more trees than one would think. Even though the idea is relatively simple, it raises the question of if there is a better approach to deal with the pollution issue. In the long run, using recyclable and sustainable products would benefit us and our future.

Project # **S0819** Category: **Engineering Applications - Sr**

Student: **Philippe Sawaf** Grade: **10** G: **M**

School: **The Buckley School**

Title: **Fire Resistant Medical Carrier Drone**

Our project aims to reduce the mortality rate of fires with a carrier drone that efficiently delivers medical supplies to fire scenes. The project consists of both a capsule and a drone. The capsule needed as much surface area as possible in order to minimize voidspace, while also being able to withstand extreme temperatures with minimal warping. The capsule will be wrapped in an aerogel insulation, so that the medication (simulated with wax) will be fully protected. The capsule is also wrapped in sorbothane, a shock absorbing material so that the capsule underneath can be protected from physical force. Data collected includes the capsule withstanding forces of 1000 newtons with minimal warping, and the most stress it undergoes is 22.17 MPa. However, with sobathane, that number is reduced even further. The maximum displacement is 6.6 mm. The capsule also withstands temperatures near 1000C with the aid of the insulation. The drone is a quadcopter that has arms made of nylon, the same material as the capsule. This is because nylon is a heat resistant material. The drone also has insulation around it so that it can be protected from the fire, especially around the adhesive areas and the battery, which are most susceptible to high temperatures. The drone itself can carry 4096 grams, which also influenced our choices of insulation and building materials. Overall, all our research will open up more opportunities for many more advances to be made for people to survive wildfires.

Project # **S0820** Category: **Engineering Applications - Sr**

Student: **Athreya Sriram** Grade: **10** G: **M**

School: **Whitney High School**

Title: **Temperature Scanning Station**

As the pandemic still lingers on, facilities continue to ensure precautions such as: sanitizing their environment, or taking the temperature of these facility workers. My project, Temperature Scanning Station, is designed to autonomously scan people's temperature and store data, integrated with facial recognition. This device could be used in many facilities, to help decrease the rate of viral transmission. An infrared sensor, used as a non-contact thermometer, was connected to an Arduino microcontroller to transmit data to a computer. I created a program to execute this by reading from the sensor and transmitting data to the database, which was also implemented with facial recognition (for identification). A clip-on grip was used to support the device to forehead level. The device was tested multiple times at varying distances, while displaying the most accurate data at a distance of 15-18 cm from the sensor. However, the measurements were more accurate if measured within 30 cm. The graph shows a trend of decreasing in temperature as the distance increases until the outliers after 30 cm. As my device has a certain level of precision, I believe it to be an effective, autonomous solution to prevent the transmission of diseases. However as this concept of device is still relatively new in the field of safety, and can be experimented with, I believe my device has a lot of room for growth. I am also currently experimenting and tweaking facial recognition algorithms, which is promising.

Project # **S0821** Category: **Engineering Applications - Sr**

Student: **Don Wong** Grade: **11** G: **M**

School: **Diamond Bar High School**

Title: **Autonomous UAV-Assisted Light Pollution Mapping**

Night skies, pristine for millennia, are plagued by ever-increasing light pollution — hindering the quality of astronomical research, harming human health, and eliminating a source of inspiration and heritage to human civilizations. To enable effective solutions for combating light pollution, efficient mapping of the night sky's brightness must be realized. The current and most widespread method of surveying the night sky involves traversing through the desired area of surveillance and gathering measurements with a handheld Sky-Quality Meter (SQM), a tedious, time-consuming, and inconsistent process. With the development of unmanned aerial vehicles (UAV) allowing advanced customizability and capabilities, this study focuses on characterizing a streamlined methodology of mapping light pollution using this technology. A quadcopter UAV incorporating previously developed SQMs is customized optimally to collect sky brightness measurements. A Crossfire radio for maximum range, low kV motors for efficiency, and a Pixhawk flight controller enabling autopilot capabilities were used. Autonomous flight paths are mapped using the Mission Planner software, enabling data collection in remote areas, including forests, mountains, and aquatic bodies. Time and location of each SQM measurement are matched via a GPS device attached to the UAV system. Data were collected in areas of Cleveland National Forest, then analyzed and mapped with Python. In contrast to manual sky brightness measurements, this work shows the implications of utilizing a UAV system to survey vast expanses of the night sky efficiently. The practicality of our gradient-colored maps created via Python allows appropriate measures and solutions for combating light pollution to be identified.

Project # **S0822** Category: **Engineering Applications - Sr**

Student: **Paul Holschneider** Grade: **11** G: **M**

School: **The Buckley School**

Title: **Optimizing Wheel Fairings for Fixed Gear Aircraft**

The purpose of this experiment is to examine the aerodynamic properties of wheel fairings for fixed gear aircraft and how altering the height of the trailing edge affects aircraft performance. Specifically, we investigated the Lift Coefficient and Drag Coefficient as indicators of aircraft efficiency at various angles of attack.

Three aircraft fairings were modeled using Solidworks, altering the height of the trailing edge between various heights. Control variables between the models include the length, maximum height, width, frontal profile, and upper profile of the fairing as well as the wheel they contain. Trailing edge height will be measured as a percentage of the maximum height of the fairing itself. We will use a 0% height fairing, increasing in intervals of 15% up to 30%.

Models were tested in The Buckley School's wind tunnel, the University of California's Fluid Dynamics Lab, and in Solidworks Flow Simulation. Physical Model testing covers a range of Reynolds numbers between 50,000Re and 180,000Re, and Simulation data cover Reynolds numbers of 2,000,000Re to 6,000,000Re, the flight regime of the Cessna 172, the most widely produced aircraft.

Preliminary data shows that laminar airflow remains attached until the highest point along the fairing, at which laminar separation occurs. Shortly after (~0.5cm), transition occurs. Separation and transition occur for all models, however, as the trailing edge height is increased, separation is delayed until further downstream.

Project # **S0901** Category: **Engineering Research - Sr**

Student: **Andreas Tempereau** Grade: **12** G: **M**

School: **Palos Verdes High School**

Title: **Designing and Constructing an Automatic, Non-Electrical Cardiopulmonary Resuscitation Machine Gen 2.0**

The ongoing problem of medical malpractice, which accounts for nearly 251,000 deaths per year, highlights the need for a more sophisticated solution to the issue of human error. To address this, the MedicalTech Automatic, Non-Electrical Dependent Cardiopulmonary Resuscitation Machine was developed, a revolutionary CPR machine that utilizes advanced technology to provide accurate and efficient chest compressions without the need for electricity.

The MedicalTech CPR Machine is comprised of two main components: the machine itself and an advanced backpack that powers the device. The machine features an upgraded aluminum body, which is welded, bolted, and supported through various mechanical techniques, making it both durable and precise. This system is movable and adjustable through a wheeled gantry system. Additionally, the device is equipped with a flexible magnetic attachment system that allows for easy switching between attachments for different aged patients, as well as four extendable legs for varying chest heights.

Furthermore, the machine is equipped with sensors that actively monitor and relay leveling information to the operator, and even in the event of power loss, the machine is still able to thoroughly perform CPR. Additionally, the device features adjustable PSI regulators to allow for changes in force application onto the chest.

The MedicalTech Gen2.0 CPR machine represents a significant step forward in eliminating human error and utilizing technology to improve outcomes in the medical field. With its advanced features and capabilities, it holds the potential to significantly reduce the number of deaths caused by medical malpractice.

Project # **S0902** Category: **Engineering Research - Sr**

Student: **Christine Xie** Grade: **11** G: **F**

School: **Palos Verdes High School**

Title: **Hydrogel-assisted brain transplantation of HOXA3-expressing endothelial progenitor cells for brain repair after stroke**

Stroke is the leading cause of disability in the United States and the fifth leading cause of death worldwide. An ischemic stroke occurs when a blockage cuts off the blood supply in the brain, leaving behind an empty cavity. While the severity of stroke may be mitigated using tissue plasminogen activator, a chemical dissolvent, or mechanically retrieving the blood clot with endovascular stents, there are no FDA-approved treatments that completely remove the resultant neurological deficits. These limitations urge the need to explore therapeutic solutions outside conventional practices in neuroscience. It has been recently found that post-stroke angiogenesis plays a major role in endogenous repair mechanisms. Additionally, HOXA3, a gene expressed during embryonic development, has been shown to assist in the rapid development of a vascular network. Here, we propose to engineer HOXA3-expressing endothelial progenitor cells and hypothesize that it will increase vascular sprouting and therefore enhance brain repair.

To evaluate the impact of HOXA3 on endothelial progenitor cells, an optimized three-dimensional engineered system was used to observe and promote angiogenesis in vitro using Human Umbilical Vein Endothelial Cells (HUVECs) coated on dextran beads that have been suspended in a fibrin scaffold. Two groups were tested: HUVECs and HOXA3-expressing HUVECs.

It was found that HOXA3-expressing HUVECs showed enhanced vascular area, longer sprouts, and a higher degree of anastomosis, or connection between blood vessels.

These findings support the hypothesis that HOXA3 creates a more robust vascular plexus, advancing understanding of the therapeutic potential of HOXA3 on stem cell-based treatments for stroke.

Project # **S0903** Category: **Engineering Research - Sr**

Student: **Sanjith Cherumandanda** Grade: **11** G: **M**

School: **La Canada High School**

Title: **Designing and Evaluating the Effectiveness of a Quartic Spline Interpolation within Engineering Simulations**

As a polynomial's order increases, its corresponding interpolation method yields more precise data trends. Many engineering softwares that simulates the effects external forces pose on geometries, such as ANSYS, use linear interpolation to generate values between successive nodes. By using an interpolation method with a higher order polynomial, we can use less nodes to generate a predicted path, which will decrease its runtime. For our project, we improved the cubic spline algorithm to design a piecewise quartic spline algorithm to interpolate data. We tested 3 different geometries—a cube, a square frame, and a pipe—under multiple stresses. These structures were tested under a moment force, linear force, and heat flux. The resultant data points were graphed and interpolated with our new methods. We calculated the error from the actual solution between our quartic spline interpolation model and a linear model (ANSYS generated model) using integration. The goal of our research was to minimize the errors in interpolated data in engineering simulations while also keeping runtime low.

Project # **S0904** Category: **Engineering Research - Sr**

Student: **Badruddin Alestwani** Grade: **10** G: **M**

School: **Institute of Knowledge High School**

Title: **The Cryptic Wifi System: Investigating the Impact of Height on Pollen Router Signals**

Objective: The goal of this project is to determine the effect of height on the performance and efficiency of decentralized WiFi routers. The hypothesis is that the router placed higher than the middle position will exhibit the best performance and efficiency.

Procedure: Five routers were installed: the first at 0m on the floor, the second on stairs at 2m, the third at 3.02m, the fourth at 4.7m near a window in the attic, and the fifth on the roof at 6.3m attached to a chimney. All were secured with screws or rope and had power and ethernet cables connected.

Results: The results of the experiment showed that the ground-level router recorded an average speed of 35 Mbps, while the router on the first set of stairs recorded 55 Mbps. The router on the second set of stairs recorded 120 Mbps, demonstrating the impact of placement on the performance of the WiFi signal. The router in the attic recorded the highest speed of 162 Mbps due to its elevated position, while the router on the roof recorded 140 Mbps due to its limited reach from its high line of sight.

Conclusion: The results were consistent with the initial hypothesis, which stated that the optimal placement for the routers would be slightly higher than the middle position. The results indicate that simply increasing height does not guarantee improved performance.

Project # **S0905** Category: **Engineering Research - Sr**

Student: **Lily Arjomand** Grade: **10** G: **F**

School: **Brentwood School - Senior Division**

Title: **Ant's Capability to Sequester Carbon Dioxide to Increase C02 Removal in the Environment**

The steady increase in CO2 concentration in the atmosphere, primarily due to anthropogenic effects and deforestation (1), highlights the need for natural solutions to slow climate change. I aim to investigate the potential of ant colonies to sequester carbon through the creation of limestone, as suggested by Robert Dorn's publication (2). The research will focus on determining if CO2 concentration decreases in a formicarium, and the first step will be to explore the use of bioremediation of CO2 in the environment using ants. The findings of this study may provide insight into a natural method for carbon sequestration, potentially contributing to efforts to mitigate the effects of climate change.

1. Chen, H. W., Zhang, L. N., Zhang, F., Davis, K. J., Lauvaux, T., Pal, S., ... & DiGangi, J. P. (2019). Evaluation of regional CO2 mole fractions in the ECMWF CAMS real-time atmospheric analysis and NOAA carbon tracker near real time reanalysis with airborne observations from ACT America field campaigns. Journal of Geophysical Research: Atmospheres, 124(14), 8119-8133.

2. Dorn, R. I. (2014). Ants as a powerful biotic agent of olivine and plagioclase dissolution. Geology, 42(9), 771-774.

Project # **S0906** Category: **Engineering Research - Sr**

Student: **Olivia Jimenez** Grade: **10** G: **F**

School: **Pioneer High School**

Title: **How does the Beta Type Stirling Engine affect the rate at which its heat source cools?**

The Stirling Engine is classified as an low temperature differential engine. There has been much research done to analyze the efficiency of the Stirling Engine, concluding that due to the thermal regeneration processes the Stirling engine goes through, (Bahrami, 2011) the Stirling Engine has a practical efficiency of 40% (Ahmadi, Ahmadi, Mehrpooya, 2016). However, no other literature published has determined whether or not the work the Stirling engine produces affects the cool down rate of its heat source. In this experiment, we tested if a Stirling Engine affects the rate at which its heat source cools down, by recording the temperature change of two beakers with hot water, one with a Stirling Engine and one covered by a thermal cup cover. Our hypothesis was the beaker with the Stirling Engine would cool down at a faster rate than the beaker that had a thermal cup. The results of our experiment proved our hypothesis to be valid, with the Stirling engine causing the water that it was depending on as its heat source to cool down at a slightly faster rate than the control. The use of a Stirling Engine could be used to create a renewable power source on oceans that are warming as a result of global warming, with the natural cool down rate of the ocean possibly increasing.

Project # **S0907** Category: **Engineering Research - Sr**

Student: **Usman Rafique** Grade: **11** G: **M**

School: **Geffen Academy at UCLA**

Title: **Factors Determining the Difference in Rocket Apogee Measurement using GPS and Barometric Altimeter**

Accurate assessment of rocket apogee is crucial. We evaluated factors which determine differences in rocket apogee using GPS versus barometric altimeters. GPS uses mathematical models to approximate Earth's shape and derives apogee from ellipsoid and geoid heights. Barometric altimeters determine apogee using relative changes in atmospheric pressure.

We conducted 16 launches (6 at 35.338°N,117.865°W, elevation 1900ft; 7 at 34.5041°N,116.9542°W, elevation 2848ft) using a custom-built 675g rocket with: F67W-6 motor (Impulse: 61.1Ns), Featherweight GPS, and PerfectFlite barometric altimeter. Three flights were excluded due to altimeter/motor failures.

The average apogee for 13 flights was 778±58.5ft (variance 3427ft2) for GPS and 796±61.6ft, (variance 3800ft2) for barometric altimeters with mean difference of -18.08±48.04ft (pair t-test p-value=0.2). Group with above(n=7) vs. below (n=6) average difference in apogee differed by: temperature (45±9°F vs. 59±2.5°F, p-value=0.006), cloud-cover (8±7% vs. 20±7.5%, p-value=0.011), dew-point (23±6°F vs. 31.5±2°F, p-value=0.01), wind-speed (2.7±2mph vs. 5.7±1mph, p-value=0.008), atmospheric-pressure (30.09±0.04inHg vs. 30.12±0.016inHg, p-value=0.016), location (FAR vs. ROC 100% vs. 25%, p-value=0.021), ground-elevation (2171±463ft vs. 2848±0ft, p-value=0.008), latitude (35.1±0.41° vs. 34.5±0°, p-value=0.008), longitude (117.6±0.44° vs 116.95±0°, p-value=0.008), and humidity (40.5±5% vs. 34±5%, p-value=0.054); but did not statistically differ by rocket-mass (654±37g vs. 675±0.4g, p-value=0.193). In multivariate linear-regression analysis wind-speed was only significant independent predictor of difference between GPS and barometric apogees (B=13.9±5.1ft, 95% CI 2.6–25.1, p-value=0.020). Barometric-altimeter measured apogee 13.9ft lower compared to GPS for every 1mph increase in wind-speed.

GPS-altimeters provide less variance in apogee compared to barometric-altimeters for similar geoid heights. In multivariate analysis wind-speed was only significant predictor of apogee difference.

