cultured in petri dishes to extract the DNA for identifying the organisms present. This provides evidence for correlation of gender or age and the resultant microbial community.

SIFTING GERMPLASM TO IDENTIFY HYPOALLERGENIC PEANUT GENOTYPES: GAINING AMMUNITIONS FOR FUTURE BREEDING

Brianna Ludlum
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A prevalent and increasing issue in the world is peanut allergies. Allergic reactions can range anywhere from minor to deadly. They actually send someone to the emergency room every three minutes (FARE, 2017). The amount of allergic reactions to peanuts is on the rise in America, and many researchers are trying to reduce this number. There are many experiments underway to find better ways to treat allergies and to identify the cause of these allergic reactions, primarily in regards to how a person’s immune system responds to these allergies. However, the purpose of our research is to identify unique molecular genotypes within the peanuts in order to identify whether molecular differences can ultimately lead to identifying what triggers allergic reactions. We performed SDS-PAGE gels on 109 different peanut genotypes and examined their banding patterns. From these gels, we were able to identify a common banding pattern, and found 20 special genotypes that differed from those patterns. Differences could mean lighter bands, missing bands, or bands that were in different locations—higher or lower than usual. These 20 special genotypes will go to Clemson campus so they can be observed further. From them, we can find their amino acid sequence to find what causes those genotypes to be possibly allergenic. After that, we can alter those sequences and create new, hypoallergenic peanuts that are safer. Hopefully these modified peanuts will help decrease the amount of allergic reactions to peanuts in the United States and around the world.

SHORT TERM AFFECT OF SALT WATER FROM HURRICANE MATTHEW STORM SURGE ON COASTAL LOBLOLLY PINE POPULATIONS

Jonathan Mackey and Brynn Wilkinson
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Hurricanes have devastating effects on the coast of South Carolina every time one passes. Their high winds and storm surge completely destroy coastal forest ecosystems. The project that we worked on focused on the immediate affects of Hurricane Matthew on these coastal forests. More specifically we focused on the affects of the storm surge on coastal loblolly pine and wax myrtle forests at Hobcaw Barony, located near Georgetown, South Carolina. These forests were divided into 20 meter by 100 meter plots, in these plots every tree was assigned a number and marked with a tag. The first method we used to gather data was to measure the DBH of the trees in these plots and use these data to calculate the basal area and mortality of the plots. The second method we used was to measure the amount regeneration in these same plots. From the mortality data we gathered, we observed that large trees weren’t as affected immediately by Hurricane Matthew. From the regeneration data we observed that loblolly pines regenerated at slower rates in plots that were covered by the storm surge and that wax myrtles fared only a little better. From this we learn that loblolly pines are at a competitive disadvantage after storm surges, as they are not able to regenerate quickly. This project has helped us to learn more about patterns forests have after hurricanes strike.

INTERACTION AND OVER-EXPRESSION OF THE PROTEIN KINASE NEK2 IN RELATION TO CENTROSOME APPENDAGES IN LEUKEMIA CELLS

Eesha Maisuria
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The second highest cause of death is cancer, a disease caused by uncontrolled division of abnormal cells. Centrosomes, organelles that facilitate cell division, have a possible role in cancer. One of the unique traits of centrosomes are the presence of distal appendages, which are noticeably lesser in leukemia cells. NIMA-Related Kinase 2 (Nek2), an early acting protein kinase, has been found to be associated with the disappearance of these distal appendages. The aims of this research are (a) to conduct Western Blot analysis to determine expression of Nek2 in various leukemia cell lines; (b) to conduct an Immunofluorescence Assay to identify and compare levels of centrosome appendages in these cells; and (c) to conduct a Yeast Two Hybrid system to determine Nek2 interaction with other proteins in the centrosome cascade. The results indicate that U937 and K562 cell lines had the greatest overexpression of Nek2, while KG1a cell line had one of the lowest expression, but still higher than normal cells. The results also showed that K562 and KG1a had no significant differences in the number of centrosome appendages, while U937 and KG1a had a significant difference in the number of centrosome appendages. Finally, the results for Yeast Two Hybrid system indicated that Nek2 did interact with the truncated version of certain kinase proteins in the centrosome pathway.

INDICATION FOR BONE REMODELING IN THE LATERAL ASPECT OF YOUNG WHITE-TAILED DEER DISTAL FEMORA

Shirley Mathur
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In this project, we examined the innate stiffness of bone material in the distal lateral femora of young white-tailed deer. We researched this property of bone in order to develop a better understanding of how bone function differs in different regions of the femur. We experimented on this property of bone material by taking small cubic samples of bone and loading them in
compression to test their stiffness in all three orientations—axial, transversal, and radial. After testing the stiffness of over thirty cubes, we analyzed our results and compared them to those of previously conducted similar research in the medial region of deer femora to see whether or not bone function differs amongst these two regions. We found that the function does appear to differ, as the results of our study were different than those of the previous research conducted in the medial region of young white-tailed deer femora.

THE EFFECT OF SOLANUM LYCOPERSICUM, ALLIUM SATIVUM, AND MENTHA PIPERITA AS DETERRENTS ON DROSOPHILA MELANOGASTER
Jane McCallum
Spring Valley High School

Around the world, mosquitoes cause millions of deaths every year. In order to deter these pesky insects, scientists have found and created several chemicals that are commonly used in commercially available insect repellents. These chemicals are, unfortunately, often corrosive and harmful to the environment. Also, some of the countries that are plagued by mosquito borne illnesses do not have access to these commercially available insect repellents. The purpose of this project was to find a natural resource that could be used as an insect repellent. Three potential natural insect repellents were chosen: Solanum lycopersicum (common tomato), Allium sativum (common garlic), and Mentha piperita (common peppermint). It was hypothesized that Allium sativum would repel the highest percentage of Drosophila melanogaster from an attractant. Drosophila melanogaster were placed in a test chamber with two attached, alternative feeding chambers and had to choose between feeding chambers containing an attractant or the attractant in combination with the potential repellent. A 2 sample z test, with a critical value of -1.65, was used to analyze the results. None of the potential repellents were able to support the claim that fewer Drosophila would choose the chamber containing the potential repellent because in all cases, the p value was higher than the alpha value of 0.05, but garlic had the lowest z score of -0.36. Allium sativum was the closest to working as a repellent, but there was not enough evidence to support the claim that it repelled Drosophila.