Project # **S0908** Category: **Engineering Research - Sr**

Student: **Anish Anand** Grade: **9** G: **M**

School: **Palos Verdes Peninsula High School**

Title: **A Novel Control System for Autonomous Quadcopter Navigation**

Quadcopters have many uses like delivering packages and search-and-rescue, due to easy maneuverability. However autonomous quadcopters are difficult to control since 4 motor inputs control 6 positional states of the quadcopter (3 translational, 3 rotational). This project investigates autonomous navigation for quadcopters with a novel dual-loop control system, so they can "self-drive".

A novel dual-loop was developed with 2 independent control loops to navigate the quadcopter. In between each navigation update to reposition the quadcopter, the quadcopter angles are forced closer to their hover states so that navigation can be robust and smooth.

Four feedback control algorithms (PD, PID, BSC, SMC) were modified to fit the dual-loop control system. Original MATBLAB programs simulated the quadcopter navigation. Parametric analysis was used to optimize each control algorithm based on settling time, noise and maximum range.

A single axis quadcopter model (theta) and quad axis quadcopter model (theta,phi,psi,z) were built to determine real-world workings of quadcopters and validate MATLAB simulation data. Each prototype contained motors, propellors, ESCs, MPU6050 (accelerometer-gyroscope), and Raspberry Pi or Pico microprocessor. The prototypes' Angle and Angular Velocity results validated the simulation data. A cost function based on settling time, noise output, and maximum range revealed SMC control algorithm performed the best (9.4 SMC, 25 BSC, 12 PD, 16 PID) due to fast settling times and reasonable levels of angular velocity to move the quadcopter in the x-y positional states. The novel dual loop system was 2X faster and more robust than existing single loop control systems in current literature.

Project # **S0909** Category: **Engineering Research - Sr**

Student: **Alexander Lee** Grade: **9** G: **M**

School: **Walnut High School**

Title: **Internet-of-Things Connected Foley Catheter Urine Collection System to Automatically and Continuously Measure Urine Output**

Urine output is an important indicator of the level of renal impairment in patients. Accurately measuring urine output is critical in the treatment of hospitalized patients with renal injury, heart failure, and other life-threatening conditions. Currently, the most common way to collect urine uses a Foley catheter connected to a urine collection bag that has volume gradation markings. This measurement method has a low level of accuracy and is labor-intensive, requiring a nurse to manually measure the urine collected periodically. This project developed an Internet-of-Things enabled system that captures urine output automatically in real time, by continuously monitoring the urine volume collected via the Foley catheter. The device is built utilizing a strain gauge load cell, an integrated circuit that contains an amplifier and analog-to-digital converter, and a WiFi-enabled microcontroller. The data is sent via wireless networking to a data collection and analysis server which provides accurate analyses of urine output. A mobile application utilizing the Blynk.io system is used to display the data. This device and mobile application was built at a minimal cost of $35 USD. The device has been tested multiple times and reported urine output accurately, with as little as 1% difference between actual vs measured volumes. In the future, further development of this device can provide hospitals and physicians worldwide with easy access to affordable, accurate, and real-time urine measurement, which would translate into better, life-saving medical care.

Project # **S0910** Category: **Engineering Research - Sr**

Student: **Dylan Rodriguez-Romero** Grade: **9** G: **M**

School: **Pomona Unified School District Senior Division**

Title: **Solar Panel Boat vs. Battery Powered Boat**

There are boats that are powered by solar panels and boats that are powered by batteries, my project will determine which energy source will create a better and faster performance. The two boats will compete with lap times around a pool that has a circumference of 195 inches.

Project # **S0911** Category: **Engineering Research - Sr**

Student: **Sophie Sun** Grade: **11** G: **F**

School: **Palos Verdes High School**

Title: **3D Printing Houses: PLA vs. Algae Filament**

According to the EPA, the construction and demolition industry produces about 230 to 600 million tons of waste each year, with most of that waste discarded into landfills. As this waste leaches into the surrounding environment and releases harmful greenhouse gasses, ecosystems are disrupted and organisms are thrown into disarray. Recently, to combat this issue, 3D printed houses have been on the rise. With companies such as ICON and Mighty Buildings producing communities of concrete-slurry based houses in a matter of days, the construction industry has been revolutionized. This new method of construction greatly reduces waste and the cost of construction, but even so, it still uses concrete, which generates 2.8 billion tons of carbon dioxide.

To resolve this problem, I designed an experiment to determine the corrosivity of algae based 3D filament. My hypothesis is that because the algae based filament is biodegradable, it will erode faster than the PLA filament. My objective is to study the difference between PLA and algae filament corrosivity.

Through experimentation by comparing PLA and algae based 3D filament, I will be able to determine whether algae filament is a suitable replacement for PLA structures in housing to reduce the amount of concrete-slurry needed.

After about 2 weeks of experimentation, I discovered that the algae based filament's mass did not reduce significantly, disproving my hypothesis that the algae filament would erode faster than the PLA filament. These results demonstrate how algae filament is a suitable and more sustainable option than PLA filament.

Project # **S0912** Category: **Engineering Research - Sr**

Student: **Caroline Collis** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Textiles Reaching Out Miles: How Washing your Clothes Pollutes the Environment with Microfibers**

Objectives

My objective is to discover what fabric is the most environmentally damaging and whether a Cora Ball, a microfiber filter, prevents microplastic pollution during the washing process, as 35% of microplastic pollution comes from textile usage.

Materials and Methods

I cut 4 fabric types (polyester, rayon, nylon, and cotton) to 8 4in. by 4in. squares. For each fabric, I washed 4 squares separately with the Cora Ball and 4 squares without. For each group, I filled a 5 gallon bucket with the released water. I used a vacuum filtration system to extract microfibers in the water. Prior to filtration, I measured the masses of the filter paper. After filtration, I measured the filter paper final mass and used a microscope at 20x to collect photos of the microfibers on the filter paper.

Results

Polyester had the highest average mass of emitted microfibers at 0.0207 g (cotton: 0.0190 g, rayon: 0.0130 g, nylon 0.0070 g, control group: 0.0048 g). The Cora Ball had an average 64% reduction in mass (polyester: 95%, cotton: 86%, rayon: 56%, nylon: 21%, control group: 64%). Rayon had the highest average visible microfibers at 60 (cotton: 57, polyester: 46, nylon 28, control group: 16). The visible microfibers decreased an average 56% with the Cora Ball (cotton; 73%, polyester: 84%, nylon 60%, control group: 62%).

Conclusion

The Cora Ball effectively decreased microfiber amounts during washing. Polyester and rayon had the most microfibers measurements, suggesting that microfiber pollution primarily comes from synthetics.

Project # **S0913** Category: **Engineering Research - Sr**

Student: **Steinunn Liorsdottir** Grade: **10** G: **F**

School: **Flintridge Preparatory School**

Title: **A Science Project For Making Science Projects**

In the recent discussions about the uses for AI chatbots, ChatGPT's abilities as a tool for scientific research have not received much attention. It can turn common language commands into programming scripts, and help with simple data analysis. Therefore, I was interested in the viability of ChatGPT for scientific research, so I conducted an experiment to analyze its accuracy and versatility. Using a data set of 117,732 stars that ChatGPT found, I was able to analyze the relationships between the absolute magnitude and the color index of stars using only ChatGPT to write code and produce results. I did not find a linear correlation between color index and absolute magnitude. ChatGPT was able to confirm the Hertzsprung-Russell diagram, and I was able to separate the different types of stars by clustering my data. With ChatGPT, I found a negative correlation between color index and absolute magnitude in white dwarfs, but not in other kinds of stars. Ultimately, I showed that while, ChatGPT is a great tool for code-writing but has some drawbacks; it offers very good debugging input, but will often give multiple possible fixes, and the user has to identify which of them works. While it streamlines the coding process, ChatGPT requires the user to be able to read over code and identify mistakes. ChatGPT cannot automate creativity and insight. Thus, while it is an incredibly powerful tool that can massively accelerate research, ChatGPT cannot at this time replace researchers.

Project # **S0914** Category: **Engineering Research - Sr**

Student: **Anthony Valencia** Grade: **12** G: **M**

School: **Palos Verdes Peninsula High School**

Title: **MLPEG: Using Machine Learning for Data Compression**

Video data is the most commonly transmitted form of data over the internet. Although streaming is fast, it can be faster. Making video transmission more efficient will allow for devices like phones, tablets, and televisions to buffer less when rendering HD videos. For long term archive storage of video footage, improved compression ratios can decrease the overhead costs of storage infrastructure. MLPEG aims to make video footage have a smaller digital footprint than H.264 (MPEG-4), which is the most common form of video compression currently.

MLPEG uses FILM, ESPCN, Python, and an AMD Ryzen 5 3600 processor to compress video files. Videos are compressed by selecting keyframes in a video through selecting data at a certain interval, downscaling the resolution on those images, and then saving those images into a file. To decompress, MLPEG will read the compressed file, run FILM–a video interpolator–to make up the frames that were lost in the compression process, and then upscale the images to the original resolution the video was at.

Using MLPEG, file sizes became increasingly smaller at an exponential rate by a factor of two. When compared with the file sizes of MPEG-4 videos MLPEG videos were relatively equal to or less than MPEG-4 file sizes. Despite some discrepancies in decompressed videos, MLPEG was also able to maintain visual quality and resolution.

MLPEG shows that machine learning models may be a viable alternative or addition to traditional forms of data compression.

Project # **S0915** Category: **Engineering Research - Sr**

Student: **Nita Kelly** Grade: **11** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Breathe with Ease: Assessing the Efficiency of HEPA Air Filters**

Objectives

This experiment aims to test the efficiency of a HEPA filter overtime. To do so, my experiment tested the ability of a HEPA filter to filter incense smoke three times.

Materials and Methods

My experiment simulated air pollution using the smoke from a lit incense stick. The incense sticks were then placed in containers with a HEPA filter covering the top, ensuring that the smoke would pass through the filter. There were three identical containers of varying heights for the incense (5in, 10in, 15in), which further allowed the experiment to analyze HEPA filtering efficiency from varied distances. After filtering, a photometer was used on the filter to assess the structural integrity after each use. This process was repeated three times, which allowed for the filter's efficiency to be analyzed after multiple uses.

Results & Conclusion

The results are still being collected, and a conclusion cannot yet be determined for this reason.

Project # **S1001** Category: **Environmental Management - Sr**

Student: **Gray Rappoport** Grade: **10** G: **M**

School: **Palos Verdes High School**

Title: **Creating a Inexpensive, Effective Super Saturated Polymer Out of Citrus Polysaccharides**

The loss of water when farming constructs a significant environmental issue, as droughts evaporate 3o% to 75% of agriculturally used water. Retaining the water in the soil is an essential environmental act, acting against water depletion. The objective of this project was to create a cheap and effective super absorbent polymer from cross linked citrus polysaccharides, using both oranges and avocados.

I constructed a chemical system that allowed me to crosslink 17 oranges and 14 avocados through blending and a heating process of sitting in an oven for 180 degrees celsius for 20 minutes. Once the three built super absorbent polymers, and orange juice solution, an orange juice, orange peel, and avocado mixture, and a orange peel and avocado mixture were completed they were put into soil containing 12 Ocimum Sanctum plants along with prebuilt super absorbent polymers acrylic, pectin, and starch. For 22 days a soil moisture meter was used to take samples of moisture from each of the soil boxes and a ruler was used to measure the plant's height.

The combined mixture of orange peels, orange juice, and avocado peels stayed above a moisture level of 8 for 17 days and gained 2.03 cm of height proving that it was the most effective super absorbent polymer. This critical result was then achieved as only four leaves were lost for 16 days of testing.

Creating a cheap yet effective superabsorbent polymer from crosslink citrus polysaccharides proved to be an effective objective and revolutionizes the future of farming.

Project # **S1002** Category: **Environmental Management - Sr**

Student: **Joyce Luo** Grade: **9** G: **F**

School: **Pomona Unified School District Senior Division**

Title: **Cooked By Soot**

My project is about the effect of carbon deposits and the melting of snow and glaciers, resulting in climate change. I measured the rate of snow melting depending on the amount of soot scattered on top by collecting the melt water in measuring cylinders. My conclusion was that snow samples with no soot melted slower than samples with soot, but samples with excessive soot melted slower than samples with moderate soot.

Project # **S1003** Category: **Environmental Management - Sr**

Student: **Ethan Lee** Grade: **11** G: **M**

School: **Crescenta Valley High School**

Title: **Landfill Coverage Through the Utilization of Charcoal**

This project aimed to test the efficacy of charcoal in mitigating methane (CH4) and carbon dioxide (CO2) emissions as an amendment in landfill cover soil over biochar. It was hypothesized that activated charcoal (AC) will be a viable alternative for biochar under incompatible soil conditions, which includes loam, due to the similarities found in the chemical composition of the two substances. This was tested through the construction of models that replicated the structures of present-day landfills. The concentrations of CH4 and CO2 were recorded weekly for four weeks, the first recording being four weeks after the models were built. This time span was given so that the models had enough time to decompose the waste material added to replicate the biodegradable waste in landfills. Three landfill models were constructed; each model was constructed identically, differing only by the type and volume of charcoal for the landfill covers. The first model contained AC, making up 15% of the cover soil, the second contained a smaller amount of AC, making up 10% of the cover soil, and the third contained horticultural charcoal to replicate the effects of biochar, making up 15% of the cover soil. In all recordings, the effectiveness of AC was very similar to that of horticultural charcoal. During the first recording, the methane concentrations in the 15% AC model and the 15% horticultural charcoal model were 289 ppm and 285 respectively. Similar results were displayed in the following weeks of data collection, ultimately supporting the hypothesis.

Project # **S1004** Category: **Environmental Management - Sr**

Student: **Esther Hwang** Grade: **11** G: **F**

School: **Crescenta Valley High School**

Title: **Water Contamination in La Crescenta Schools**

This project aims to test water fountains and refill stations in La Crescenta schools for the presence of bacteria, nitrate, and copper at levels outside the safety standards set by the EPA. Nitrate is a common contaminant in drinking water, coming from fertilizer runoff, animal manure, or naturally occurring sources. The maximum contaminant limit (MCL) for nitrate is 10 mg/L and 1.3 mg/L for copper. Consumption of copper levels above the MCL may lead to gastrointestinal distress (short-term) and liver or kidney damage (long-term). The presence of Escherichia coli in drinking water would indicate fecal contamination. It was hypothesized that a high concentration of at least one contaminant would be detected. To test for bacteria, samples were collected in separate 5 mL sterile test tubes from select water fountains and refill stations at a high school (CVHS) and a local elementary school. 10 ?L of each sample was inoculated onto an agar plate then placed in an incubator at 35°C. The agar plate was checked every 24 hours. Samples with bacterial growth was tested again to rule out E.coli. A color indicator was used to test for nitrate, and test strips were used for copper. The highest level of nitrate detected in both schools was 80 mg/L. Our results supported our hypothesis, showing bacterial growth in some samples, a high concentration of nitrate in all but one water fountain at the elementary School, and copper levels ranging from 0 to 1 mg/L.

Project # **S1005** Category: **Environmental Management - Sr**

Student: **Scarlett Tinajero** Grade: **11** G: **F**

School: **Pioneer High School**

Title: **How detergent affects our environment**

My topic was how laundry detergent soap affects our plants and environment. I chose this topic because many plants are being contaminated by soapy toxic water and we think it is important for our plants to stay alive and grow to provide carbon dioxide and other nutrients for our earth, insects, animals and our own well being. My hypothesis was that the plant that was watered with a mixture of soap and water will slowly die. I watered two of the same plants with different water, one with a mixture of laundry detergent and water and one with just regular water. Each plant was watered with a half a cup of water or mixture every morning and night. I discovered that the plant with soapy water ended up meeting its end of life, concluding the fact that there are certain toxicants in just soap that are able to cause harm to our environment. I learned that the basic household cleaning products that are used everyday by everyone are slowly killing our environment and that this could lead to a very serious issue in the future for not only our environment but for our population.

Project # **S1006** Category: **Environmental Management - Sr**

Student: **Aiden Park** Grade: **10** G: **M**

School: **North Hollywood Senior High School**

Title: **The Effect of Temperature on the Shedding of Microplastics**

Microplastics have always been a problem in society ever since their discovery in 2004 and arguably even all the way back since the 60's. They've been plaguing our water supply, our food supply, and even the air around us. They come from a multitude of sources and one of the most known sources are water bottles. However, if they plague us with microplastics in the ocean, what's to say they aren't plaguing our drinking water too?

Microplastics are, by definition, pieces of plastic that are between 1 micrometer and 5 millimeters in diameter. While people keep mentioning microplastics as a dangerous health concern, surprisingly, as of now, there is no solid scientific evidence to show that microplastics are harmful in and of themselves. However, it is possible that chemicals released by these microplastics are extremely harmful. Depending on the source, they can contain many different heavy metals. These heavy metals have known harmful effects on the body and are already labeled as bad far and wide.

A study by Sherri Mason looked at 11 different water bottle brands and observed the amount of microplastics contained in each. They found that there were, on average, 325 microplastic particles per liter. However, they didn't look at temperature's effect on the amount. In my experiment I will put water bottles in a refrigerator, at room temperature, and in an incubator set to around 40 degrees C. Then we will see the amount of microplastics in each water sample using a stainer to help identify the microplastics.

Project # **S1007** Category: **Environmental Management - Sr**

Student: **Ruby Rose Carlson** Grade: **12** G: **F**

School: **Brentwood School - Senior Division**

Title: **Caenorhabditis elegans Soil Rejuvenation**

Soil, the most extensive living system on this planet, contains billions of organisms within a few square inches.
Each microbe works to sustain the lives of plants, supporting other lives, animals, and humans.
Forests are essential in maintaining a steady climate as carbon sinks and homes for organisms. As climate change worsens, humans are tasked to discover new ways to access fertile agricultural land other than through deforestation since biodiversity in the soil is decreasing, which are the stewards to degrade organic waste.
This experiment will provide the first steps towards turning arid desert sand into a fertile environment for burgeoning plant life by examining the affects of Caenorhabditis elegans (C. elegans) and a food source, a rotting apple, on arid desert sand. We designed a soil column experiment with and without fruit bait and germination of the Wisconsin Fast Plant occurred. By examining the health of the Wisconsin Fast Plant, e.g., stem thickness, leaf vibrance, and soil absorption to the roots, we can observe the effects of C.elegans on arid Earth soil. Preliminary results indicate that the addition of C. elegans to Earth sand benefited plant growth.

Project # **S1008** Category: **Environmental Management - Sr**

Student: **Adam Azzaz** Grade: **10** G: **M**

School: **Institute of Knowledge High School**

Title: **Fighting Fire with Science: A Comparative Study of Flame Retardant Effectiveness**

Objective: The purpose of this study is to assess the efficiency of different flame retardants through a vertical flame test, with the goal of identifying the most effective one. This experiment is of utmost importance in the present scenario as it serves as an added measure to prevent the escalation of wildfires, mitigate the consequences of climate change, and minimize damage caused by fires of any kind.

Procedure: In this study, four different types of fire retardants (No-Burn, Dri-One, FireGuard, and Master Flame) were applied to 21 cotton cloths, with five trials conducted for each fire retardant and one control group with no treatment. The char marks on each treated cloth were then measured for both length and width, and the results were compared to determine the most effective fire retardant.

Results: The results showed that No-Burn was the most effective fire retardant, followed by Dri-One, FireGuard, and Master Flame. This contradicts the initial hypothesis that FireGuard would perform the best.

Conclusion/Discussion: The outcome of the experiment was satisfactory, but improvements can be made if it were to be repeated. These include increased control over environmental factors such as temperature and wind flow, as well as expanding the testing to include other materials like nylon, polyester, concrete, and marble. The research holds potential in enhancing the development of effective fire safety protocols and strategies.

Project # **S1009** Category: **Environmental Management - Sr**

Student: **Daron Kasparian** Grade: **10** G: **M**

School: **Rose and Alex Pilibos Armenian High School**

Title: **"The Fuel of the Next Generation" Transesterification of Biodiesel Using Recycled Cooking Oils**

The objective of this project is to use waste material, such as recycled oils, to make biodiesel and investigate if the energy output of biodiesel varies according to the type of vegetable oil and concentration of animal fat used in the production of biodiesel. I hypothesize that if equal concentrations of oils are used in each production of biodiesel, then the biodiesel containing lard as a reactant will have the greatest energy content, as lard is fatty oil.

In this project I used the reaction of transesterification to produce Biodiesel from recycled oils:

Triglyceride (cooking oil) + Alcohol (methanol) --> Biodiesel + Glycerin

The results of the experiment were as I expected. The average energy content (J/g) for canola oil, corn oil, sunflower oil, and lard were 8179, 8932, 6578, 11648, respectively.

In conclusion, my hypothesis was supported in this project. The lard biodiesel had the highest energy content out of all of the other biodiesels I made. The reason behind this is that the lard has a very high percentage of saturated fatty acids that will make a biodiesel with high energy contents.

Project # **S1010** Category: **Environmental Management - Sr**

Student: **Yvette Shu** Grade: **12** G: **F**

School: **The Webb Schools**

Title: **Microplastic Fallout Density of Polyester Fabrics from Fast Fashion Companies under UV Light**

This project was designed to investigate the density of released microplastics from articles of clothing made by various fast fashion brands. Two 10-centimeter squares of 100% polyester fabric were removed from tops made by Shein, H&M, and Forever 21. Two other squares were cut from the hem, where one piece of fabric was stitched onto another. These fabric squares were separated into beakers; half was placed in a control group and another half exposed to a 6-watt UV light source. After 30 minutes of exposure, the fabrics were removed, and distilled water was sprayed into the beaker to collect the microplastics. The water and microplastic mixture poured through Grade 2 Whatman filter papers with an 8 μm pore size, enough to capture large microplastics. These filters were dried in an 85^{o}C heat oven for 10 minutes. The weight of the filters was compared, and qualitative and quantitative analysis of the microplastic density was recorded. Preliminary results showed that fabrics under UV light release much more microplastics than control. Shein fabrics released the most microplastics, while Forever 21 release the least overall. Examining a roughly 6.5 x 2.5 cm rectangular piece from the filter under the microscope revealed microplastics of various sizes, shapes, and length. These results prove the omnipresence of microplastics within polyester clothing and the differences in quality between Shein, H&M and Forever 21 fabrics. They also provoke further experimentation into the effect of UV light onto plastic materials.

Project # **S1011** Category: **Environmental Management - Sr**

Student: **Charlie Clayton** Grade: **10** G: **F**

School: **Archer School for Girls - Senior division**

Title: **The Health Implications of Recent Bacterial Waves Along the Coast of Southern California**

Objectives

The objective of this experiment was to see the amount of bacteria from populated beaches that have sources of contamination. To do this, I tested the amount of bacterial colonies (in water from four different beaches) visible on Petri dishes after being incubated for 48 hours altogether.

Materials and Methods

In my experiment, I first used an LB agar solution that I made from water and agar powder and poured it into 15 Petri dishes. I collected 360 ml of water from Santa Monica Pier, Mother's Beach, Topanga State Beach, and Crystal Cove. During my experimental process, I used goggles, approximately 18 pairs of gloves, and sterile swabs to transfer the water to the Petri dishes. I also used the same incubator for all 3 trials, as well as 6 portions of 10% bleach solutions for cleaning surfaces and sterilizing disposed of materials.

Results

In the end, Topanga State Beach had the highest average of bacterial colonies, and Crystal Cove (control group) had the lowest average. Topanga's waters are very populated and the water had a lot of motion in contrast to Mothers Day Beach in Marina Del Rey, but the samples taken were visibly cloudy, unlike other beaches.

Conclusion

These results disprove my hypothesis because I predicted Santa Monica Pier's waters to have the most bacterial colonies, but all the experimental beaches had the capacity and contamination history to contest these results, while Crystal Cove had the best environment and lowest bacterial colonies.

Project # **S1012** Category: **Environmental Management - Sr**

Student: **Skylar Roberts** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Using Homemade Magnetite Ferrofluid to Extract Microplastics From Water**

Objectives

Microplastics are an increasing problem, polluting our oceans and drinking water. It is estimated that the average human consumes 114,000 microplastics each year, and that amount is growing. Magnetite ferrofluid has been proven to be efficient at extracting microplastics from water, but is costly and not widely available. This experiment investigated the efficiency of a more cost effective version of magnetite ferrofluid, composed of synthesized magnetite and vegetable oil.

Methods

The most common types of microplastics were tested (PET, HDPE, PVC, LDPE, PP). A 5 g/L microplastic suspension was created with each plastic and tested in twenty milliliter batches with homemade ferrofluid created with a ratio of 0.5 grams of magnetite and 2.5 milliliters of vegetable oil. The suspension was observed under a microscope before and after extraction. The microplastics were counted using photoshop.

Results

The investigation found the homemade ferrofluid was an average of 93.73% effective. The range of the efficiency rate over the different types of plastic was 8.64%, meaning the efficiency rate varies slightly based on the plastic. The method was 97.05% effective on LDPE plastic, 96.00% on HDPE, 95.62% on PVC, 91.59% on PET, and 88.41% on PP plastic.

Conclusion

This more cost effective version of magnetite ferrofluid shows great potential in the removal of microplastics from water from domestic to industrial levels. This method being more widely available than regular ferrofluid will ultimately lead to a greater removal of microplastics worldwide.

Project # **S1013** Category: **Environmental Management - Sr**

Student: **Ashley Song** Grade: **11** G: **F**

School: **Whitney High School**

Title: **All It Takes is a Switch of Chemicals: A Safer Approach to Extracting Hydrophobic Plant Wax**

Hydrophobic coatings release toxic chemicals and produce pollution over time. Therefore, scientists developed a process to extract a safer hydrophobic wax from plants. However, the process involves strong chemicals that can lead to health hazards. My objective was to compare the yield amount and hydrophobicity of the waxes produced between strong chemicals and weaker chemicals. The chemicals used in this experiment were pure methanol and the safer alternative, acetone-based nail polish remover. To extract the wax, a mixture of 37 grams of crushed kalanchoe leaves and 30 milliliters of a chemical was cooled in a freezer. The cooled mixture was then filtered and left to evaporate, leaving only the wax. The wax produced was used to coat a small piece of filter paper. Cotton balls were placed inside a flask with the filter paper on top, and water was dropped from a pipette onto the paper. I noted how much water weight gain occurred with each cotton ball. There was a significant difference in the weight of the cotton ball between the waxed filter paper and the control, no wax applied, indicating hydrophobicity. There was no significant difference between the methanol and nail-polish remover waxes. More data will need to be collected to finalize this result. I hypothesized that even though nail polish remover is a weaker chemical than the potent methanol, the hydrophobicity of the wax produced will be similar. The result of the research shows that my hypothesis holds, proving that there is no need to use a dangerous chemical to produce a hydrophobic wax. Since I only tested two chemicals to compare, I may consider incorporating other chemicals like ethanol to expand my project.

Project # **S1014** Category: **Environmental Management - Sr**

Student: **Alishba Salman** Grade: **10** G: **F**

School: **Institute of Knowledge High School**

Title: **A Magnetically Attractive Solution: Comparing the Efficiency of Ferromagnetic Nanoparticles for the Purpose of Oil Remediation**

Problem/Question: The goal of this project was to investigate the correlation between the iron content in ferrofluids and their efficacy in cleaning up oil spills.

Procedure: Three ferrofluids were prepared by mixing vegetable oil and iron fillings: the first with 7mL of vegetable oil and 4.2g of iron fillings, the second with 8.4g of iron fillings, and the third with 16.8g. The ferrofluids were then tested for their effectiveness in cleaning up oil spills by simulating an oil spill using 14mL of water and 2.5mL of mineral oil in a petri dish. One petri dish was treated with 1 drop of ferrofluid, the other with 5 drops, and the performance of the commercial ferrofluid was also evaluated for comparison.

Results/Data: On average, the commercial ferrofluid left 1.34mL and 0.56mL of oil in the petri dishes. The ferrofluid with 4.2g iron had an average of 2.84mL and 3.24mL of oil left. The ferrofluid with 8.4g iron had an average of 1mL and 0.26 mL of oil left. The ferrofluid with 16.8g iron had an average of 2.2mL and 1.7mL of oil remaining.

Conclusion: The results partially supported the hypothesis as adding more iron filings increased the efficiency of the ferrofluid. However, there was a point beyond which further addition of iron reduced its efficacy. In conclusion, the results suggest that increasing the amount of iron can improve the effectiveness of ferrofluid to a certain extent.

Project # **S1015** Category: **Environmental Management - Sr**

Student: **Raffi Boghossian** Grade: **10** G: **M**

School: **Rose and Alex Pilibos Armenian High School**

Title: **Do Not Worry about Plastic, We Have Worms!**

Rapidly increasing production of disposable plastic products overwhelms the world's ability to deal with them. This experiment aims to see which of these two types of worms (waxworms and superworms) will eat the most plastic in 5 days. I hypothesized that the worms would consume less plastic if their favorite food were available, and that the superworms without their favorite food would consume the most plastic.
My method was to put 100 waxworms in a plastic bag with no food in one container, and another 100 waxworms in a plastic bag with their favorite food, brown sugar cereal, in another container. Place 100 superworms in a plastic bag with no food in a third container, and 100 superworms with their favorite food, bran cereal, in the fourth container. Wrap the tops of the four containers with Saran wrap and punch small holes for the worms to be able to breathe. Label the containers accordingly. Weigh the plastic bags in the beginning to have the initial weight. Collect data by taking out the plastic bags and weighing the bags every day for 5 days. Find the weight of consumed plastic in grams after 5 days and record.
I found out that my hypothesis was incorrect because I hypothesized that the superworms without their favorite food will consume the most plastic. In my experiment, the waxworms without their favorite food ate the most plastic during the span of five days.

Project # **S1016** Category: **Environmental Management - Sr**

Student: **Ruhini Saha** Grade: **11** G: **F**

School: **Granada Hills Charter High School**

Title: **Pyrolysis of plastic waste to fuel**

My project was designed to test how environmentally sustainable the pyrolysis process is in converting plastic to fuel. My hypothesis stated that pyrolysis is a somewhat sustainable process since it produces a small amount of oil and hazardous byproducts. For the procedure, I made a pyrolysis reactor using a cleaned paint can with a layer of concrete used for insulation. I drilled a hole in the paint lid can and put a copper tube to go through the lid and sealed it using a welded metal to minimize gas loss. The copper tube was then set to go through a cooling chamber which was a bucket of ice. The copper tube was connected to an empty can to collect the oil. I put plastic into the pyrolysis reactor and let oxygen absorbers usually used for food sit in the reactor for a while with the reactor sealed shut. I then removed the oxygen absorbers and put the lid back on. The pyrolysis reactor was heated on a stove and the gas+oil produced was passed through the copper tube. The process produced gases that had a bad odor and were hard to breathe in. It also produced a small quantity of oil. We did not have proper ventilation or industrial equipment, so we weren't able to produce sufficient fuel. The harmful gases were also not disposed of properly due to a lack of proper ventilation. My results supported my hypothesis by showing that the pyrolysis process was semi-efficient.

Project # **S1017** Category: **Environmental Management - Sr**

Student: **Bill Sun** Grade: **11** G: **M**

School: **The Webb Schools**

Title: **Hybrid Photobioreactor System for Economical Biofuel Production with Upcycled Plastic Bottles**

Modern algal photobioreactors for biodiesel production are costly and require significant quantities of material to construct. To determine whether it is possible to create an efficient biofuel production system of equal cost to open pond systems, a new hybrid photobioreactor system made of upcycled plastic bottles was created and run on a 2.5W centrifugal pump powered by a solar panel along with a control open pond system. Both were inoculated with equal amounts of Chlorella Vulgaris culture (0.8 absorbance liter of culture). Microalgae production in the prototype PBR exceeded the other by 7.14% by the end of the cultivation experiment. Further research was done to determine comparative levels of lipid concentration in the algae. Lipids were extracted from 100 mL samples from each cultivation system using a seven-step wet processing method and their quantities were compared. The lipid content of Chlorella Vulgaris grown in the open pond system was 10.81% higher than in the PBR, due to adverse metabolic stress. Throughout the experiment, the average outdoor daily solar flux level was found at 313 umol/m2/s, with the corresponding average daily temperature fluctuation of between 5° and 17.8° C in Claremont. While the pilot-design photobioreactor was equal in construction cost and operation to the open pond system, it had significantly greater algae production rates and propagated less metabolic stress. In conclusion, this experiment demonstrates the potential for an economical and scalable biofuel production system using an upcycled plastic bottle tubular photobioreactor, proving to be cost-effective and efficient.

Project # **S1018** Category: **Environmental Management - Sr**

Student: **Vana Scorza** Grade: **10** G: **F**

School: **Rose and Alex Pilibos Armenian High School**

Title: **Photovoltaic (PV) Solar Cells' Output (watts) vs. the Ambient Temperature (F)**

So I wondered, what happens to solar cells or panels as ambient temperature increases. I hypothesize that solar cells will have a lower power output at higher temperatures. I hung a 90 watt light bulb over the solar panels to simulate the sun. That light was also used to heat up the panels for the experiment. I placed the solar panels, propped up on pots, under the light bulb. I hooked up the panel to a renewable energy monitor and a small DC motor. To cool down the panels, I put ice in a plastic bag under the solar panels inside the pots. Using the renewable energy monitor, I measured the watts from the panels at the different temperatures. I found that when the temperature was lower, the watt output was higher. When the temperature was higher, the watt output was low. My hypothesis was correct: watt output was higher at a lower temperature.