THE EFFECT OF NICOTINE ON DROSOPHILA MELANOGASTER LIFESPAN AND NUMBER OF OFFSPRING
Claire McDonald
Heathwood Hall Episcopal School

The purpose of this experiment is to determine the effect of nicotine on Drosophila melanogaster lifespan and number of offspring. It was hypothesized that if the amount of nicotine solution is increased, then Drosophila will have a shorter lifespan and fewer offspring. Four different concentrations of nicotine were mixed by filling jars with 10 mL of water and using a micropipette to measure each amount of nicotine, using 3 uL, 6 uL, 9 uL, and 12 uL as the amounts. Each vial of food was made by mixing 10 mL of food with 8 mL of the nicotine solution. Five test tubes were assembled, each with a different concentration of nicotine, and four male Drosophila and four female Drosophila were placed in each vial. The number of living Drosophila was recorded every day for 25 days. The data reveals that the flies that were not exposed to the nicotine food had much longer lifespans and they produced offspring. The 3 uL group had one fly at the end, but the rest died by day 18. The 6 umL group died after the 19th day. The 9 uL group had two flies left, but the rest of the group died at day 21. The 12 uL group died at day 7. The control group started to reproduce on day 15. These results support the hypothesis that the Drosophila exposed to nicotine would have shorter lifespan and fewer offspring than the control group.

THE EFFECT OF ORGANIC MATTER ON THE AGGREGATION RATES AND KINETICS OF SILVER NANOPARTICLES
Anne McElvenny
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Due to the rise in use and many questions raised regarding Silver Nanoparticles (AgNPs), we tested the behavior of the AgNPs against different water properties and the effects of ion concentration of Sodium Nitrate (NaNO3). The water properties included the presence of Natural Organic Matter (NOM) from Pacific Ocean and Everglades samples. We used Dynamic Light Scattering (DLS) to measure the hydrodynamic Matter (NOM) from Pacific Ocean and Everglades samples. We used Dynamic Light Scattering (DLS) to measure the hydrodynamic diameter, which correlates to the aggregation rates and kinetics of the AgNPs. The diameter increases because particles aggregate, increasing the overall size. We graphed these results against the different ion concentrations. We concluded that as the concentration of Sodium Nitrate increase, the aggregation rates of AgNPs also increase. This could be attributed to the surface charge screening in presence of counter ions. We also determined that the different NOMs did not show significant influence on the aggregation rates of AgNPs. Future works will continue to test how nanoparticles react in various environments with different physiochemical properties.

THE EFFECT OF NEODYMIUM MAGNETS ON THE AMOUNT OF SALT FILTERED OUT OF A SEAWATER REVERSE OSMOSIS SYSTEM
Jackson McFadden
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The purpose of this experiment was to test if the addition of neodymium magnets made a significant difference on the efficiency of a reverse osmosis machine in filtering salt out of imitation seawater (salt water with a concentration of 35 ppt). “It was hypothesized that if more magnets are added to the solution, less salt would be able to pass through the system, thus the overall system readings would be lower.” It was also hypothesized that the average salinity would decrease by at least 5 ppt. 1 liter of
Imitation seawater solution was put into the pressure tank on the water side. The pressure was preset to 30 psi and then the "seawater" was run through the system. After being forced through the system, the salinity of the water was then recorded using an optical refractometer that measured the grams of salt in one liter of water, also referred to as "parts per thousand", but will be referred to as ppt throughout this paper. Levels of the independent variable measured the results of a 0-Magnet group, a 14-Magnet group, and a 28-Magnet group. An ANOVA test revealed that there was no statistical difference between the means, $F(2,87)= 1.75, p>0.05$. It can be concluded that the neodymium magnets did not adversely or beneficially affect the machine's efficiency at filtering salt out of the water, thus rejecting the hypothesis. These findings were not statistically significant, but with a few alterations to the procedures and to the materials, there is a possibility that a correlation between the two variable could be found.

EFFECTS OF CONNECTEDNESS ON VISUAL ENUMERATION
Felicia McGill
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Visual enumeration refers to the process by which individuals determine quantity without sequentially counting. When people enumerate small quantities, for example less than 5 items, it is referred to as subitzing (G.S. Starkey, B.D. McCandliss). As quantities increase, so does difficulty in enumerating correctly and accurately. Therefore, many people use a method called groupitzing by which they group larger quantities together in order to enumerate them. This experiment aimed to look at how grouping by connectedness (Palmer, S. and Rock) affects visual enumeration. In everyday life, experiments like these can assess mathematical skills, and early signs of numerical cognition impairments. The total experiment consisted of 420 trials of dot stimuli that were flashed to 11 participants for 0.15 seconds. There were 4 different types of arrangements for the dots, with 105 trials per condition. The respondents were told that the answer choices ranged from 2-50, but in fact only prime numbers were possible answers. In 2 out of the 4 conditions, most subjects could accurately enumerate up to 5 dots 100% of the time. These successful conditions were those which connected the dots with lines, as opposed to the other two conditions which did not. Among the unconnected conditions, success rates were never higher than 60%. These findings provide further evidence for Gestalt's principle of uniform connectedness, which explains that connected items can be more easily enumerated than unconnected ones.

THE EFFECT OF ZINC ON BRASSICA JUNCEA'S ABSORPTION ABILITIES
Rahithya Meda
Spring Valley High School

In many developing countries, sufficient and inexpensive resources needed to provide their citizens with safe and healthy food are not available. Because of various issues such as money, many areas are searching for cheap and accessible methods to prevent contaminants from entering through the ground and toxicaing their food. One way to eliminate this is through a process called phytoremediation. Phytoremediation is when plants are used to eradicate harmful metal contaminants from the soil. They are able to do this by absorbing the metals into their roots. In this experiment, Brassica juncea seeds were planted into the soil with varying amounts of zinc to see how much zinc the plants could remove. The purpose was to see which group of plants could not only consume the most zinc, but grow the longest roots, which would much aid in the phytoremediation process. It was hypothesized that if Brassica juncea is grown in an environment with 2.6 ppm of zinc present, then it will result in the most absorption of the metal and inhibit the greatest root growth. In this experiment, 3 groups of plants were grown having a zinc concentration of 0.8 ppm, 2.6 ppm, and 3.7 ppm. After a period of 6 weeks, 5 plants chosen at random from each group were measured for their absorbance. This was done by viewing pieces of the plant's root combined with a Zincon reagent under the microscope. The reagent allowed for the color of the root tissue to change to a shade of blue depending on the amount of zinc present. The darker the blue, resulted in more zinc being present. Each shade was then matched with its closest color on a color scale ranging from 0.0m ppm to 4.0 ppm. A one-way ANOVA was conducted and then a post-hoc tukey test. The results showed that at $\alpha = 0.05$, $F(2, 12) = 12.67, p < 0.001$. Because the p-value was less than the alpha value, it was concluded that the null hypothesis was rejected. The tukey test then confirmed that there was a difference in mean concentrations between groups 0.8 ppm and 3.7 ppm, and groups 2.6 ppm and 3.7 ppm. It was concluded that the plant Brassica juncea was very efficient in the phytoremediation process. As the zinc concentrations increased, the zinc absorption amount increased as well. Overall, the plant group containing 2.6 ppm of zinc concentration inhibited the great root growth and was able to absorb much zinc.