Project # **S1019** Category: **Environmental Management - Sr**

Student: **Debayon Roy** Grade: **11** G: **M**

School: **Crescenta Valley High School**

Title: **Predicting Sewer Pipe Longevity Through Deep-Learning Methods: A Novel Way To Prevent Sanitary Sewer Overflow**

Sanitary sewer overflow occurs when sewers release raw sewage into the environment due to structural defects in the sewer system. The objective of this study is to predict the longevity of the sewer pipes and determine the optimal type of pipe in the case of replacement. The scope of the conditions was within the LA region, which contains the largest sewer pipe network in the nation. The most prevalent internal pipe defects were tested experimentally to determine their effects on different pipe material. The defects tested experimentally were: grease collection, root intrusion, and corrosion caused by acidic conditions. Conditions were measured in 4 different types of pipes: high density polyethylene (HDPE), polyvinyl chloride (PVC), Vitrified Clay Pipe (VCP), and Concrete. Experimentation shows that plastic based pipes (HDPE & PVC) performed the best in all 3 scenarios. NavigateLA, a data source containing information on existing LA sewer systems, was used to collect the information necessary to determine pipe longevity. Literature analysis of the NASSCO pipe guidelines reveal that the conditions that affect the longevity and health of the pipe are: pipe material, surface topography, structural defects, adjacent soil conditions, and installation length. Features determined from the NASSCO guidelines were implemented as independent variables to create a deep-learning program to predict the lifespan of the pipes. This was created through Google Collab and PyTorch. Through neural network programming, machine learning programs were able to accurately predict the useful life of sewer pipes in Los Angeles County, within the optimum 5-10 year range.

Project # **S1020** Category: **Environmental Management - Sr**

Student: **Erica Ro** Grade: **12** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **Measuring the Effectiveness of Thermochromic Roofs for Urban Heat Island Mitigation**

Increased energy costs, air pollution, and heat-related illness and mortality are all consequences of "urban heat islands" - urban areas which are significantly warmer than their surrounding areas due to human activity. Current solutions, such as white, reflective roofs, prove impractical for cold climates. Thus, this experiment tested whether roofs painted with thermochromic paint, which changes from black to clear when heated, could help mitigate urban heat islands by reflecting incoming solar heat in hot weather and absorbing it in cold weather.

Three model buildings were constructed and had their roofs painted with black, white, and thermochromic paint. Temperature sensors were placed inside the roofs and on the ground floors of the models. The models were then placed outside on six different days where sensor data, the surface temperature of the roofs, and the ambient temperature were recorded every fifteen minutes for approximately three hours.

There was a significant difference ($p<0.05$) in the roof surface temperatures and the roof interior temperatures among the three houses. The thermochromic building consistently had temperatures similar to those of the white building in hot weather and temperatures above the white building in cold weather. However, the heating effect was not as pronounced as the cooling effect. There was no significant difference between the ground-level temperatures of the buildings.

These results suggest that thermochromic roofs show promise as an urban heat island mitigation strategy, and further studies should assess their effects in different climates and on different types of buildings.

Project # **S1021** Category: **Environmental Management - Sr**

Student: **Annalia Henderson** Grade: **9** G: **F**

School: **Palos Verdes High School**

Title: **Ballona Wetlands Remove Contaminants from Municipal Runoff: An Ecological Sink for Enterococcus**

Cities are rapidly losing wetlands to urban development. The Ballona Wetlands Ecological Reserve was built in 2003 to help protect the ocean from contaminated municipal runoff. This study investigates whether the wetlands decrease Enterococcus concentrations, a leading indicator of water pollution.

Water samples were collected from the Ballona Wetlands inlet and outlet. Each sample was diluted 1:10 with Enterolert media. Quanti-Trays were filled with 100 ml of each sample diluent and a control tray was used. Quanti-Trays were incubated at 41? for 24 hrs. Using 365nm UV light, the number of wells with fluorescence was recorded. Precalibrated tables were used to quantify Enterococcus concentrations. The results show that the Ballona Wetlands serve to remove Enterococcus and can dramatically lower bacterial counts to safe levels. Alterations such as reed trimming for mosquito control impair the ability of the wetlands to remove dangerous bacteria. Other factors, such as temperature and rainfall, show no clear correlation with reducing bacterial concentration.

This research shows that wetlands serve an important role in improving water quality and safety. Climate change makes effective wetlands even more important as severe weather alternately drains and inundates the wetlands. Future studies include quantifying a critical biomass of reeds to help maintain the effectiveness of wetlands and investigating how the wetlands reduce other pollutants, such as heavy metals. I hope my research will help cities realize the importance of protecting wetlands as part of water management strategies.

Project # **S1101** Category: **Mathematics & Computer Sciences - Sr**

Student: **Jenna Chow** Grade: **12** G: **F**

School: **Palos Verdes High School**

Title: **BerthaBot: A Student Interface with Realistic Communication Through Artificial Intelligence Knowledge Bases**

The impetus for the creation of BerthaBot was an article describing the issues in the American education system. Among the most dire listed was the nation's teacher shortage. This project aims to solve the symptoms causing high teacher turnover. BerthaBot will seek to mimic teacher communication in order to help students with recurring questions in order to liberate time for teachers to spend elsewhere.
Many novel technologies were involved in the fabrication of BerthaBot. Most notable was the BERT and SQuAD natural language processing technologies, which completely redefined BerthaBot's abilities in gaining new knowledge in its knowledgebase. Its previous dual-knowledgebase system was eliminated in favor of a single source with both user input and world knowledge for a faster response time and a more refined data structure. BerthaBot's efficacy has been studied with a thorough method to be described in the methods.
The resulting product of this project is a machine with world knowledge for basic conversation as well as the capability to gain new knowledge in the academic sphere. This product should be able to help teachers to lessen their workload through the automation of answering repetitive student inquiries, thus achieving the initial goal of the project.
Additionally, this project serves to prove that a program can be made to mitigate the issues that created the decline in this country's educators. Furthermore, BerthaBot is an example of how AI can be applied to applications in schooling to improve the educational experience for all.

Project # **S1102** Category: **Mathematics & Computer Sciences - Sr**

Student: **Angelina Tsuboi** Grade: **11** G: **F**

School: **Chadwick School**

Title: **ADS-B Plane Spoofing Detection using Neural Networks and RF Fingerprinting**

In the aviation industry, aircraft spoofing is a growing concern as the use of Automatic Dependent Surveillance-Broadcast (ADS-B) technology becomes increasingly widespread. To combat this threat, I developed a device and a web app that detects spoofed aircraft using a neural network trained on a dataset of verified and spoofed ADS-B signals. The implementation is two-fold: a low-cost device made with the Raspberry Pi, a FlightAware RTL-SDR, and a 1090MHz antenna-based tailored for research that uses a Convolutional Neural Network and RF Fingerprinting techniques to identify and flag suspicious signals, and a Flask-based web application that uses the same algorithm to detect spoofed aircraft from any location using an API, and displays the information onto an intuitive map layout. After testing the implementations on multiple flights in a single-engine aircraft throughout Los Angeles and possible attack scenarios in a simulated environment, both the device and the web app have a real-time detection system with an accuracy rate of over 90% and protect against potential flight delays and mid-air collisions caused by fake aircraft signals.

Project # **S1103** Category: **Mathematics & Computer Sciences - Sr**

Student: **Rachel DeMerit** Grade: **12** G: **F**

School: **Flintridge Preparatory School**

Title: **Predictive Data Model for Diabetic Recommendations**

The growing health care crisis surrounding Type 2 diabetes is of high concern to health professionals. Outside of those already identified as diagnosed as in the range of unacceptable blood glucose levels, there are an estimated 96 million other individuals that are identified as Prediabetics (CDC). The need to create tools to bring awareness to each individual's eating patterns has inspired taking a statistical approach to predictive awareness of the impacts that food choices have on our health. This research delves into the creation of an individualized model and provides a basis for building expanded applications including the likes of mobile application technology to bring higher awareness to the large population of those already inflicted with this disease.

Project # **S1104** Category: **Mathematics & Computer Sciences - Sr**

Student: **Harris Song** Grade: **11** G: **M**

School: **Walnut High School**

Title: **Algorithmic Generation and Implementation of the Protein Universe**

We formulate and implement an algorithmic process for visualizing multi-dimensional distance matrices in the protein structure. The algorithm is developed to convert a multi-dimensional distance matrix into a two-dimensional image that better represents the connected protein structure based on the closest distances between points. The problem can be recursively calculated to produce a multi-distance accurate graph. Previous methods do not effectively utilize the displacement of the angle between vertices and attribute to convey distances between points as manually computing the geometric structures would be time-inefficient. The resultant lines represent the natural distance between two proteins and give directionality; with the development of this algorithm, more information can be efficiently conveyed and better understood with more distances considered in the graph.

Project # **S1105** Category: **Mathematics & Computer Sciences - Sr**

Student: **John Xu** Grade: **10** G: **M**

School: **Harvard- Westlake High School**

Title: **Procedural Generation in 2D Metroidvania Game with Answer Set Programming**

Video game designers often find themselves at a crossroad when designing levels; namely, many have a difficult time balancing the amount of control they want to have over what their levels look like. If too little control is given, like in the case of pure perlin-noise generation, levels can end up with too much variation and unideal generations. Softlock is an example of unideal generation in the case of metroidvania games, if the placement of keys cannot be easily controlled and end up being placed behind gates, the players can get permanently stuck. Developers may usually hand-make all levels in order to try and prevent this from happening, however they risk spending too much effort and time on designing levels, resulting in a general lack of quantity in levels. Objectively speaking, both methods have their strengths and work well in specific genres of games, but limiting oneself to the boundaries of these methods does not fundamentally achieve both quantity and accuracy. This paper proposes an unique solution to this dilemma, providing automated generation of levels while also giving developers much more control over the overall output. Our method uses Answer Set Programming (ASP) to verify generation based on restrictions we place, guaranteeing the outcome to be what we want. To demonstrate our method, we applied our solution to a 2D metroidvania game made in the Unity game engine and conducted quantitative tests to assess how well our method works as a level generator.

Project # **S1106** Category: **Mathematics & Computer Sciences - Sr**

Student: **Michael Dalva** Grade: **11** G: **M**

School: **Granada Hills Charter High School**

Title: **Crush Guard**

The goal of this project is to create a software that can identify and present hazardous crowding situations from a video of a simulated crowd environment, allowing the user to address these crowded conditions. To create the application, we used Visual Studio, an official Microsoft tool used for application development. We programmed a WinForm in the programming language C#, and developed our own algorithms for proximity detection and marble/simulated human detection. We created numerous videos of simulated crowd environments to feed into the algorithm and test its accuracy. These videos were produced by rolling white marbles on a black surface, recording their movement, and feeding it into the algorithm. The program was able to accurately identify a majority of the dangerous situations in the sample videos. There were some inconsistencies in its accuracy when the simulated “humans” started overlapping to the point where the program couldn’t differentiate the humans, but it was able to identify that the situation was dangerous before the results started getting inconsistent. Before conducting the analysis of the videos, we believed that the software would be an accurate measurement tool of the danger of a simulated crowd. Our results indicate that the tool was able to accurately identify dangers and call them out to the user. Next time, we can use AI to identify actual humans instead of using simulated marbles meant to mimic crowd patterns.

Project # **S1107** Category: **Mathematics & Computer Sciences - Sr**

Student: **Anthony Yoon** Grade: **12** G: **M**

School: **Palos Verdes High School**

Title: **Machine Learning Ensemble for Operational Variables and Prediction of Truck Turntime at the Port of Los Angeles**

This research involved advanced computational tree modeling to identify insights and correlations within variables to help facilitate efficient port logistics at the Port of Los Angeles by improving truck turntime. Combined with previous work, multiple AI generated models were used to discover meaningful correlations and a model between variables and truck turntime.
Using the same data from previous research, 19,780 unique data points were applied to develop an appropriate prediction model by utilizing AWS based service DataRobot. The platform performed parallelization of following ensemble models: LightGBM Random Forest Regressor and Gradient Boosted Trees Regressor. Another tool, a Python Based LightGBM script, was used to perform a different approach of 5-fold cross validation to establish a unique prediction model and a SHAP summary plot.
All models unanimously concluded 'Location', 'Trucks', 'Import-inventory' and 'Dwell' as key features that the terminal must consider while planning. Suggestions like limiting the number of trucks inside the range of 5,600 to 5,900 and others were made. These are effective business intelligence to improve truck turntime. The downstream result appears positive. The terminal factored such variables into its daily planning and allocated resources to optimize its operation, resulting in improved truck turntime by 10% in February and March and 12% in September compared to the same periods of 2021. The Port of Los Angeles acknowledged environmental and economic contribution of reduced turntime and awarded the terminal $198,126 upon its Truck Turntime Incentive Program defined in the Port of Los Angeles Tariff No. 4.

Project # **S1108** Category: **Mathematics & Computer Sciences - Sr**

Student: **Justin Liu** Grade: **12** G: **M**

School: **Palos Verdes Peninsula High School**

Title: **A Novel Super-Resolution AI Engine and Multi-Stage Abnormality Detection Pipeline for Early Blindness Prevention**

Diabetic retinopathy (DR) is the leading cause of blindness in the US. The eye disease is particularly pervasive in developing countries, where there exists a severe insufficiency of ophthalmologists. Consequently, there has become a pressing need for accurate eye screening methods for blindness in the absence of doctors.

To meet this need, this research developed an AI engine for the automated detection of DR through four comprehensive stages comprising: (1) a super-resolution generative adversarial network to enhance the resolution of medical eye scans and optimize retinal imaging features; (2) 24 image recognition architectures to diagnose DR; (3) three small-object detectors serving as the first to localize major retinal abnormalities; and (4) 10 clinical regression models that prognose and triage patients into five categories of severity based on positive DR correlations found in OCT scans, blood biomarkers, optic cup-to-disc ratios, and electronic health record data.

The diagnosis ensemble model attained an accuracy of 97.7%, and its 4 explanatory AI visualizations successfully identified abnormal retinal patterns. The object detection algorithm localized DR lesions with an Intersection-over-Union score of 0.853 ± 0.017, a 30% increase in precision over prior studies. The clinical model discovered HbA1c as a novel DR biomarker ($p<0.001$). Patient risk stratification and time-series analysis forecasted blindness progression n years in advance with accuracies upwards of 93%.

This work presents a cost-effective, human-interpretable, and scalable solution to globalize early blindness prevention. Support from clinical professors for model deployment with FDA-approved, smartphone-based eye cameras to under-resourced healthcare centers is underway.

Project # **S1109** Category: **Mathematics & Computer Sciences - Sr**

Student: **Emily Ren** Grade: **11** G: **F**

School: **Diamond Bar High School**

Title: **Intersection of Longest Cycle and Largest Bond in 3-Connected Graphs**

Since many real-life problems can be represented by graphs, graph theory has found extensive applications in various areas such as computer science and bioinformatics. One of the most important concepts in graph theory is connectivity, and there is much interest in studying the longest cycles and largest bonds in graphs. A. Sanford determined in her Ph.D. thesis the cycle spectrum of the well-known generalized Petersen graph P(n, 2) (n is odd) and P(n, 3) (n is even). M. Flynn proved in her honors thesis that any generalized Petersen graph P(n, k) is dual Hamiltonian with the largest bond of size (n + 2). H. Wu conjectured that any longest cycle must meet any largest bond in a 3-connected graph.

In this research, I first studied the co-spectrum of generalized Petersen graphs and extended Flynn's result by proving that in any generalized Petersen graph P(n, k), 1 =< k < n/2, the co-spectrum of P(n, k) is {3, 4, 5, …, n + 2}. In my second result, the core part of this research, I proved that the conjecture is true for certain classes of 3-connected graphs: Let G be a 3-connected graph with n vertices and m edges. Suppose c(G) is the size of a longest cycle, and c*(G) is the size of a largest bond. Then each longest cycle meets each largest bond if c(G) >= n - 3, or c*(G) >= m - n - 1.

Project # **S1110** Category: **Mathematics & Computer Sciences - Sr**

Student: **Kevin Wang** Grade: **11** G: **M**

School: **The Webb Schools**

Title: **Effects of Using Neural Networks to Generate Music**

The objective of this project is to discover the effect of using Neural Networks in AI to generate piano music. Music is sentimental and emotional. In this project 1) I am exploring if AI-generated music can resonate with human emotions; 2) would the AI-generated music follow music theory. This can be a popular tool for everyone to use to personalize their own music without any composing knowledge.
The 88 piano keys (52 white and 36 black) are converted to numbers, and pitch value (single note or chords) and duration (the time for which the note is held) are tokenized. AI can produce notes based on the combination of numbers and tokens. To comply with music theory, I use the Concise Oxford Dictionary to check the harmony of the notes and expression of emotions. I used Long-Short Term Memory (LSTM) of recurrent neural network in Python with the TensorFlow platform and Keras model to create an application that can play and compose music on its own. The model is able to take a sequence of inputs and predict the best fit for the output based on the creativity parameter.
The effect of AI to generate piano music by using Neural Networks is confirmed powerful. The model has achieved great results and is able to demonstrate music theory knowledge.
There is future work to be done to eliminate some randomness in the music and add more creativity, along with a clear distinction between different eras of music.