A SEMI-AUTOMATED METHOD OF GENERATING GROUND TRUTH FOR INVOICES
Vivian Medina
Governor's School for Science and Mathematics

This project came about to solve a problem in a bigger project, one in which an insurance company contracted the German Research Center for Artificial Intelligence (DFKI) to autonomize the making of medical invoices. DFKI was given access to the database necessary to recreate a set of 60 previously made invoices along with a scanned image set of those original invoices—information to create an output and information to verify the output. The project came about in the process of verifying the output; to check the values from the code, researches would have to spend valuable time looking at all of the original invoices, all of which vary in format and content, finding which information was needed, and typing out those values into a document where they could be directly used to assess the accuracy of the code. Therefore, the need to make this ground truth extracting process semi-autonomous became vital to the progress of the bigger project. The result of the research came about in a code that
THE EFFECT OF SOUND FREQUENCIES ON THE GROWTH RATE OF THE PHYSARUM POLYCEPHALUM
Lauren Mehta
Spring Valley High School

A large part of the environment is made up of soundwaves. Infrasound, audible sound, and ultrasound are the three most commonly found in nature. Even though these soundwaves are a key part of the environment, they have been neglected in research when it comes to their relationship with organisms. This study found the correlation between soundwaves and single-celled organisms. It was hypothesized that when two specific soundwave frequencies were played regularly during the Physarum polycephalum’s life cycle, the higher of the two frequencies would have a higher growth rate. Thirty of these protists were tested, one set of ten with a high frequency, one set of ten with a low frequency, and one set of ten with no frequency. A one way ANOVA was run, and the conclusions of this test showed that the high frequency’s growth rate was faster. However, the overall objective of this study was to find if the frequencies grow faster compared to the regular growth pattern of the Physarum Polycephalum. The raw data and ANOVA results showed that the frequencies do grow at a faster rate.

THE EFFECT OF SILICA-CONTAINING TOOTHPASTE ON DENTAL STAINS
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The purpose of this study is to determine the effect of silica-containing toothpaste on dental stains on eggshells. There were three different dental stains tested during this experiment: Coke, coffee, and red wine, as well as three different toothpastes: Arm and Hammer Complete Care plus whitening, Colgate Total Whitening, and Crest Pro-Health. The hypothesis states “if Colgate Total Whitening, Arm and Hammer Complete Care plus whitening, and Crest Pro-Health toothpastes are used on common dental stains applied to egg shells, then the eggshell will become the most white on the stains from the Crest Pro-Health toothpaste, and therefore have a positive change.” In each trial there were the three stains with one of the previously mentioned toothpastes. Each egg was soaked in the stain over night, and then let dry for 24-hours. Each egg was then brushed ten times clockwise and ten times counterclockwise with a pea-sized amount of toothpaste. After completing 30 trials, an ANOVA test and descriptive statistical analysis was taken for that data. Both inferential and descriptive statistical tests suggested that the Colgate Total Whitening toothpaste was most effective at removing the stains from the eggshells; however, the Crest Pro-Health toothpaste had more consistent results overall. In conclusion, the Colgate Total Whitening toothpaste had the most positive effect, therefore having the highest average removal for each stain.

PREVENTION OF CHRONIC MEMORY LOSS IN ALZHEIMER'S PATIENTS THROUGH DIET CHANGE
Shane Mikolajczak
Center for Advanced Technical Studies

THE EFFECT OF VIRTUAL REALITY EDUCATION TOOLS ON THE RETENTION OF INFORMATION
Andrew Miller
Spring Valley High School

This paper examines the prospects of virtual reality (VR) in aiding and or replacing traditional education methods. The purpose of this experiment was to test the viability of virtual reality in education and also see alternative uses for virtual reality. Two groups utilized the two different methods to learn about a subject and were assessed on how well the information was retained. They were assessed using a nine question quiz that included questions about the subject and opinion based questions on the medium used. It was believed that the group using the virtual reality application would produce better results on the post-assessment than the traditional group. Based on the results, the group the utilized the traditional method of learning produced a better mean score on the post-assessment than the virtual reality group. However, based on the independent t-test conducted, there was no significant difference between the scores of the two groups, t (22) = 1.36, p > 0.05. From this, it can be assumed that either method could be used interchangeably. Most of the participants, on the other hand, believed that virtual reality applications should only be used as supplemental material rather than standalone material.

THE EFFECT OF ALUMINUM ON THE MECHANOSENSORY BEHAVIOR OF C. ELEGANS
Shubhanjali Minhas
Spring Valley High School

Parkinson’s disease (PD) is a major neurological disease that involves the degradation of dopamine neuron networks within the brain and the accumulation of the alpha-synuclein protein. Although these phenomena are typical of PD patients, it is unknown how they develop. Previous research has led to the hypothesis that environmental factors such as pesticides and heavy metals lead to the onset of PD-like symptoms (Zhou, Wang, and Klaunig, 2013). Thus, aluminum, a metal found in many pieces of...
American foreign aid and intervention has been a central point of debate for as long as the nation has existed. United States mediation has many goals, chief among these being the promotion of peace, security, economic development, and humanitarian advancements. Despite these goals and the trillions of dollars spent to achieve them, life around the world, especially in areas of great turmoil, has not clearly improved. In many cases, it has gotten worse since an intervention by the United States. This
study traces the effects of intervention events as they spread from their origin into other countries around the world. Most emphasis was put on The CIA's Operation Cyclone in the 1970s and 1980s, new and existing alliances with the United States, and the War in Iraq and Afghanistan in the 2000s. Time was also spent looking at various smaller intervention and aid events, such as CIA assisted coups, arm sales, and aid distributions in Afghanistan, Iraq, Syria, Yemen, Somalia, Nigeria, and Iran. We used various governance, development, and humanitarian indicators as well as more tangible data such as death tolls and monetary expenditure to trace the outcomes of these events for the years between 1979-2016. In many cases, the results were contradictory to what was expected by the Government of the United States. The perverse incentives (and armament) they gave to the peoples of the regions came back to cost them.

MEASURING THE RATE OF LIGAND EXCHANGE REACTIONS: ELUCIDATION OF COPPER AND NICKEL TOXICITY IN AQUATIC ENVIRONMENTS

Collin Myers and Savannah Finely
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In this research, the behavior of copper and nickel was studied when exposed to different ligands at various concentrations. Traces of copper and nickel can be found in local water sources, but little is known about just how safe these metals are to the environment, especially nickel. To test how these metals would complex, ligands such as nitrilotriacetic acid (NTA) were tested when mixed with the metal solutions, and spectrofluorimetry was used to analyze the complexing nature. Calcein was used to initiate the reaction, much like the way these metals would complex in a natural environment. The data generated shows how kinetically stable the substance is based on the amount of free calcein remaining over time. The results will help to better understand toxicity in a water source based on its ability to react. This can further help protect from pollution since the behaviors of metals in water can be observed.