Project # **S1111** Category: **Mathematics & Computer Sciences - Sr**

Student: **Tejaswi Krishna** Grade: **10** G: **M**

School: **Mira Costa High School**

Title: **Analysis of Rising Interest Rates on Student Loans from a Macro and Microeconomic Perspective**

Student loans are the second largest source of debt in the average American household after mortgages. Since 2022, interest rates have been increased by the federal reserve in response to inflation. The assimilated data over twelve years in two six-year time frames: 2010-2016 and 2016-2022, showed the average interest rate was 4.02% and 4.05%, respectively. The average monthly repayments on a twenty-year term for the two periods were amortized. The projected new student loan interest rate in the 2023-2024 school year is 7-9%. We extrapolated the student loan repayment for a twenty-year term under the new conditions. We studied the increase in debt repayment and the potential downstream effects on the individual borrower, the community, and the nation from a macro and microeconomic perspective.

Project # **S1112** Category: **Mathematics & Computer Sciences - Sr**

Student: **Zexin Bi** Grade: **10** G: **M**

School: **The Webb Schools**

Title: **Using Pretrained Natural Language Processing Model to Extract Drug-Drug-Interaction from Medical Paper**

Owing to people's growing attention to public health, scientists have invented a substantial number of medicines in recent years. However, the most recent drug-drug interactions (DDI) between many new medications must be better informed. Ordinary people's limited medical knowledge makes it hard to comprehend professional papers about DDIs quickly and accurately. Potential misunderstandings about DDIs can lead to fatal consequences. To address this problem, I propose an end-to-end system to extract DDIs from medical papers. The system can provide people with accurate information automatically mined from massive research documents. To build the system, I first apply a Name Entity Recognition (NER) toolkit based on Spacy to identify all drugs in an article, then construct a Relation Extraction (RE) model to classify whether two drugs of interest have any interaction mentioned. In the RE system, I first obtain sentence embeddings using Bidirectional Encoder Representations from Transformers (BERT). Different from previous work, I merge grammatical features by performing Graph Convolution Network (GCN) on sentence dependency trees. The accuracy of the BERT + GCN model is more significant than using BERT solely. In my experiment, the combined model attains a 0.85 macro-averaged F1 score on the binary classification task, while the best result of BERT is 0.83. Beyond the model, I created a knowledge graph-based database that includes COVID-19-related DDIs extracted from PubMed. Compared with reading thousands of papers on the internet, my database could clearly inform patients of potential DDIs, thereby reducing DDI incidents.

Project # **S1113** Category: **Mathematics & Computer Sciences - Sr**

Student: **Xiangzhou Sun** Grade: **10** G: **M**

School: **The Webb Schools**

Title: **Communication Reduction via Compression-Aware Training for Efficient Edge-Cloud Computing on AR/VR Systems**

To decrease workload on Virtual Reality (VR) devices, my project accelerates the computation of Artificial Neural Networks (ANNs) on VR devices by modifying the ANNs' training process.

First, I utilized distributed computing to optimally divide the network workload onto both devices and the cloud. To reduce communication latency between devices and the cloud, I introduced feature pruning by setting elements in the communicated feature to 0. However, naively pruning the feature causes a significant accuracy drop. To compensate for this limitation, I applied pruning-aware training to preserve the ANNs' task performance.

I evaluated the proposed methods on multiple datasets and models, like VGG-11 and ResNet-18, through PyTorch. Empirical results demonstrate that my methods can reduce the computational latency by 50-75% with a negligible 1% accuracy loss. Specifically, I first identified the system bottleneck by comparing on-device, on-cloud, and communication latencies (on-device: 14.8%, on-cloud: 1.7%, communication: 83.5%). Then, I compared multiple pruning strategies and observed the superiority of magnitude-based pruning. At 0.992 sparsity, magnitude-based pruning outperformed other strategies by 45% in accuracy.

Finally, I verified the effectiveness of the proposed pruning-aware training method by comparing it with the baseline at various splitting points and networks. Pruning-aware training decreases the accuracy loss by up to 26% at 0.998 sparsity.

In conclusion, even though distributed computing can accelerate AI applications on VR/AR devices, compressing the communication cost is crucial and challenging. My proposed methods effectively reduce communication latency without sacrificing accuracy and the applications' user experience.

Project # **S1114** Category: **Mathematics & Computer Sciences - Sr**

Student: **Matteo Paz** Grade: **10** G: **M**

School: **Institute for Educational Advancement**

Title: **Long-Short Term Memory Recurrent Neural Networks as a Stock Market Prediction Tool**

I trained an AI to predict future stock prices and make me money. The goal of this exposition is to predict short to medium term movements on the S&P 500, price of BRK.B, and the price of continuous gold contracts using a Long-Short Term Memory model of recurrent neural networks and historical price data. Using PyTorch on my home desktop and a large historical dataset of the S&P 500 values, other stocks in the financial sector for Berkshire Hathaway, and other commodity prices like Silver, Copper, Oil for the Gold model, I trained 3 separate networks of the same model. Using a test set of the past six months, the models predicted the medium term (1-6 months) direction of change, and short term (1-14 days). Raw stock market data proves insufficient to predict short and medium term movements reliably based on a vanilla LSTM model. A complete model considers fundamental stock data, stock indicators, and interprets the news to make a better prediction.

Project # **S1115** Category: **Mathematics & Computer Sciences - Sr**

Student: **Gabriel Fergesen** Grade: **11** G: **M**

School: **Institute for Educational Advancement**

Title: **Watching the Death-Clock: Simulating Prion Infection of Human Cells**

This research constructed a series systems biology models that simulate prions' interactions with a human cell and can quantify the cell's probability of death given varying initial prion concentrations. This simulation was designed using NumPy and MatPlotLib, written in Python 3.10.8, and executed both in Google Colaboratory and on a 2.6 GHz Quad-Core Intel Core i7 running macOS Ventura. These models were derived from Mass Action Kinetics equations, abstractions that allow for the simulation of large quantities of intermolecular interactions, and stochastic models, primarily Gillespie, were used for simulations. The prion and protein structures were sourced from common databases such as Protein Data Bank (PDB) and Universal Protein Database (Uniprot); structures were modeled in ESMfold and AlphaFold. This project has concluded that, using standard modeling techniques, the virulence of prions in the human body can be simulated, both in large concentrations and in intermolecular interactions described by stochastic modeling. The code this project produced was uploaded to Github repository github.com/Glaferg/prion-emulation-2022. These stochastic and mass action kinetic prion models' predictions of probability of infection and virulence can, then, estimate a patient's probability of infection. Before this model is applied, its accuracy must be quantified by comparing its predictions against the behavior of live prions in equivalent conditions. This research could inform humanity's efforts to slow, contain, and cure one of the deadliest families of pathogens, prions.

Project # **S1116** Category: **Mathematics & Computer Sciences - Sr**

Student: **Gavin Sarmiento** Grade: **9** G: **M**

School: **California Academy of Mathematics and Science School**

Title: **IllumiBox: The Lock-Box that Combats the Rise of Porch Pirates by Autonomously Detecting and Securing Packages**

With the rise of online ordering, package theft has become increasingly common. Especially with the rise and continuity of the COVID-19 pandemic, there have been reports of increasing rates of package theft within our communities. Technology such as Ring, ADT, and MailBoss has been developed to address this issue, but these devices seem to have minimal impact on the growing problem. Not only this, but many people have found ways to avoid these devices, making it even more difficult to catch porch pirates.

To solve this issue, our team used the Arduino platform to create a mechanical security system that would be able to prevent theft. In order to ensure maximum security, a fingerprint sensor and keypad will be integrated into the device. An ultrasonic sensor inside of the lock-box is programmed through C++ to detect any incoming packages. Once the package detector is activated, this circuit incorporates a locking system using components such as a servo motor and photoresistor, which can only be deactivated by either the fingerprint sensor or number pad. Meanwhile, a metal base encompasses the circuits and system while also creating a protective coverage for the package that ensures maximum security. Overall, the IllumiBox appliance is designed to limit the scope and impact of package theft throughout urban communities and serve as an impenetrable security mechanism.

Project # **S1201** Category: **Microbiology - Sr**

Student: **America Valenzuela** Grade: **9** G: **F**

School: **Applied Technology Center High School**

Title: **Avoiding another Pandemic**

Have you ever wondered how much bacteria a simple wipe could remove? In this project we are trying to test the following hypothesis. If we use a name brand (Lysol wipe) antibacterial wipe to clean a surface then it will remove 50% of bacteria from a flat surface because the wipe is higher quality. The purpose of this project is to test the claims made by advertisements of 3 varieties of antibacterial wipes. We tested 3 varieties which were our Lysol, Spencer Health, and Daily Guard.
Each of these wipes are known to pick up bacteria off of flat surfaces due to the word anti which implies that it will remove bacteria . This is important because It helps reduce the chances of pathogen transmission and all consumers can benefit from a wipe that is efficient and protects their health at a reasonable price. Our method of testing the validity of the claims made was to prepare surfaces with items such as glo germ powder and proceeded to use the antibacterial wipes to clean the surface. We then used the uv light to analyze the amount of bacteria that was absorbed by each variety of antibacterial wipe. In our results we discovered that the Lysol brand wipe did in fact work best. The consumer can feel at ease knowing that even in spending a little more on antibacterial wipes they are protected from pathogens. For those who cannot afford the Lysol wipe and choose to buy an alternative, they may risk getting infected by known pathogens.

Project # **S1202** Category: **Microbiology - Sr**

Student: **Mason Hong** Grade: **9** G: **M**

School: **La Salle College Preparatory**

Title: **Spectral Autofluorescence: Towards Quantitative Pathology**

Cancerous lesions are the outcome of mis-programmed cells. These cells propagate between healthy tissues and are characterized by subtle shape and color. Surgeons and pathologist strain for years in recognizing these features, utilizing standard color cameras, white light and trained human eyes. Recently, scientists at the Translational Imaging Center, developed technologies that probe the intrinsic signals in tissues utilizing modalities of imaging that overcome the limits of human vision: hyperspectral imaging andfluorescence microscopy. In my project this summer I explored applications of these technologies for identifying cancer in human tissues. I utilized advanced microscopes to image fixed esophageal cancer biopsies from patients and quantify the image contrast of cancer with respect to healthy tissues, comparing to the gold standard of pathology. This project exposed me to a multidisciplinary scientific method, where I learned how to operate state of the art instruments, quantify data and connect technology with highly valuable and impactful biomedical problem.

Project # **S1203** Category: **Microbiology - Sr**

Student: **Jade Martinez** Grade: **9** G: **M**

School: **Applied Technology Center High School**

Title: **The Battle Between The Hand Sanitizers**

Have you ever considered if the hand sanitizers you used have an immediate effect for preventing pathogens? We took it upon ourselves to test 3 varieties of hand sanitizers. Purell says it removes 99.9% of germs and Target Aloe says it kills 99.9% of germs, our generic brand did not include a percentage of germs removed. Our hypothesis was that Purell was going to work best for germ removal and time drying. This experiment is important and helpful because we have a worldwide problem which is the ongoing COVID 19 pandemic. Each variety prevents diseases because of the ingredients that are incorporated; for example the amount of alcohol. Our materials for our science experiment are the 3 varieties, Germ Kit, UV Light and a timer. Our findings were that the 3 varieties each had different amounts of alcohol in it (99%, 70%, 20%), which reduces the chances of preventing diseases. We also found out that time for the hand sanitizers to dry varies (20 seconds, 30 seconds, 50 seconds). From the start of the experiment, we found out how much each hand sanitizer costs ($6, $4, $1). Our findings indicate that the most expensive brand works best for germ removal and time to dry. We can say that everyone might have to pay a little more for Purell, but does everyone have equal protection from viruses and bacteria? Hopefully, our project helps everyone across California to use the right hand sanitizer during these stressful times for disease prevention.

Project # **S1204** Category: **Microbiology - Sr**

Student: **Samuel Cendejas** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **Evolving ecoli**

The purpose of this experiment is to find if E.coli can be forced to evolve to survive in an environment where deadly substances are present. The hypothesis of the experiment is that if E.coli is exposed to substances that would normally kill it for a long amount of time then the E.coli will be able to evolve and future generations will survive when exposed to these same substances.

To test the hypothesis 5 different sets of four agar plates with E.coli will be made with one of the 5 substances in each of the plates. They were placed in an incubator for 24 hours and the next day they were transferred to new plates and let to grow for 24 hours. Results will be measured counting the number of colonies on the plate. The bacteria will be passaged this way for up to 15 "generations."

So far I have no results but I have done some research into this process of evolution and it is possible for the E.coli to become resistant to the cleaners that I will be testing. This will have to include a mutation but this also may be forced by the fact that it will adapt to survive in this environment. I have been observing all safety precautions such as a lab coat and long pants, wearing a mask and gloves, keeping the e coli in a biosafety cabinet, and sterilizing all used instruments with a 10% bleach solution.

Project # **S1205** Category: **Microbiology - Sr**

Student: **Gilbert Shen** Grade: **10** G: **M**

School: **Walnut High School**

Title: **The Investigation of Various Factors Affecting Yeast Growth**

This project seeks to understand the effects of temperature, pH levels, and common preservatives such as salt and cinnamon on yeast fermentation. The experiment involves raising yeast as part of a standardized bread dough, in which variables such as pH, temperature, and preservatives, are being changed. After a set time, the volume of the dough is measured and conclusions on yeast metabolism are drawn. After three repeated tests for each variable, it was concluded that yeast favors an acidic pH of around 6, with temperatures around 33 degrees Celcius. Large amounts of salt and cinnamon have also been shown to reduce volume. This could have implications for yeast-reliant industries, for example, baking and brewing, and has implications for understanding the fundamental processes of yeast metabolism.

Project # **S1206** Category: **Microbiology - Sr**

Student: **Lingyi Tang** Grade: **11** G: **F**

School: **The Webb Schools**

Title: **Chemical Inhibition of Yeast Growth**

Yeast (Saccharomyces cerevisiae) plays an essential role in food production. Yeast growth, which relates to several signaling pathways, can be impacted by chemicals and understanding their impact is important for baking. In this project, we designed an assay to test salt (sodium chloride), caffeine, and EDTA to test the growth inhibition of yeast. For EDTA, we set up one control and two variable groups with 3 samples each. Each test tube has 5 ml of sterilized LB broth and 5?L of yeast stock as the constants. Control group has only LB and 5?L yeast stock solution. The variable group has LB, 5?L yeast stock solution, and an EDTA concentration of 400?g/mL. The samples were then put into the spectrophotometer to measure the absorbance. For Caffeine, we set up one control and three variable groups (10mM, 20mM, and 30mM of caffeine) to have 3 samples each. Each test tube has 5 ml of sterilized LB broth and 5?L of yeast stock solution as the constants. Then, the samples were put in the shaking incubator for a 17-hour interval. We use the spectrophotometer to measure the concentration of yeast at the initial time and the end of 17 hrs. The results indicate that all chemicals inhibit yeast growth significantly. After reviewing data and comparing to other chemicals, caffeine with 20mM best inhibits yeast growth. Next time, we would like to test more chemicals on yeast inhibition to see if there are better chemicals to inhibit growth.

Project # **S1207** Category: **Microbiology - Sr**

Student: **Katherine Le** Grade: **12** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **Efficacy of Bacteriophage Cocktails on E. Coli K-12 in HEK Cells**

Bacteriophages are viruses that infects specific targeted bacteria, reproducing within it. The therapeutic use of phages to treat bacterial infections is known as phage therapy. Phage therapy has the potential to treat infections and could be an alternative to antibiotics, especially against antibiotic resistant strains. The efficacy of phages is enhanced through bacteriophage synergy: a phenomenon where the antibacterial properties of phages are augmented when two or more phages are combined. It was hypothesized that due to phage synergy, a cocktail of phages T2 and T4 would exhibit enhanced antimicrobial properties against E. coli K-12 and would demonstrate therapeutic properties in presence of HEK cells.
Through measuring the combinational effects of the two phages on the bacteria, it was tested to observe whether the phages individually and together would eradicate E. Coli K-12 successfully without harming the human cells. Plaque assays were performed to quantify the amount of plaque forming units (PFU) in the phage samples. In the plaque assays, the phage cocktail was not as effective against the E. coli K-12 compared to individual phages. However, for the cell culture assays, data from OD600 readings demonstrated that the cocktail exhibited increased effectivity. The data also indicated that the phages were not lethal to the HEK cells.
With the current rise in antibiotic resistance, phage therapy holds the potential to provide a cost-efficient method of treatment. Future research could include genetically modified phages to allow them to be increasingly effective as a therapy.

Project # **S1208** Category: **Microbiology - Sr**

Student: **Abira Dost** Grade: **9** G: **F**

School: **Institute of Knowledge High School**

Title: **What's Poppin'? Evaluating Effective Treatments for Acne and Examining the Psychological Impact of It on Adolescents**

Objective: The purpose of this project is to determine the psychological effects of acne on adolescents and to identify the most effective product for treating it. The goal is to educate teens on how to improve their skin health and mental well-being.

Procedure: A survey of 50 participants aged 11 to 16 was conducted to gather information about the effect of acne on their psychological well-being. An experiment was conducted using self-made agar, staphylococcus epidermidis, benzoyl peroxide, salicylic acid, turmeric, honey, and water. The bacteria was streaked onto agar dishes and a paper disc was placed in the center of each dish, treated with the acne product. The dishes were sealed to prevent contamination and the zone of inhibition was measured.

Results: The larger the zone was, the more effective the product was. In the end, my results showed that my hypothesis was correct. The benzoyl peroxide had the largest zone of inhibition while the water had the smallest. From my survey, I discovered that 84% of participants were upset by their acne and 54% believed that others negatively treated them because of it.

Conclusion: The results confirm that benzoyl peroxide is the most effective acne-fighting product, as hypothesized. The benzoyl peroxide disc showed no bacteria growth, while water had the smallest zone of inhibition of 0mm. The benzoyl peroxide's effectiveness is due to its ability to kill Cutibacterium acne, which is the cause of acne vulgaris.

Project # **S1209** Category: **Microbiology - Sr**

Student: **Mark Lin** Grade: **11** G: **M**

School: **Cabrillo Marine Aquarium**

Title: **Sustaining Spacecraft: Application of Novel Photobioreactor System in Aerospace Oxygen Exchange Systems**

Algae has shown promise in many industries; its growth efficiency and health benefits demonstrate the capacity to enhance human sustainability. Recent research by the National Aeronautical and Space Administration (NASA) has shown potential for the aerospace implementation of photobioreactors (PBRs), which use algae to convert carbon dioxide and light into oxygen and harvestable biomass. While prototypes have been developed, experimental difficulties indicate the need for more efficient systems.

The project's hypothesis is that immobilized Chlorella vulgaris will grow comparably to liquid algae when implemented in a PBR. A proposed PBR is developed and used to test the growth of algae in both solid and liquid media over a two-week experimental period. Data on oxygen, carbon dioxide, and temperature is collected and analyzed, and spectrophotometry is utilized to determine algae population density.

Results show that both the solid- and liquid-based PBRs displayed growth over the 14-day period. Throughout the experimental timeframe, algae in solid media showed higher carbon dioxide consumption and oxygen production compared to algae in liquid media. In addition, a higher population density (relative to initial population density) is noted compared to that in the liquid media, as measured by spectrophotometry.

Further research could facilitate the development of space-efficient algae "cells" in functional spacecraft, with the advantage of reduced mechanical complexity. Experimental results also show promise in other industrial applications, where algae plates could effectively remove carbon dioxide emissions from factories. As human exploration and settlement activity increase, the merits of this technology may prove vital for long-term sustainability.

Project # **S1301** Category: **Pharmacology - Sr**

Student: **Brielle Young** Grade: **12** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **OpenBook: A Novel Machine Learning Tool for Prescription and Pharmacologic Management of Drug Dosage for Patients with Depression and Anxiety**

Depression is the most common mental disorder, with approximately 280 million people affected globally. An estimated 50% of patients with depression respond inappropriately to antidepressants, and pharmacogenetic attention is necessary, as 60 to 90% of individuals carry at least one genetic variation that alters drug response. This creates a need for more accurate prescription in order to provide effective treatment for individuals with one of these prominent mental disorders.

In this study, machine learning (ML) algorithms were developed, accounting for the pharmacogenetic profile of patients by primarily accessing data from PubMed of the NCBI database and the Centers for Disease Control and Prevention. Random forest algorithms (MSE=3.0, RMSE=4.2, CART: MSE=3.1, RMSE=4.4) were utilized to create decision trees for all antidepressant drugs. 4,100 patients in the National Health and Nutrition Examination Survey (NHANES) study provided information on antidepressant drugs, demographics, omic factors, patient clinical parameters, and environmental factors for analytical use.

The developed classification-backed network ensemble for this tool yielded an average 92.3% (SD 8.3) accuracy rate after assessing 612 patients in a validation set and 552 patients in the final test set ($p<0.01$ for all assessments).

This tool outperforms classic machine learning pharmacologic prescriptions for patients with depression and anxiety. These findings support the efficiency of using ML algorithms applied to large datasets with genetic, clinical, and demographic features to improve accuracy and reduce bias in antidepressant prescription.

Project # **S1302** Category: **Pharmacology - Sr**

Student: **Michelle Chung** Grade: **11** G: **F**

School: **Crescenta Valley High School**

Title: **Testing Antimicrobial Effects of PYED-1 Derived Corticosteroids**

More than 3 million people die from an antibiotic-resistant infection every year and it can lead to high medical expenses and longer hospital stays. Previous research done shows that PYED-1 (Pregnadiene-11-hydroxy -16?,17?-epoxy-3,20-dione-1), which is a synthetic precursor of deflazacort, exhibited antibacterial activity against bacteria without showing cytotoxicity. The objective was to identify an effective agent that displays potential in preventing bacteria from developing resistance to treatments. This was addressed by assessing the growth rates of bacteria which have been affected by corticosteroids at different concentrations and when repurposed at fixed proportions. The corticosteroids used were triamcinolone acetonide, fluticasone propionate, and budesonide, used in the form of nasal sprays. The first experiment observes the drugs' individual antibacterial activity by plating the drugs at different concentrations onto the bacteria. The performed serial dilution produced four different concentrations for each corticosteroid (100%, 50%, 25%,12.5%). The second experiment tests the effects of repurposed corticosteroids on bacterial growth. At combined fixed proportions, about 10-30μL of each repurposed drug is plated after the bacteria has been plated. After 24 hours, the plates were observed for areas of no growth which indicates that the repurposed drugs inhibit bacterial growth. Results have shown that for each trial the triamcinolone acetonide and fluticasone propionate at higher concentrations inhibited the growth of bacteria. They both exhibited antimicrobial properties, therefore it can be concluded that these glucocorticoids have the potential to inhibit further bacterial growth and may serve to be more effective at higher concentrations or dosages.

Project # **S1303** Category: **Pharmacology - Sr**

Student: **Brandon Kao** Grade: **11** G: **M**

School: **La Salle College Preparatory**

Title: **The Correlation Between Pesticide Exposure and Alzheimer's Disease: A Meta-Analysis**

Alzheimer’s Disease is a neurodegenerative disorder and the most common type of dementia that affects memory, thinking, and behavior. The mechanism of action of this disease is the slow degeneration of neural connections that eventually leads to neural cell death. Overtime, as more cells die the condition worsens and the afflicted individual is no longer able to function normally. Research of autopsied brains of patients who have passed and were diagnosed with Alzheimer’s disease show that there is an increased number of neurofibrillary tangles and plaques present in the brain. Chemically speaking, these samples also showed decreased levels of neurotransmitters such as acetylcholine, serotonin, somatostatin, and norepinephrine, all of which are responsible for normal neural communication in the brain. Currently, there are no known specific causes of Alzheimer’s Disease, however, much research has been done to narrow down potential culprits. One of those suspected of causing this disease are pesticides. In being able to correlate the risk of Alzheimer’s and exposure to pesticides, strides can be made in controlling the use of these toxins. For this project, scientific literature published from 2017 to present analyzing brain tissue from autopsied Alzheimer’s patients indicating levels of pesticides in toxicological studies is systematically reviewed using meta analysis techniques to create correlations between exposure to specific pesticides and instances of Alzheimer’s disease.

Project # **S1304** Category: **Pharmacology - Sr**

Student: **Nathaniel Jaramillo** Grade: **10** G: **M**

School: **Crescenta Valley High School**

Title: **The Evaluation of 20-Hydroxyecydsone's Potential to be Further Investigated as an Alternative Therapy for Osteoporosis**

Over 10 million individuals in the U.S. are diagnosed with osteoporosis and over 40 million persons suffer from complications relating to bone loss. The aim of this project is to evaluate the potential of 20-Hydroxyecdysone to be further investigated as a therapy option for osteoporosis. Based on its chemical properties and its positive impact on the acceleration of fracture healing, it was hypothesized that 20-Hydroxyecdysone could be a promising candidate to move on within the drug discovery process. The hypothetical comparison of 20-Hydroxyecdysone as a drug to current medications for the treatment of osteoporosis is also addressed. Existing treatment methods are commonly inefficient and have many side effects. The preliminary results gathered by this project lay in the binding affinity measured by Autodock Vina between 20-Hydroxyecdysone and the BMPR. The data gathered on binding measured an average of slightly above -11 kcal. When conducting computational analysis for binding efficacy, any score exceeding -8 kcal/mol can be considered substantial. Various other data points such as side effects and criteria from Lipinski’s rule of 5 and Veber’s rule were also assessed in the report. The data gathered on binding affinity provides strong evidence to conclude the in silico portion of the drug discovery pathway, supporting the hypothesis. In vivo testing of characteristics such as dosing, location of compound sequestration in the body, and general efficacy would be needed to cement a more concrete claim on 20-Hydroxyecydsone’s standing as a medication for the remediation of osteoporosis.

Project # **S1305** Category: **Pharmacology - Sr**

Student: **Mahesh Arunachalam** Grade: **11** G: **M**

School: **Crescenta Valley High School**

Title: **New Generation Drug Development Pipeline From in-silico Identification to Preclinical Evaluation for Novel Drug Candidates in Glioblastoma**

Glioblastoma(GBM) is the most common malignancy of the central nervous system in adults. Despite medical advancements, the continued shortfall of many treatments such as temozolomide, alongside the stagnant survival rate improvements (<13%) have led to pressing concerns for novel drug discovery methodologies.
This study developed and utilized two key stages within the drug discovery process, namely: drug-target prediction and in-vitro preclinical functional evaluation to identify a safe, bioactive, and effective treatment for GBM.
Stage 1 fabricated a novel five phase in-silico pipeline for drug-target prediction against Ephrin-Type-A Receptor 2. 1561 FDA approved drugs were run against the pipeline and analyzed for bond type, location, repulsion, Gibbs free energy, stability, interactions over time, blood brain barrier permeability, and possible false positives (PAINS). These results provided five plausible hits: Empagliflozin, Mycophenolate mofetil, Carvedilol, Canagliflozin, and Rivaroxaban.
Stage 2 involved the preclinical evaluation of the top five predicted drug candidates using an in-vitro Suphorhodamine-B cytotoxicity assay on glioblastoma cell lines U251. Mycophenolate mofetil currently holds the highest toxic effect with 50% cell death shown at 10 μM in GBM cell line U251, showcasing effective interruption of tumor proliferation at required concentrations. However, its cytostatic continuation in higher concentration rules it unfavorable for complete tumor removal. Therefore, this study is currently improving upon its five phase pipeline by utilizing current literature to integrate a tool engaging results from successful drug targets, and is actively screening new hits for wet-lab screening.

Project # **S1306** Category: **Pharmacology - Sr**

Student: **Mohuli Ganguly** Grade: **11** G: **F**

School: **La Salle College Preparatory**

Title: **Examining how different medications and electrolytes affect Pluripotent Stem Cell to Cardiomyocyte Differentiation and Cell Pulse Rate**

Induced pluripotent stem cells (iPSCs) are skin or blood cells that have been reprogrammed to their embryonic state allowing them to be differentiated into other cell types. The use of stem cells in medicine has made it possible for novel discoveries in regenerative therapies; which gives patients a second chance at life. For this experiment, iPSCs will be differentiated into cardiomyocytes using a cardiomyocyte differentiation medium. During the process of stem cell to cardiomyocyte differentiation, the cells will be treated with three naturally occurring electrolytes and three commonly prescribed medications. The electrolytes being used are Potassium, Magnesium, and Sodium, and the drug medications: Metoprolol, Aspirin, and Digoxin. All supplements will be directly diluted into the medium at 3 different concentrations: 0.5mM, 5mM, and 10mM. The amount of each supplement that will be added separately to the cells will be calculated based on its individual atomic mass and stock concentration. If stem cells are treated with cardiac medications or electrolytes then it is expected that the differentiation process and cardiomyocyte pulse rate will be affected. Incorporating the supplements during the differentiation process allows for the observation of how cardiomyocyte yield and muscular beats per minute (BPM) are impacted by supplements. Furthermore, these outcomes will add to research on how electrolytes/medications impact the heart muscles at their most basic, cellular level. The main goal of this study is to find which of the chosen medications and electrolytes will be the most effective in blood pressure reduction and stem cell differentiation.

Project # **S1307** Category: **Pharmacology - Sr**

Student: **Layla Negrin** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Making Life Sweeter: A study on how Sugar and Coenzyme Q10 reduce Huntington's Disease Symptoms**

Objectives
My objective was to see if coenzyme Q10 (coQ10) and increased/decreased sugar can reduce Huntington's Disease (HD) symptoms.

Materials and Methods
To do this, I used genetically engineered fruit flies with HD and placed them inside an activity monitor with varying treatments. I measured the amount of counts (amount of times the fly went back and forth in the activity monitor tubes). There were 5 groups: Added Sugar- 1.5g, Reduced Sugar- 0.5g, coQ10- 50mg, coQ10- 50mg/Added Sugar- 1.5g, and a Control group. The treatment was poured in tubes (in food form) which was then put in the Activity Monitor.

Results
The results were based on the total amount of counts after 48 hours. The coQ10 group had the most average counts (758), while the coQ10 and Added Sugar group came in second with 645 counts (which was predicted to have the most). Next, came the Reduced Sugar group with 602 counts and second to last came the control group with 588 counts. The added sugar group had the least amount of counts of 333.3.

Conclusion
In conclusion, my hypothesis is rejected, meaning that the coQ10 group had more counts than the coQ10 and added sugar group. I now know that giving HD patients coenzyme is the best way to reduce symptoms of HD and make their lives happier.

Project # **S1308** Category: **Pharmacology - Sr**

Student: **Joseph Choi** Grade: **10** G: **M**

School: **Crescenta Valley High School**

Title: **Comparing Methods of Reducing Matrix Metalloproteinase Mediated Cartilage Degradation Through the NF-kB Pathway**

Osteoarthritis (OA) is a joint disease that causes impairment of joint function and inflammation of cartilage. Mechanical stress causes the production of matrix metalloproteinases (MMPs), enzymes that break down joint cartilage. This causes lasting damage, and can not be repaired naturally. In addition, most existing treatments for OA involve surgery, and the drugs only alleviate pain. In this review, three repurposed drugs are discussed as well as an Insulin-like growth factor 1 (IGF-1) treatment that can be used to treat OA through the inhibition of cell signaling pathways (NF-?B and MAPK). The testing of different repurposed drugs as well as the IGF-1 treatment was done through computer modeling to compare efficacy and clinical potential. The four treatments were compared to determine which treatment is the most optimal for treating cartilage degradation. The criteria used to compare the treatments were their binding affinities, costs, and side effects. The binding affinity was tested using computer modeling through AutoDock Vina, and visualized through PyMol visualization. According to computational results, it can be concluded that sunitinib malate is the most viable pharmaceutical for the treatment of osteoarthritis, with the highest binding affinity of -11 kcal/mol. The IGF-1 treatment is an alternative, although it is held back by its poor binding affinity, accessibility, and damaging side effects. However, these computational results require clinical studies and trials to solidify their reliability. Overall, the compared repurposed pharmaceuticals and the IGF-1 treatment can propose a safer, more efficient pathway for treating osteoarthritis.

Project # **S1309** Category: **Pharmacology - Sr**

Student: **Finley Vincent** Grade: **9** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Keen on Green Tea: Can Epigallocatechin Gallate prevent Cadmium Chloride induced Cancerous Tumorigenesis within Planarians?**

Objective
My objective was to see if epigallocatechin gallate (EGCG) could prevent cadmium chloride (CdCl2) induced tumorigenesis, and if so, what concentration works the best. If EGCG can prevent tumors in planaria, then it could possibly be used to prevent tumors in humans.

Methods
I had 5 groups of 10 planaria that I observed for 2 weeks. Control group: PAM, Group 1: 32.7 micromolar CdCl2 , Group 2: 32.7 micromolar CdCl2 + 1 micromolar EGCG, Group 3: 32.7 micromolar CdCl2 + 5 micromolar EGCG, and Group 4: 32.7 micromolar CdCl2 + 10 micromolar EGCG. Each planaria had a separate petri dish that was filled with 10 ml of PAM. I added the EGCG to their respective petri dishes, waited 24 hours, and then added the CdCl2. After 2 weeks, I viewed each planaria individually underneath a microscope at 40x and counted the amount of tumors.