THE EFFECT OF VARIOUS LIGHT BULB AND ACCOMPANYING VISIBLE LIGHT FREQUENCIES ON POGONOMYRMEX OCCIDENTALIS ACTIVITY

Connor Myrick
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Numerous ecological systems are built upon the foundation laid by keystone species, such as ants, whose relationships are typically mutualistic. Different light bulbs emit various wavelengths of light with different energy outputs. Often animal and insect behaviors are dictated by circadian rhythms, internal clocks that regulate the internal processes of organisms, and zeitgebers, which are environmental cues (such as light and temperature) that alert and help modulate circadian rhythm. This experiment was conducted with the purpose of viewing how lights affect the nest building activity of the insect. P. occidentalis. It was hypothesized that LED lights would have the least negative effect on ant activity. For this experiment, a series of ant farms were placed beneath a light bulb for seventy-two hours and the length of the tunnel was measured every eight hours. This procedure was repeated four times, with a different variable including, LED bulbs, fluorescent bulbs, and halogen bulbs and no-light. To analyze the data, an ANOVA and post hoc test were performed at =0.1, which revealed that there was enough evidence to support the claim, F(1,36)=1.82, p=0.161. In fact the LED bulbs had a positive effect on the ants, since ant activity was greater in LED lights than in darkness. To conclude, the hypothesis was partially supported because the statistical analysis revealed that half of the data had differences between the means and this difference became more prominent as time passed.

THE SYNERGISTIC EFFECT OF EPIGALLOCATECHIN-3-GALLATE (EGCG) AND ARTEMISININ ON THE PLASMODIUM MORTALITY RATES OF PHYSARUM POLYCEPHALUM AND CELL MOTILITY/CHEMOTAXIS OF DICTYOSTELIUM DISCOIDEUM UTILIZED AS AN AMOEbic HOST

Abhijith Nair
Spring Valley High School

Plasmodium falciparum is an organism that causes the deadliest type of malaria. Its methods of adhesion and drug resistance make it lethal and difficult to treat. Artemisinin is a drug currently used as treatment, but resistance is increasing exponentially. A secondary drug to be used synergistically with artemisinin has been sought after. Physarum polycephalum is in the Plasmodium class and is biologically similar. This study focused on an accepted method of synergy-based prophylaxis, while maintaining neurological capabilities of Dictyostelium discoideum. EGCG (Epigallocatechin-3-gallate) is a cost-efficient, longer-lasting, and natural drug that has provided exceptional synergic results. The combination would offer treatment, while allowing the patient to recover with minimal neurological damage. The preliminary test was run using a well-plate synergy-based method, while maintaining neurological capabilities of Plasmodium. The results were contradictory to what was expected by the Government of the United States. The perversely incentives (and armament) they gave to the peoples of the regions came back to cost them.

The FIC (Fractional Inhibitory Concentration) at 2.18>1 showed remarkable synergy between artemisinin and EGCG.
Researchers are looking for new ways to generate solar energy in a cheaper, safer, and faster method. Anthocyanin pigment photovoltaic cells have been used in solar cells due to their ability to convert light energy into electrical energy. Fruit dyes have been incorporated into photovoltaic cells due to the anthocyanin pigments they contain, but roses, which also contain anthocyanin, have not yet been tested. The purpose of this analysis was to test if anthocyanin pigments from a Rosoideae rosa petal could generate more electricity than a photovoltaic cell made from copper. It was hypothesized that the darker the anthocyanin pigment, the higher the voltage of the cell. This was assumed as darker anthocyanin pigments were proven to have higher concentrations of anthocyanins and have high pH values, which can conduct electricity. Experimentation was accomplished by using rose colors of purple, red, pink, and yellow and using copper as the basis of comparison. The cells containing anthocyanin pigments were created along with a titanium dioxide paste and were put under direct light. The copper cells were made by adding a sodium bicarbonate solution to the copper sheets. A one-way ANOVA test was run to test a difference in the means, and was proven to have a difference at = 0.05 when p = 0.0001. The hypothesis was mostly proven, resulting in the darkest color, purple, having the highest amount of electricity generated, but followed by the copper having the second highest electricity amount, instead of the next darkest color, red.

THE EFFECTS OF CLINOTPITOLITES VS. CONTROL-RELEASE FERTILIZER ON NITRATE LEACHED FROM SILT LOAM SOIL
Keshav Nair
Spring Valley High School

Agricultural leaching is where nutrients, minerals, and chemicals from the soil contaminate the groundwater after rainfall and irrigation. A method used to prevent leaching is the use of nitrate inhibitors but recently other minerals have been used. The purpose of this experiment was to find a more abundant and efficient method of reducing nitrate leaching in soil. The effectiveness of clinotpitolites minerals versus control-release fertilizer were observed in this experiment. It was hypothesized that control-release fertilizer will more effectively reduce the amount of nitrate leached from silt loam soil than clinotpitolites. A one-way ANOVA showed that the differences between the control (n = 30, M = 9.667, SD = 0.232), the clinotpitolite soil mixtures (n = 30, M = 4.300, SD = 0.474), and the control-release fertilizer soil mixtures (n = 30, M = 5.247, SD = 0.580) were not statistically significant, F(5,174) = 67.45, p < 0.001 < α = 0.05. A post hoc Tukey test was performed on the data at α = 0.05 for the nitrate concentrations of different soil/mineral mixtures to determine where the mean differences lie. The results showed there was no significant difference between the before and after of the control, but there was a significant difference between the after for the control and the after of the clinotpitolite and control-release fertilizer soil mixtures. There was also a significant difference between the before and after of the clinotpitolite soil mixtures, the before and after data of the control-release fertilizer soil mixtures, but no difference of the after data of the clinotpitolite and control-release fertilizer soil mixtures. These results showed the difference in the effectiveness of the clinotpitolite soil mixtures versus the control-release fertilizer soil mixtures in reducing nitrate leaching was not statistically significant.

THE EFFECT OF TOPSPIN SERVES, FLOAT SERVES, AND JUMP SERVES ON THE TYPE OF PASS MADE BY HIGH SCHOOL VOLLEYBALL PLAYERS
Rachael Nall
Spring Valley High School

There are three main types of serves in volleyball: float serves, jump serves, and topspin serves. These three types of serves can be returned with an underhand pass or an overhand pass. The purpose of this study was to determine if there was a difference between the type of serve performed and the resulting type of pass. It was hypothesized that all three of the volleyball serves would be mainly returned by underhand passes, but the float serve would have the most number of overhand passes. Also, it was hypothesized that the jump serve and topspin serve would be mainly returned by underhand passes. The data in this study was obtained from tryouts of sixteen year old volleyball players at the Plex Indoor Sports in Sandhills where 51 serves were observed. The sample size of the jump serves was too small so it was taken out of the analysis. This could have been due to the fact that the results were only gathered from sixteen year old volleyball players rather than a higher age range which would have potentially utilized more jump serves to produce the maximum power. The passes of the float serve and topspin serve were extremely similar. This was probably why no significant difference (t (40.7) = 0.68, p = 0.5) was detected in the passes returned in the two sample t-test at alpha value 0.05.

EVALUATION OF HANDS-ON AND VIDEO RESOURCES FOR TEACHING ECONOMICS AND FINANCIAL LITERACY
Mehrwam Namiranian
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This paper examines research done on Economics and Financial Literacy teachers in order to discover the most effective type of resource. Teachers were asked to rate several online resources and to answer questions about their general opinions on hands-on resources and video resources used in economics and financial literacy. The means of evaluating these resources involved online surveys sent through e-mail. Although it was found that the effectiveness of each type of resource was fairly the same,
teachers preferred hands-on resources. Additionally, they claimed their students preferred hands-on resources. Teachers either taught grades 4 through 5 or high school. The goal of this research was to determine what type of research-hands-on or video-is more effective at teaching economics and financial literacy in the classroom. The results showed that hands-on resources were more effective based on the opinions of teachers since the rubric evaluations had similar mean scores. Surprisingly, the majority of teachers believed that video resources were easier to implement.

EVALUATING WOMEN’S AWARENESS OF HEART ATTACK SYMPTOMS
Haley Nazario
Center for Advanced Technical Studies

Cardiovascular disease holds a societal stigma of being a man's disease; however, this mentality is detrimental to another another demographic who is undereducated in the area of heart attacks: women (Albarran, J.W, etc, 2006). This is because women experience a more atypical presentation of symptoms than men. This study’s objective is to determine women’s ability to correctly identify the heart attack symptoms specific to their gender. If women were asked to name female symptoms of a heart attack, then they would only cite the male related warning signs. To achieve this, a survey will be supplemented to men and women. Its content will cover heart attack differences between genders. Then a video will be viewed, describing symptom differences and other areas previously tested on. Lastly, a post test will be administered, and the results will portray women’s understanding of heart attack symptoms. Paired T testing will be used to analyze the mean difference between the pre and post evaluations. A successful procedure would be the hypothesis being supported through a discrepancy between the two mean scores indicating a lack of awareness within females. However, the goal of the campaign portion of the project would be successful when recognition of symptoms are increased within the female demographic. The implications of this project would be to stimulate concerted efforts to increase female awareness of heart attack symptoms. Future work would focus on shifting risk profiles of a heart attack patient as well as conducting more studies on women with cardiovascular diseases.

THE EFFECT OF CAFFEINE ON THE FORAGING BEHAVIOR AND REPRODUCTION OF DROSOPHILA MELANOGASTER
Jordan Nealey
Spring Valley High School

The purpose of this experiment was to determine the effects of caffeine on the foraging behavior and reproduction of Drosophila melanogaster. It was hypothesized that if higher doses of caffeine were given, then the Drosophila would choose the lesser ideal option for their nutritional needs and the least amount of fertility would occur within that generation than Drosophila exposed to no caffeine. In testing the F1 generation for foraging behavior, the flies ingested varying doses (.001 g,.002 g,.005 g,.014 g, and .024 g of caffeine) and were given 15 minutes to forage for nutritionally substantial (banana) and nutritionally unsubstantial (sugar) food. In order to forage, two jars were placed into cut corners of a bag. The flies were transferred into the bag from the top of the Ziploc and foraged for either the banana or sugar. In testing the F2 generation, the mass of Drosophila population was calculated for the Drosophila whose F1 generations went to banana and to sugar. An ANOVA test \[F (5.1148) =5.21, p < .001\] on the effect of caffeine concentrations on the foraging behavior of Drosophila was significant. Both hypotheses for the reproduction of the F2 generation were supported. The mass of the F2 banana culture \[r = -0.8530, r^2 = 0.727686, p < 0.030807\] was significantly correlated with caffeine concentration while the mass of the F2 sugar culture \[r = 0.7949, r^2 = 0.631944, p < 0.058758\] was not. These results imply a high overall effect of caffeine on Drosophila.

THE EFFECT OF DEVELOPMENTAL NUTRITION ON ETHANOL ADDICTION IN DROSOPHILA MELANOGASTER
Dawn Nguyen
Spring Valley High School

Alcohol addiction and other substance abuse disorders have led to unhealthy life choices and mortality around the world. Thus, research has been conducted to study the correlation between epigenome and environmental factors in order to raise awareness and help for others. The purpose of this experiment was to analyze whether developmental nutrition affected ethanol addiction. It was hypothesized that the *Drosophila melanogaster* raised in a poor nutritional environment would consume the most ethanol. In order to test this hypothesis, the experiment consisted of raising the fruit flies in the developmental environments. Once the organisms became adults, a 0.1% ethanol and 5% sucrose mixture was introduced using a capillary feeding (CAFE) assay. This was used in order to study the ethanol consumption between each developmental treatment over two weeks. An average consumption rate of microliters per day was recorded. An ANOVA test \[F(2,10) = 6.85, p = 0.013\] showed that nutritional treatments impacted ethanol addiction. The Scheffé test found that the Fs of the rich treatment compared to the poor and control treatments to be greater than the critical value, 8.2. Overall, the cultures raised in rich developmental nutrition had the highest ethanol consumption.
CAN BOTH SYNTHETIC AND NATURAL DYEING METHODS BE COMBINED TO CREATE A NEW DYEING METHOD

Nam Nguyen
Spring Valley High School

The experiment was conducted in order to see if synthetic and natural dyes can be used together to make a dye mixture. It was hypothesized that both test groups will maintain an average of 4 by the end, with the mordant group having a higher average. Testing was done by dyeing cotton swatches with the dye mixtures (made with store-bought synthetic dye and homemade natural dye). The swatches then went through 5 fastness trials, their final status was recorded based on a scale of 1-5. The same swatches were used throughout the fastness trials, no new swatches were introduced. The mean of each fastness trial from each data set were taken, and 6 independent t-tests were used to see significance between the two means. The p-values for the start, trial 1, trial 2, trial 3, trial 4, and trial 5 are .369, .438, 0, 0, .003, and .136 respectively. Using an alpha value of .05 with p<.05, trials 2, 3, and 4 showed significance while the p values at the start, trial 1, and trial 5 do not. The t-values for the start, trial 1, trial 2, trial 3, trial 4, and trial 5 are .91, .78, 7.42, 5.06, 3.29, and 1.53 respectively. Using a critical value of 1.311, trials 2 through 5 showed significance, while the start and trial 1 did not. This shows that there is no significance difference between the two datasets at the start and towards the end, which means that there could be no difference overall, should more fastness trials be conducted.