Results
I found that the planaria with 10 micromolar of EGCG had the least amount of tumors, with an average of 1 tumor. Planaria with 5 micromolar of EGCG had on average 2 tumors and planaria with 1 micromolar of EGCG had on average 3 tumors. The control group had no tumors and the group with the addition of only CdCl2 had an average of 6 tumors.

Conclusion
In conclusion, 10 micromolar of EGCG is the best concentration of EGCG for preventing CdCl2 induced tumors in planaria. This proves my hypothesis as I hypothesized that this concentration would have the least amount of tumors.

Project # **S1310** Category: **Pharmacology - Sr**

Student: **Helen Yang** Grade: **11** G: **F**

School: **Harvard- Westlake High School**

Title: **Association of genetic polymorphisms with pancreatic adenocarcinoma progression**

Pancreatic cancer (PC) is one of the most malignant types of cancer. It is characterized by an insidious onset, aggressive tumor growth, and early metastasis. Advances in treatment strategies are critically needed. In this research project, it was hypothesized that single nucleotide polymorphisms (SNPs) in chromosome 17 may play a role in the development and progression of metastatic PC.

Method:
Blood samples from a total of 129 individuals were previously collected from a clinical cohort sponsored by Memorial Sloan Kettering, including patients with primary PC (n=70), metastatic PC (n=55), as well as healthy control (n=4). DNA sequencing in chromosome 17 from all samples was also previously obtained. The research work started by obtaining a source database from the National Library of Medicine. The bioinformatics analysis programs Bowtie2, Sequences Alignment Map Tools (SAMtools), and Burrows-Wheeler Aligner (BWA) were then downloaded and used to analyze and sort the sequences into data tables. Finally, the Entrez Molecular Sequence Database system was used to compare the sequences to the reference.

Results:
153 SNPs were identified. Among them, 10 SNPs were unique to the metastasized PC samples studied. Specifically, 87-94% of the samples from the metastasized PC patients carry at least one of these 10 SNPs, whereas none of the SNPs was identified in the primary PC patients or in the control.

Conclusion:
Overall, the finding may provide insight into the mechanism that drives the growth and spread of PC cells and may help inform the future development of new cancer treatments.

Project # **S1311** Category: **Pharmacology - Sr**

Student: **Nathan Vipapan** Grade: **10** G: **M**

School: **Institute for Educational Advancement**

Title: **Modification of Bee Venom Peptide Melittin for Reduced Cytotoxicity to Increase Usefulness in Treating Ovarian Cancer**

My goal was to edit the bee venom peptide melittin to reduce the amount of cytotoxicity caused during treatment of ovarian cancer. Bioinformatics was used and protein folding software to design a modification of the peptide melittin to reduce cytotoxic effect. The approach was to attach a fusion partner to melittin to target a specific receptor on ovarian cancer cells exclusively. Alpha fold/ESM fold validated proper folding of the fusion protein/complex. Protein docking software, CLUSpro validated preservation of binding to the ovarian cancer receptor. Simulations suggest that bee venom retains its anti-cancer properties, while its fusion partner is still able to bind to its corresponding receptor, suggesting that it should have reduced cytotoxicity, which would allow the of use melittin as a treatment against ovarian cancer and possibly other cancers without the added cytotoxic effects that would decrease its effectiveness.

Project # **S1312** Category: **Pharmacology - Sr**

Student: **Ruotong Gao** Grade: **9** G: **M**

School: **The Webb Schools**

Title: **Investigation of controlled underexpression of IGFBP7 on geriatric diseases using a Bayesian Network and Protein-Ligand complex models/simulations**

Currently, geriatric diseases have caused around 75% of all deaths since the 20th century. Many diseases seem separate but may possess a general cause around their occurrence of them. In this article, connections are drawn through biological pathway analysis and an analysis of a specific gene known as Insulin Growth Factor Binding Protein 7, or IGFBP7 `which creates the IGFBP7 protein. The IGFBP7 protein is 27 kD protein inside of the senescence secretome. This gene, in particular, has shown correlations between a crucial part of aging and geriatric diseases, cellular senescence, and is a frequent occurrence of upregulation within vascular-related geriatric diseases. IGFBP7 is connected with a variety of pathways, the majority of them related to cellular growth and development. Multiple models are tested within this research, including but not limited to a bayesian probabilistic network, Autodock Vina binding affinity, P2Rank pocket/concentration analysis, and much more. The results from running these simulations show a positive correlation between higher upregulation of IGFBP7 and heart failure, with 74% of first-quartile IGFBP7 expression patients possessing HF (only 11% of the control sample, which was mainly elderly patients, contained upregulated IGFBP7). In comparison, 98% of fourth-quartile IGFBP7 expression patients possess HF. The binding affinity of the drug Sacubitril/Valsartan, which is a novel and extremely notable heart failure drug that also lowers IGFBP7 expression, is analyzed for its binding with the IGFBP7 protein giving a binding affinity of 6.2 kcal/mol as opposed to a test of other five drugs resulting average of 4.6 kcal/mol. Prankweb, COACH, and PrDOS analysis was performed to pinpoint the binding location of the interaction to be around the upper 150's in the sequence, mainly around number 158. Interaction analysis was also performed using PLIP analysis to determine what the interactions were in the complex resulting in 9 hydrophobic interactions, 3 hydrogen bonds in Valsartan while Sacubitril had 9 hydrophobic interactions, two salt bridges, and one hydrogen bond.

Project # **S1313** Category: **Pharmacology - Sr**

Student: **Muhammad Motala** Grade: **9** G: **M**

School: **Institute of Knowledge High School**

Title: **Unequal Relief: Examining Racial Disparity in the Pharmacokinetics of Acetaminophen**

Problem/Question: According to knowyourdose.com, “More than 50 million Americans use a medicine that contains Acetaminophen every week.” It is the most common drug ingredient in the world. Is this drug suitable for everyone? Recent studies show racial disparity in studies used to test the efficacy of drugs in various ailments. History is filled with horrible stories of abuse in medicine against African Americans and Native Americans. The objective is to determine the suitability of the recommended dosage of Acetaminophen/Paracetamol for all races and ethnicities.

Procedure: The study was designed to gather information about the experiences of individuals regarding the use of Acetaminophen/Paracetamol. The methodology involved the administration of a voluntary online questionnaire. Collected responses were categorized and analyzed based on several key demographic factors, including race, stated gender, and geographical location.

Results: 227 people responded to my survey, 48% were South Asian, 12.3% were Caucasian, 14% were North African/Middle Eastern, 5.7% were African American/Black, and 6.2% were Hispanic. 65% of participants said they found the recommended dose effective.

Conclusion: The study's findings were inconclusive due to various constraints and limitations. However, a meta-data analysis revealed that African-Americans eliminate acetaminophen more rapidly through glucuronidation compared to White-Americans, which could necessitate higher doses to achieve a therapeutic effect. However, this could also increase the risk of hepatic toxicity. The true efficacy of Acetaminophen in people of color remains unknown and requires further investigation.

Project # **S1401** Category: **Physics - Sr**

Student: **Nicolas Revolorio** Grade: **11** G: **M**

School: **Pioneer High School**

Title: **Electromagnetism and it's affecting Variables**

Electromagnetism; is the phenomenon of two objects being attracted or repelled by one another. This occurs in conjunction with two things, magnetism, and electricity. When an electric current is formed, it creates a perpendicular magnetic force according to the strength of the current. While this creates magnetic fields and attractions, it's not always permanent because when the electric current is removed the magnetic field is also removed. Through wires, batteries, and magnetic items, a homemade experiment was formed to create magnets with these simple items. Results came from testing revealing that the position of the wire mattered, as to how close it was to the magnetic end, how many loops, and how close it was to each other. These factors created a wide variety of differing results. With different bolts, it was found that steel, galvanized steel, and zinc all had different magnetic strengths. Zinc was the weakest magnet, not having a magnetic pull with an electrical current flowing through it, and galvanized steel was 40% weaker than pure steel. Different batteries were also used, from 1.5V to 3V, this being a difference of about 15% in strength. Temperature also became a factor, the more heat applied weakened the magnet (90 degrees Fahrenheit decreased by about 15%) as colder temperatures enhanced the strength (Freezing at 0 degrees Fahrenheit increased by 10%). At the end of the experiment, it was concluded that electromagnetics relied heavily on the electrical current and how it is on an object transferred.

Project # **S1402** Category: **Physics - Sr**

Student: **Madeline Gross** Grade: **11** G: **F**

School: **New West Charter High School**

Title: **Using Conservation of Energy to Optimize Results of Women Pole Vaulters**

Objective: Pole vault, a track and field event, uses a flexible pole to leverage an athlete over a cross-bar. Kinetic energy is generated by running down a runway. A transfer of energy occurs after the pole makes contact with the box. Next, the athlete takes off and the pole bends. Finally, the pole straightens, with the net effect of redirecting horizontal motion into vertical height. A successful vault occurs when the athlete converts a sufficient amount of the kinetic energy during the run-up phase into potential energy as height. The goal of this project is to explore how the conservation of energy can be used to monitor the energy transfer efficiency and success of each vault.
Materials and Methods: Video footage was obtained by filming a pole vault competition from a fixed camera location. Kinovea (kinovea.org, a freely available sports video analysis program) was used to obtain measurements of velocity and height from each vault attempt. Energy equations were used to estimate the total kinetic energy at take-off ($k = \frac{1}{2} mv^2$) and gravitational potential energy at maximal height ($Ug = mgh$).
Results: A relationship between the kinetic and potential energies generated in successful vaults is observed. Differences in the initial kinetic energy and efficiency of the energy transfer are reflected in the performance of successful vaults.
Conclusion: The most successful athletes can generate the greatest kinetic energy during the run-up phase and can most efficiently transfer this energy into potential energy to achieve a maximal vault height.

Project # **S1403** Category: **Physics - Sr**

Student: **Brindha Srivatsav** Grade: **11** G: **F**

School: **Palos Verdes Peninsula High School**

Title: **ERND (Electromagnetic Radiation Neutralization Device): A Novel Device to Counter Detrimental Effects of 5G Radiation**

High-frequency (HF) (up to 80 GHz) electromagnetic waves (EMWs) from 5G devices cause particle vibrations in surrounding matter at the same frequency, inducing structural alterations in surrounding matter. HF vibrations within humans lead to numerous health defects, from nerve damage to incomplete cell development. With no methods to mitigate these ramifications, a feasible solution is pressing.

This study designed, fabricated, and tested the Electromagnetic Radiation Neutralization Device (ERND), a device that shields particles exposed to 5G waves from vibrating at a HF, ultimately countering the detrimental effects of 5G radiation. 61 models of the ERND were fabricated, each releasing a high-energy EMW at a different frequency. Phase I designed and simulated the ERND models' circuit schematics. Phase II built the ERND models and tested their functionality to release EMWs with different characteristics. Phase III tested the ERND models by exposing matter (ice samples) to ERND and 5G radiation simultaneously and observing if any models neutralized the HF vibrations.

When the matter was exposed to ERND radiation at frequencies close to its natural frequency (3305-3454 Hz), the particles within the matter established resonance with ERND radiation. As a result, they continued to vibrate at their natural frequency, which shielded the HF vibrations from 5G and avoided structural alterations within the matter. Future studies include in-vitro testing of the device, installing it in households and workplaces, and perhaps selling it with 5G devices. By following these steps, a feasible, ready-to-use device to counter harmful effects of 5G can surface this world.

Project # **S1404** Category: **Physics - Sr**

Student: **Gerardo Cordova** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **Magnets Matter**

This science project's purpose is to figure out what effective materials can reduce the attraction between two magnets on a string. In each trial, different materials such as a barrier, paper(s), wood, cinderblock, ferrous metal sheet, and a Mu-metal metal sheet. This experiment will be using a special type of neodymium magnets that are strong when close to each other but won't pose a threat to the tester being me. The independent variable(s) for this project are the various materials/walls such as paper, wood, cinderblock, ferrous metal, Mu-metal. The dependent variable(s) is the decrease in distance between the magnets (relative to the controls) measured in centimeters necessary for them to still be attracted enough to come together. The hypothesis for this experiment is that since it is extremely hard to block out magnetic force fully, therefore only the ferrous metal sheet and the giron metal sheet would most likely succeed in reducing the magnet's magnetic force. For the control group, there will be two trials which are releasing the two magnets at the same height with no push-off and no barrier, then the next trial releasing the two magnets with no push-off just the usage of gravity, and using the different barrier per trial set, meaning that each trial done will allow each different barrier to test against the magnets.

Project # **S1405** Category: **Physics - Sr**

Student: **Madelyn Li** Grade: **10** G: **F**

School: **Mira Costa High School**

Title: **Electrical Wire Heating with Portable Battery for Preventive Masks**

This goal of this physics project is to study the electrical heating phenomenon of fine metal wires with a portable and rechargeable battery for masks to prevent flu and covid-virus. It is known that a temperature between approximately 40–50 °C is capable of effectively killing airborne bacteria and/or viruses. Thus, a facial mask equipped with suitable heating capability would reduce the risk of infection of diseases for humans who wear the heated masks. In this project, I conducted experiments to understand the physics of Joule heating of fine metal wires with small rechargeable batteries. Then I designed, fabricated, and tested facial masks with flexible heating wires with a suitable battery. I used two layers in the new mask where the heating wire array was inserted near the outside layer while trying to make the inner cloth layer at a comfortable temperature range for human faces. I optimized the configuration and compliance of fine metal wires. I used 3D printing to fabricate fixture prototypes for the assembly of the tiny metal wires into masks. I was finally able to control the outside layer of the flexible mask to reach the designed temperature of 40-50° C quickly while the interior layer of the mask remains comfortable for human faces. Through this project, I have gained a good understanding of electrical heating phenomenon for temperature control. I also gained knowledge in physics-driven product design and optimization.

Project # **S1501** Category: **Plant Biology & Physiology - Sr**

Student: **Adrian (Xavier) Monteon** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **"chloromeleon"**

"Chloromeleon" is an experiment where a plant that already has the capacity to exhibit multiple colors, will be subjected to only a section of the light spectrum in hopes to cause the plant to exhibit colors that it wouldn't normally show under the light of the sun. This will be accomplished by putting a colored, opaque film in front of a grow light to, in turn, only let that section of the light spectrum affect the plant. For example, a blue, opaque film would be placed in front of a grow light so that the plant may only interact with blue light. The hypothesis is, if plants are subjected to only a section of the light spectrum, then their exhibited colors will change because the chlorophyll will not have access to the full color spectrum to express color after photosynthesis. The independent variables are the different color filters that will be placed in front of the grow lights while the controlled variables will be the environment, how many sources of light each group of plants will be in contact with (1 source per group), the soil and pot each plant will be placed in, the type of plant that will be experimented on (prayer plant), the amount of plants per group (3 plants), and the amount of water and how often the plants will be watered. The control group will be a trio of plants subjected to the full color spectrum by the grow light.

Project # **S1502** Category: **Plant Biology & Physiology - Sr**

Student: **Anai Duenas Padilla** Grade: **10** G: **F**

School: **Magnolia Science Academy 4 Venice**

Title: **Drip Drip Sprinkle**

The Drip Drip Sprinkle Project will compare which system (sprinkler or drip) will be more efficient and conserve more water. The drip irrigation system is a system where water droplets drip slowly from a pipe (depending on your dripper) onto the plant's roots. The sprinkler system is another water system that consists of tubes and pipes which are buried half way into the grass and shoots out water reaching the whole lawn and longer distances. I will determine which system is best by doing different tests and studying different processes. First, I will observe how wet or dry the soil is after leaving the water on for 2 minutes. Second, I will measure how much water the drip systems and the sprinkler releases for 2 minutes. I will be using plastic water bottles to catch the water from the 4 different dripper's and a 5 gallon paint can for the sprinkler. In the third and last test, I will measure how deep the water penetrates the soil by using a clear glass straw and sticking it into the dirt about 4 inches deep. I will take the glass straw out and measure the dirt's soil wetness/dryness with a measuring tape.
The results of this experiment demonstrated the sprinkler wasted the most water as it wasted 92 ounces of water while the 2 gallon per hour pressure compensating dripper wasted 18.6 ounces of water. The drip system that used the most amount of water was the 2 gallon per hour pressure compensating dripper. The drip system that used the least amount of water was the fogger which used 0.16 oz of water due to it being a mist dripper. The most efficient and water-conservor dripper is the 1 gallon per hour pressure compensating dripper because it uses 5.3 oz of water in 2 minutes . There are different types of dripper's and I will be demonstrating four of them in my homemade wooden planter model. My homemade wooden planter will show how the dripper's work and how they each one differently distribute's water. I will also show how the DC water pump works and show all the connections you would need for it to work.