THE EFFECT OF DIFFERENT CONCENTRATIONS OF CAFFEINE IN COFFEE ON THE GROWTH OF WISCONSIN FAST PLANTS

Hailey Nicks
Heathwood Hall Episcopal School

The purpose of this experiment was to study the effects of various concentrations of caffeine, found in coffee, on the growth of Wisconsin Fast Plants. Three different volumes of coffee were compared in the study, being 10 oz, 6 oz, and 2 oz, and all of which were Community Coffee Ground Dark Roast. The effects of the three liquids were compared to those of the control group. The plants were set up to absorb a mixture of water and the three respective ounces of the liquid coffee (or simply just water in the case of the control group), and were left to grow for a total of 15 days. The hypothesis was that the greatest concentration of caffeine, contained in the 10 oz of coffee, will have the greatest effect, and will cause the greatest acceleration of plant growth. In addition, the null hypothesis was that the control group would cause the greatest acceleration of plant growth, since it contained no caffeine. The results of the experiment supported neither the hypothesis nor the null hypothesis, since the 6 ounce group showed the most mean plant growth by the end of the fifteen day experiment period. In conclusion, this experiment could prove to be beneficial for plant growth, and determining if different caffeine concentrations could possibly act as a sort of stimulant for botanical growth.

THE EFFECT OF COPPER AND SORBIC ACID ON AMPICILLIN-RESISTANT BACTERIA

Johannamarie Nwanagu
Heathwood Hall Episcopal School

This experiment was conducted to research the effects of transition metals and organic acids on antibacterial resistant Escherichia coli bacteria using copper sulfate, sorbic acid, and ampicillin resistant E. coli by mixing 12g of CuSO₄ and 2.8g sorbic acid into 500mL of nutrient agar, and growing the ampicillin resistant E. coli on petri dishes with the CuSO₄+Sorbic acid and some with plain nutrient agar. The independent variable (IV) in this study was the CuSO₄+Sorbic agar used in some of the plates, and the dependent variable (DV) was the number of colonies that grew on each plate. The hypothesis was if ampicillin resistant E. coli is grown in a petri dish with copper sulfate and sorbic acid added into the agar, then the bacteria will not grow. The results indicate the plates with the CuSO₄+Sorbic acid experienced almost one third of bacterial colony growth the plates without CuSO₄+sorbic acid, and had no visible colonies. These results seem to support the hypothesis, but the bacterial colony counter phone app called “Colony Counter” that over counted the number of colonies in the the CuSO₄+sorbic acid plates. The reason why the the bacterial colony counter counted nonexistent bacteria is because the sorbic acid mixed into the agar did not fully dissolve (either because of over saturation or poor mixing), and solidified with white speckles dispersed in the agar that colony counter mistook as colonies.

ONE WORD SAYS IT ALL

Nainaa Oberoi
Governor’s School for Science and Mathematics

Emotions are considered to be a basic part of human nature; however, emotions can be quite difficult to understand. For this research project, the goal was to divide 76 emotion words into clusters containing words that were similar to each other. Emotions can have many different dimensions; Valence and Arousal are the dimensions considered in this paper. After many analyzations, 16 individual clusters were formed. The clusters were groups of similar words with one word that described the entire set.

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THE EFFECTS OF COPPER(II) SULFATE PENTAHYDRATE ON ABScisIC ACID IN CUCURBITA PEPO
Kayla O’Grady
Spring Valley High School

The purpose of this experiment was to determine whether copper (II) sulfate pentahydrate can positively or negatively affect the amount of abscisic acid (ABA), represented by parts per million (ppm), produced by Cucurbita pepo plants. If the copper (II) sulfate pentahydrate were to positively affect the amount of ABA, the plants would undergo fermentation quickly and have a more vibrant color to the leafs and stem. It was hypothesized that the copper (II) sulfate pentahydrate would cause the zucchini plant to produce less ABA, thus causing poor physical characteristics of the plants, such as poor color and poor growth. There were 2 groups in this experiment consisting of 30 zucchini plants, a control group and an experimental group. The control group was given only water and sunlight everyday until the plants finished fermentation. The experimental group was given the same type of soil. After the control group plants finished fermentation, the ABA was measured using an electrochemical ABA sensor, was given only water and sunlight everyday until the plants finished fermentation. The experimental group was given the same type of soil. After the control group plants finished fermentation, the ABA was measured using an electrochemical ABA sensor, which was referred as an ABA meter, obtained from Amazon.com. This measures the amount of ABA produced by each plant. Each plant was separated from the rest. The unplooled independent t-test, represented by graph 4, shows the statistical significance of this experiment, having a low p-value. The control group (M=0.75, SD=0.12) reported significantly higher levels of ABA ppm than the experimental group (M=0.12, SD=0.06), t(29) = 23.90, p < 0.0001.

REFINING THE PHOTOLITHOGRAPHY PROCEDURE FOR THE USE OF MEASURING HALL VOLTAGES
Ian O’Dell
Governor’s School for Science and Mathematics

The purpose of this research was to reduce the time required to perform an experiment that tested the Hall effect under the effects of certain organic compounds. In the experiment, the scientist must bond wires to a thin film of metal and a mounting chip that connects the film to an electromagnet lock-in. My job was to remove the long process of wire bonding from this experiment. To accomplish that job, I was given a wired plate, and was instructed to redesign a Hall bar pattern to fit it, as well as find an efficient way to create the Hall bar. I had to account for the process of photolithography, which included creating a new shadow mask, finding the optimum way to expose the silicon chips on which the Hall bars were placed, while ensuring that they were still usable in the lab. The final results were a much larger Hall bar, shadow masks constructed of ink and metallic paint on transparency sheets, scanned by sweeping light across the sample in strips.
VALIDATION OF WRIST-WORN CONSUMER HEART RATE MONITORS DURING EXERCISE
Jacob Palchak
Governor's School for Science and Mathematics

The purpose of this study was to test the validity of the heart rate monitors on the Apple Watch 2 and Fitbit Charge HR during exercise. Ten subjects performed treadmill, cycling, and TRX suspension training exercises and their heart rates were tracked continuously using five devices: two Fitbit Charge HR's on one arm (one worn on the upper wrist and the other on the lower wrist), two Apple Watch 2's on the other arm (one upper, one lower) and one Polar H7 Chest Strap. Data was collected from the Apple Watch using the Apple Health and Motifit apps and data was collected from the Fitbit Charge HR using www.squashleagues.org. Our results indicated that the Apple Watch had a lower overall Mean Absolute Percent Error (MAPE), both watches had a lower overall MAPE of approximately 1.76% when worn at the upper wrist position, and a significantly higher MAPE of approximately 3% during TRX interval training.

THE EFFECT OF DIET ON COGNITIVE FUNCTION
Michaela Palmer
Governor's School for Science and Mathematics

Obesity rates have skyrocketed in recent years in America due to diet and increased portion sizes. A diet of saturated fats, trans fats (now made illegal by the FDA), and high levels of sugar result in increased insulin levels and can lead to type II diabetes or obesity. High fat diets can lead to lower levels of insulin in the brain resulting in memory functions to be disabled. In rodents, the hippocampus of six high fat diet mothers and six control chow diet (AIN-93 diet) mothers were studied with different antibodies to measure the difference in protein expression between the different diets. Ultimately, this allowed us to see that the insulin receptors are turned off in the HFD rodents, and they were turned on in the control diet rodents.

THE EFFECT OF TURMERIC ON THE REGENERATION RATE OF PLANARIAN, GIRARDIA TIGRINA
Serena Parmar
Heathwood Hall Episcopal School

Cell regeneration has great significance in the field of science. Its advancement can lead to faster healing of damaged tissue in the human body. There have been many studies on curcumenone, a compound in turmeric, that have revealed its ability to stimulate neural stem cell reproduction and generate healing properties. Every multicellular organism can regenerate to a certain extent. Humans regenerate skin cells constantly and when healing wounds. Animals like the brown planaria, Girardia tigrina have the ability to regenerate parts of their body when transected. This study was conducted to test the effect of turmeric on the regeneration rate of Girardia tigrina compared to a control group in water. During this experiment, incised planaria were exposed to various concentrations of turmeric (0%, 0.00875%, 0.0175%, and 0.025%) for 4 days. Their lengths were measured every 24 hours, and the measurements, along with the percent changes, were analyzed in single factor ANOVA tests. The data showed positive growth for overall length of the planaria in control, 0.0175%, and 0.025% groups, however no statistically significant data was found between 0% and 0.00875%. The hypothesis, which stated if Girardia tigrina are treated with turmeric, then the regeneration rate will be increased was rejected. The null hypothesis that there would be no difference in tail regeneration rate between planaria treated with turmeric and the control failed to be rejected.

THE EFFECTS OF ALUMINUM OXIDE AND MANGANESE IRON OXIDE NANOPARTICLES ON THE EXTRACTION OF MOTOR OIL FROM BUCEPHALA ALBEOLA FEATHERS
Jay Patel
Spring Valley High School

As the industrial revolution increased demands and sales, petroleum has risen to be the largest import. There is an increase in the amount of oil and petroleum being spilled and they are proving to be hazardous to the wildlife, including a variety of bird species. The purpose of this experiment was to find a more effective way to extract oil from Bucephala albeola feathers than the current method, which is not efficient. It was hypothesized that if Aluminum Oxide and Manganese Iron Oxide nanoparticles were used to extract oil, then the Manganese Iron Oxide nanoparticles more effective than the Aluminum Oxide nanoparticles at removing oil from the Bucephala albeola feathers. Twenty feathers had motor oil applied to them, and half were treated with Aluminum Oxide nanoparticles and the others with Manganese Iron Oxide nanoparticles. They were then massed before and after the extraction process. A two sample t-test (t(9)=5.53,p<0.001) determined that there was a significant difference between the two treatments. The Aluminum Oxide nanoparticles had an average difference of 0.220 grams after the extraction while the average difference for Manganese Iron Oxide was 0.0255 grams. In conclusion, the treatment consisting of the Aluminum Oxide nanoparticles was more efficient at removing the oil.
Glyphosate and the Increased Prevalence of Autism

Parth Patel
Governor's School for Science and Mathematics

The increased prevalence of Autism Spectrum Disorder (ASD) is often correlated with the heighten use of glyphosate. Glyphosate is used as an herbicide, but it also doubles as an antibiotic. This chemical finds its way into our diet and harms our nerve cells via the release of a compound known as Lipopolysaccharides (LPS). LPS is released from the bacterial lysis that glyphosate causes in the gut flora, as LPS is found on the cell walls of gram negative bacteria. The hypothesis was that secretions from bacteria exposed to glyphosate (experimental group) would cause more axonal degeneration in the nerve cells as opposed to secretions from bacteria regularly grown in medium (control group). The 2266 (female) and 2267 (male) neuroblastoma cell lines were used to test the hypothesis. In the experimental groups, the secretions of bacteria exposed to glyphosate caused more axonal degeneration than the control group. Although Glyphosate cannot be directly called an environmental cause of ASD, it definitely caused axonal damage.

The Effect of Nonassociative Learning on Oxidative Stress in Caenorhabditis Elegans: A Potential Application for Alzheimer's Disease Research

Gillian Patton
Spring Valley High School

Alzheimer's disease results in learning and memory deficits due to toxic changes in the brain caused by amyloid-β plaques and oxidative stress (Alzheimer's, 2011). Oxidative stress is caused by the overproduction of free radicals, which are uncharged molecules containing an unpaired valence electron (Morcos and Hutter, 2009). Nonassociative learning is a type of cognitive processing that only uses one stimulus instead of two related stimuli. Cognitive processing promotes neural growth and learning, while Alzheimer's inhibits it. The purpose of this study was to test how nonassociative learning impacts oxidative stress and thus, if it might be considered as a potential treatment option for Alzheimer's disease. It was hypothesized that the application of nonassociative learning would reduce the effects of oxidative stress on C. elegans, resulting in increased mobility and egg-laying. Mechanosensory, chemosensory, and novel environment habituation were used to increase mobility and egg-laying. Mechanosensory, chemosensory, and novel environment habituation were used to increase mobility and egg-laying in C. elegans, in opposition to a hydrogen peroxide treatment that induced oxidative stress. The equation F(3,236)=44.73, p<0.0001 was used to run the one-way ANOVA for time to paralysis. The Tukey test demonstrated differences between the control group and all of the experimental groups. The equation F(3,16)=4.72072, p=0.021252 was used to run the one-way repeated measures ANOVA for egg-laying. The Fisher test demonstrated differences between the control group and the mechanosensory and chemosensory groups. It was concluded that the application of nonassociative learning to C. elegans reverses the negative effects of oxidative stress, stimulating mobility and egg-laying.