Project # **S1503** Category: **Plant Biology & Physiology - Sr**

Student: **David Macedo** Grade: **11** G: **M**

School: **Pioneer High School**

Title: **How does fertilizer effect plant life**

Our research project involves discovering how elements inside fertilizer affect plant traits, such as growth speed, lifespan, and the overall design of the plant to see if it's necessary to be given. The plants used were radishes because they were well known to survive through temperatures close to 20 degrees. We placed 32 radish seeds into a 4 x 4 plot and planted 2 seeds into each grid. Seeds were separated into two groups; one consisting of 16 seeds to measure the outcome of plants when given fertilizer which we called the “Control Group”, and the other 16 seeds named the “Water Group” to measure how many plants naturally grow, with no assistance with fertilizer. The results display that plants in the water group at the beginning stage of growth will have a faster development rate compared to the control group due to the plants needing to adapt to fertilizer. When looking at the later development of the plants, the water group still had an edge in having more seeds being bloomed compared to the control group. This shows the importance of fertilizer being known as a supplement, it takes time for it to kick in and for most of the plants in the control group weren’t able to survive until they got the nutrients they needed during the cold weather.

Project # **S1504** Category: **Plant Biology & Physiology - Sr**

Student: **Gabriella Gamez** Grade: **10** G: **F**

School: **BELL GARDENS HIGH SCHOOL**

Title: **Proceso de germinacion y alteraciones**

Mi proyecto tratara acerca del crecimiento de las plantas, Explicar que en las plantas hay un tipo de crecimiento que es la germinación. Es una respuesta coordinada que involucra las interacciones bidireccionales entre el eje embrionario y los cotiledones; por lo tanto, la relación de esas dos estructuras en las semillas de frijol es fisiológicamente relevante. En la germinación, los minerales se unen a las proteínas, haciendo que sean más fácilmente absorbidas por el cuerpo. Las semillas, los cereales de grano entero y las legumbres germinadas ayudan a la regeneración celular. Mostrare lo que impide este crecimiento y experimentare con distintos productos para ver lo que sucede, si afecta el crecimiento o de alguna forma lo altera.

Project # **S1505** Category: **Plant Biology & Physiology - Sr**

Student: **Vianka Ramos** Grade: **10** G: **F**

School: **Pioneer High School**

Title: **How does different types of water affect the rate of growth in algae**

My project is on The effects of pH levels on Algae growth. We had different types of water brands and tested their pH levels. The pH levels were Pond: 7.81, Alkaline 9.84, Tap: 7.32, Arrowhead: 7.29, and Kirkland: 7.63. Then we put 7 drops of plant food in each bottle. This process had all started on January 9th. Then on January 10th we brought them to school and put them in a greenhouse with a heat pad at the temperature of 70°. Then put them under a LED light. At the end of the experiment I had used a colorimeter. With the colorimeter we used 2 different colors: red and blue. With the results of the colorimeter being Arrowhead absorbance 0.260 while Kirkland absorbance 0.021 both under the blue light. Which had shown a big difference since the pH were also very different. As well as we had measured the mass from when we first started to when we ended. The mass of Arrowhead in the beginning is 400 oz then when it ended it was 430 which shows that the algae did grow a good amount. While the kirkland started the same with 400 oz but ended with 400 oz so it shows that not even one Oz of algae grew in kirkland. This proves that the higher the pH level is the more chance of algae growing in the water.

Project # **S1506** Category: **Plant Biology & Physiology - Sr**

Student: **Xiomara Zamacona** Grade: **10** G: **F**

School: **Pioneer High School**

Title: **How does the temperature affect plant growth?**

The purpose of this experiment is to determine whether or not temperature has an impact on pepper plant growth. Pepper plants will be grown under lights and heating pads at temperatures ranging from 65°-80°. The objective is to see how much the pepper plants will grow in a prolonged period of time. You will need 12 plastic plant pots and four different temperatures for germination of pepper seeds. Wait for the pepper plants to germinate for about a week before setting them up under lamps and heating pads. After germination, you will need to give the plants about a week before adjusting the temperature. Measure each pepper plant using a 12-inch ruler. The pepper plants will begin to grow at this point. Every two to three days, check on the pepper plants' progress and water them. After two weeks, measure the average heights of each of the pepper plants. The results of the data collection revealed that there was not much variation in the average heights. Our analysis of the data led us to the conclusion that the temperature has only a minor impact on pepper plant growth. This invalidated our hypothesis since we thought that the pepper plants would show a bigger variation than those at the recommended temperature at a hotter temperature.

Project # **S1507** Category: **Plant Biology & Physiology - Sr**

Student: **Diego Ramirez** Grade: **9** G: **M**

School: **Discovery Charter Preparatory High School**

Title: **Homemade Fertilizer**

Most people live in houses or apartments, and the living area is nicely decorated with beautiful vegetation, flowers, and trees. People do everything to see their landscape beautiful. The question is, how much money are people willing to spend on their landscape? The purpose of this experiment is to test the effect of a store-bought fertilizer vs. a home-mode fertilizer. Which kind of fertilizer will be cost-efficient and effective? The homemade fertilizer cost no money because it was made from food items that were going to be discarded. The store-bought fertilizer costs $ 8.00. We hypothesize that homemade fertilizer can be as effective and sometimes even more effective than store-bought.
The experimentation will be on parsley plants. The homemade fertilizer will contain baked and ground egg shells, chopped banana peels, orange peels, diluted vinegar, and pineapple skin. The store-bought fertilizer was general. The plants are embedded in the fertilizer and soil and placed in a pot. 2 plants are the control group that is placed in regular soil. 2 plants are in homemade fertilizer and soil. 2 plants are in store-bought fertilizer and soil. The experimentation lasted four weeks. Every day data was collected on the general health and growth (in cm) of the plants. The data revealed that homemade and store-bought fertilizers outperformed the control group equally. The experimental data proved the hypothesis that both fertilizers would be similarly effective. As it was proposed, the home made fertilizer was more cost-effective than the store-bought fertilizer.

Project # **S1508** Category: **Plant Biology & Physiology - Sr**

Student: **Sydney Wynn** Grade: **9** G: **F**

School: **Palos Verdes High School**

Title: **How Genetically Modified Glycine max Interferes with the Growth of Sorghum bicolor**

The grain sorghum is a calorie source for millions of food insecure people. Additionally, Sorghum is commonly intercropped with soybeans. 80% of soybeans grown are genetically modified (GM) to handle pesticide application. The goal of our study was to discover if the GM soybean can affect sorghum in intercropping because genetically modified soybean seeds can be coated in pesticides. We hypothesized that the sorghum intercropped with the conventional soybeans would grow more efficiently than the sorghum with the GM soybeans.

We first set up a dark room with heat lamps over the plant beds. In one bed we planted 6 conventional soybeans and in the other, we planted 6 GM soybeans, each with a proportional amount of sorghum in the bed. In 3 separate plant pots we grew the sorghum without any soybean in the soil as a control. For 60 days, we measured the plants daily and made a detailed spreadsheet.

The sorghum with the genetically modified soybeans grew at a faster rate in the beginning, but the sorghum with conventional soybeans in the end was 0.6 cm taller. The sorghum plants intercropped with the soybeans grew taller than the average height of the control sorghum, providing further evidence for how sorghum grows better intercropped with soybeans.

Our results were consistent with our hypothesis, proving the harmful effects that can come with growing crops in the presence of GM soybeans. With further study, we aim to bring more efficient agricultural practice for the food insecure.

Project # **S1509** Category: **Plant Biology & Physiology - Sr**

Student: **Nicholas Dominguez** Grade: **11** G: **M**

School: **Don Bosco Technical Institute**

Title: **All Hail Hydroponics**

The purpose of this project is to test if hydroponics has a faster growth rate on plants compared to soil and Miracle-Gro. The hypothesis is that plants grown hydroponically would grow faster than plants grown in regular and fertilized soil.

To test the hypothesis, three sets of plants were grown with different methods. The same plants used were tomatoes, kale, and peppers. The plants were placed in different growth media: regular soil, MiracleGro, and Hydroponics. To find the growth rate, a set's height would be measured in centimeters weekly. The measurement will be repeated for one month, between January and February.

The height of the three methods were measured for five weeks and compared to one another. The plants in regular soil grew slowest, tomatoes growing at 2.2 centimeters per week, kale growing at 1.59 cm per week, and the peppers growing 3.1 cm per week. The plants in MiracleGro grew the second fastest, tomatoes grew 2.25 centimeters per week, kale grew 2.4 centimeters per week, and peppers grew 3.8 centimeters per week. Hydroponics was fastest growth rate with tomatoes growing 2.2 centimeters per week, kale 2.9 centimeters per week, and peppers growing 3.8 centimeters per week.

The hypothesis that plants grown hydroponically would grow faster than plants grown with regular soil and fertilized soil is strongly supported by the results. It would be interesting to repeat this experiment with more plants to get a border sample size of growth rates.

Project # **S1510** Category: **Plant Biology & Physiology - Sr**

Student: **Andrew Kim** Grade: **12** G: **M**

School: **Flintridge Preparatory School**

Title: **Transformation of Chromochloris Zofingiensis to Enhance Lipid Production for Biofuel Development**

Chromochloris zofingiensis is a promising unicellular microalga that can reversibly regulate photosynthesis while producing biofuel precursors. Triacylglycerols (TAGs) and lipids are key components in biofuel production and are produced by algae. C. zofinginesis has become a microalga of interest due to its high productivity and flexible metabolic characteristics, specifically in various nutritional modes revolving around glucose. Within C. zofingiensis, one enzyme that has garnered attention is hexokinase. Hexokinase, and thus glycolytic enzyme hexokinase (CzHXK1), is known to be a photosynthetic and metabolic switch in relation to fatty acid biosynthesis and enables the engineering of the processes that produce algal bioproducts like lipids. Thus, the aim of this project is to introduce exogenous DNA (hexokinase) and develop a novel strain of algae with the ability to produce greater biofuel precursors in a controlled environment. Forward genetic screens found that hexokinase 1 (CzHXK1) in C. zofingiensis acts as the regulator of photosynthesis, carbon metabolism, and ketocarotenoid synthesis. Consequently, the ability to regulate this function allows for control over the rate of lipid production. Furthermore, it is established that hexokinase in C. zofingiensis acts as a mechanism of signaling in the green lineage, ultimately enabling more biofuel precursors to be created. The color of the colony was used to determine the successful transformation and overexpression of the hexokinase gene in the algae colonies for enhanced lipid accumulation. A greater color change occurs when orange-shaded keto-carotenoids are synthesized in greater quantities in unison with the desired lipids.

Project # **S1511** Category: **Plant Biology & Physiology - Sr**

Student: **Lucy Liu** Grade: **11** G: **F**

School: **Flintridge Preparatory School**

Title: **Effect of Human Multivitamins on the Health of Epipremnum aureum**

All plants need nutrients to survive, which they primarily obtain from their environment or fertilizers. Many of these nutrients also appear in the ingredients list of multivitamins, so many have wondered whether it's possible to supplement plants with human dietary supplements instead. To test this hypothesis, I observed the health of Epipremnum aureum leaves before and after propagation in various dissolved multivitamins and water concentrations. I propagated six cuttings in solutions of increasing amounts of dissolved multivitamins for 12 days and recorded the leaf health before and after the experiment. Leaf health was measured by photographing each leaf before and after, averaging the pixel values in each leaf to obtain a single composite color value, and running it through the Dark Green Color Index to determine which concentration of solution improved plant health most significantly. The solution with a concentration of 0.5 tablets/L with 124 mg of multivitamins dissolved in it produced a leaf with the most similar color to its initial healthy state and therefore the healthiest leaf. The difference in DGCI value was only 0.088 compared to the difference for the next healthiest leaf, 0.130, in a 1 tablet/L solution, and the difference for the least healthiest leaf, 0.196, the control with no tablets dissolved. Therefore, the addition of multivitamins significantly improved the health of Epipremnum aureum leaves. These results mean it is possible to supplement plants with small amounts of human multivitamins instead of potentially expensive or toxic fertilizers.

Project # **S1512** Category: **Plant Biology & Physiology - Sr**

Student: **Arman Omidvar** Grade: **12** G: **M**

School: **Palos Verdes Peninsula High School**

Title: **The Significance of Iridescence in Selaginella uncinata as a Strategy to Reduce Leaf Damage from Sunflecks**

Iridescence is widespread among tropical understory plants, and it is suggested to have a role in protecting photosynthetic structures against sunflecks or short periods of high intensity light. Yet, this relationship has yet to be demonstrated. In this study, we sought to determine if iridescence in Selaginella acts as a strategy to reduce leaf damage during sunflecks.
To do this, we grew two Selaginella species, S. uncinate (iridescent) and S. serpens (non-iridescent), in plastic bins using sphagnum moss as a growth substrate. Half of the specimens were exposed to constant moderate light (100 μmol·m-2·d-1) while the other half were exposed to daily 2-minute sunfleck-like light intensities (1,000 μmol·m-2·d-1), with both light fixtures maintaining a 14-hour photoperiod. Humidity and temperature were maintained at 90% RH and 25 Celsius, respectively. CO2 levels in each plant's container were recorded and pictures were taken every day.
The results of our study showed that the non-iridescent S. serpens specimen in the experimental group suffered more leaf damage and had a more stunted growth rate than the iridescent S. uncinate specimen. The iridescent S. uncinata individual in the group which experienced sunflecks grew at almost double the rate of all other individuals in the study. These findings are the first to support the hypothesis that iridescence in Selaginella acts as a protective mechanism against periods of potentially damaging light intensities.

Project # **S1513** Category: **Plant Biology & Physiology - Sr**

Student: **Zoe G** Grade: **12** G: **F**

School: **Archer School for Girls - Senior division**

Title: **Sweltering Soil: Counteracting Heat and Water Stress in Agriculture Using Hygroscopic Materials**

Objectives
My objective was to find how to improve soil moisture retention and how this could impact agriculture for areas with high heat damage. To achieve this I tested the hygroscopic materials; glycerine, dimethyl sulfoxide, and table salt, on broccoli and lettuce to find which would improve the soil water retention.

Materials and Methods
My project used 3 different types of hygroscopic materials; dimethyl sulfoxide, and table salt. For all of the groups, I used regular potting soil. The seeds for both the broccoli and lettuce were pre-germinated for 2 weeks in a petri-dish prior to being placed in the dirt. The dosage of the hygroscopic material was decided; 15 g Table Salt, 15 ml Glycerine, and 15 ml dimethyl sulfoxide. Once placed into the potting soil, the plants were given their first dose of the hygroscopic material and watered with 50 ml of water. Every 2 days the liquid hygroscopic materials, glycerine and dimethyl sulfoxide were re-added and the measurement using a soil meter monitor with a 1-10 point range was taken.

Results
My experiment found that the addition of glycerine, dimethyl sulfoxide, and table salt killed both the broccoli and lettuce plants but retained the water in the soil better than the control groups.

Conclusion
In conclusion, my control group was the only group that didn't kill the plant, disproving my hypothesis. Now I know that due to the lack of natural crop growth substitutes we must focus on solving the root problem.

Project # **S1514** Category: **Plant Biology & Physiology - Sr**

Student: **angel gomez** Grade: **10** G: **M**

School: **BELL GARDENS HIGH SCHOOL**

Title: **soil temperature and plant growth**

My project's goal is to help determine if the soils temperature would affect a plant's growth.

Project # **S1515** Category: **Plant Biology & Physiology - Sr**

Student: **Valentina Mancilla** Grade: **10** G: **F**

School: **Flintridge Preparatory School**

Title: **How Temperature Affects The Rate of Photosynthesis**

In our experiment, we wanted to see how temperature would affect the rate of photosynthesis. We hypothesized that the higher the temperature of the sodium bicarbonate solution the higher the rate of photosynthesis. Our independent variables were the different temperatures of the solution; hot, cold, and room temperature. Our dependent variable was how many leaf disks were floating. To begin we placed 10 spinach leaf disks in a syringe and filled it with its corresponding sodium bicarbonate temperature solution, which acted as a source of carbon dioxide for the leaves. We created a vacuum in the plunger by holding a finger over the syringe opening while drawing back the plunger. We continued this process until all the leaf disks had successfully sunk. We then poured the disks and the solution from the syringe into the appropriate beaker with the same sodium bicarbonate temperature. Finally, we turned on the lamp and observed how many disks floated in 25 minutes. We repeated this same procedure with the other two solutions and recorded our data. Our hypothesis was proven correct. Our results show that in the hot temperature solution all 10 spinach leaves had risen, in the room temperature solution only 9 had risen, and in the cold temperature solution, none had risen. Our experiment proves that as climate change escalates it will continue to affect the process of photosynthesis. Plants in environments with extremely cold weather will experience a decrease in the production of photosynthesis.