Assembly Line Improvements of Efficiency and Safety and Their Effect on the Working Class

Using the Yumi Collaborative Robot as a Model

Nicholas Peckich
Governor's School for Science and Mathematics

My research focused on the use of collaborative robots and the delivery systems which would be used to deliver them stock material. After visiting with Anderson Brass, which is a local brass manufacturer in Hartsville, SC and Integrated Systems Inc. located in Darlington, SC, I began to design a robotic automation system that could make the assembly line process more efficient and safer for the workers. I created two functional Lego mechanisms designed to work with the YuMi collaborative robot and its vision system. The final mechanisms demonstrate a work environment where collaborative robots would be able to do the dangerous portions of the assembly line process so that worker injuries would be reduced.
AN ECOLOGICAL STUDY ON THE COASTAL REGIONS OF SOUTH CAROLINA TO DETERMINE THE CAUSE OF SOIL NUTRIENT DEPLETION BASED ON THE UNIQUE CONDITIONS AND INDUSTRY
Jayra Penaloza
Spring Valley High School

Soil is defined as the loose upper layer of the Earth’s surface composed of rock, mineral particles, nutrients, and decayed organic matter that sustain complex ecosystems. However, the natural nutrients found in soil can easily be depleted through natural events such as climate change and human-caused events as a result of development and changes in economy. This ecological study was conducted on the coastal regions of South Carolina which include the coastal zone, inner coastal plain, and outer coastal plain to determine the main cause of soil nutrient depletion. This is important in an ever changing climate which heavily affects the agricultural industry as a result of changes in soil. To conduct the meta-analysis, data was derived from national databases regarding agricultural statistics. It was then analyzed using one way ANOVA tests to test for differences in means for each year of data, 2014-2016. It was hypothesized that the coastal zone of South Carolina would be most affected by soil deprivation due to proximity to the ocean, which brings in salt water and frequently floods the land causing the depletion of water-soluble nutrients. It was observed that during 2014 to 2016 the crops grown had diminished slightly, but, in some areas, had flourished greater than before. At α = 0.05, the p values were greater than alpha making data statistically insignificant. In conclusion, the hypothesis was rejected given that the null was not rejected and thus there was not enough information to support the claim or alternative hypothesis.

THE EFFECT OF CHANGING THE ACTION OR BARREL LENGTH OF A SHOTGUN
Joseph Pope
Heathwood Hall Episcopal School

The purpose of this experiment was to examine the effect of changing the type of action or the barrel length on the power of a shotgun. To do this the researcher fired three different types of shotguns including a long barrel manual action shotgun, a short barrel manual shotgun, and a short barrel semi-automatic shotgun were fired at a paper target made from ⅓ of a pack of paper. The number of pages of paper the shotgun pellets broke were then recorded. This step was repeated three times for every gun and then an average number of pages were determined for each gun and compared to each other. The average number of pages broken by each shotgun are as follows: the long barrel manual shotgun broke 84.67 pages, the short barrel manual shotgun broke 96.67 pages, and the semi-automatic shotgun broke 79 pages. This means that the shotgun that had the most power was the short barreled manual shotgun, followed by the long barreled manual shotgun, and then the short barreled semi-automatic shotgun. In the end, the results ended up being that a short barrel manual shotgun produces the most power. This does not support the hypothesis that the long barrel manual shotgun would produce the most power. Instead the research suggests that a short barreled manual shotgun is able to produce more power when the pellets impact the target than any other type of gun tested in this experiment.

ANALYZING INFORMATION TRANSFER PATTERNS IN EAST ASIAN FINANCIAL MARKETS
Christopher Poston
Governor’s School for Science and Mathematics

This research uses statistical transfer entropy to map the strength and directionality of connections between major financial companies in South Korea, China, and Japan. A matrix of daily stock prices was compiled from the SSE 250, KOSPI 200, and NIKKEI 225 stock indices, which was then fitted to a logarithmic trend. By modeling the price curves of different companies as connected, stochastic processes and calculating the information-theoretic transfer entropy between them, this study developed a network of the connections between nodes in each country and sector.

After the price trends were discretized, a sliding-window plot of transfer entropy was generated for each of the countries in the study. Companies were grouped by financial sector – banking, insurance, investment, real estate – in order to facilitate analysis of information transfer trends between sectors. The research found that compared to both China and Japan, South Korea experienced a significant increase in transfer entropy across all financial sectors. The mapping for Japan shows a spike in mid-2013 which this study attributes to massive bond purchases by the Bank of Japan. Total transfer entropy matrices (TTEs) were also generated for each country in order to compare relationships between individual companies. The most notable result displayed by the aggregate matrices was a consistently lower transfer entropy between companies of the same type (compared to those from other financial sectors).

RELAXATION AND ADHESIVE BIOMECHANICAL PROPERTIES OF BIOSYNTHETIC MATERIALS FOR A PREOPERATIVE BRAIN MODEL
Shawn Potter
Governor’s School for Science and Mathematics

Neurosurgeons can improve primarily with experience which can be maximized with the proper training materials. The experience of the neurosurgeons right now is coming from either cadavers or actual surgery. Cadavers are not unlimited since there are a limited amount of people donating their body to science. It would be a lot safer if the surgeons were not gaining experience from surgeries which is exactly what you want them to have the experience for. MRI scans of patients can be 3D printed to create a model that exactly replicates the patient’s brain. The problem is that there are no materials that can be 3D printed and act like the brain. Hydrogels and emulsions are the closest materials to the brain. The purpose of this project is to
test hydrogels’ and organogels’ biomechanical properties in an effort to find one that most closely resembles the brain. The hydrogels with the closest perceived mechanical properties to the brain are ones that include a varying combination of a chromium variant, gelatin, oils, agarose, and water. The emulsion with the closest mechanical properties to that of the brain is one with a mixture of lecithin, flax seed oil, borax, and water. The results will allow neurosurgeons to be more successful in the surgeries they perform and it will also allow for faster learning of techniques by neurosurgeons.

**AUTISM SEVERITY IN CHILDREN WITH FRAGILE X SYNDROME AND GENETIC VARIATION**

Elise Pyon  
Governor's School for Science and Mathematics

Fragile X Syndrome (FXS) is a rare genetic disorder that causes neurodevelopmental deficits. It is caused by a mutation on the FMR-1 gene due to an excessive amount of CGG repeats, which inhibits the growth of Fragile X Mental Retardation Protein (FMRP), an essential protein for neural plasticity. Children with FXS often develop autism, a disorder characterized by mental delays and physical features but an unknown cause. To study the correlation between children’s behavior and genetic variation, CGG repeats and FMRP levels were studied. Higher CGG repeats would indicate a more severe autistic behavior, while higher FMRP levels would indicate typical development. In this experiment, the number of CGG repeats and FMRP levels were compared to a child’s CARS score to determine if those two variables were the determining factor in the severity of autism. High amounts of both correlated to a high CARS score.

**THE EFFECT OF VINEGAR AND TAP WATER ON THE RELEASE OF NICKEL IN GRADE 304 STAINLESS STEEL CUPS**

Caroline Quan  
Heathwood Hall Episcopal School

Consumption of nickel rich liquids and foods pose a risk to human health, causing reactions such as dermatitis. This study examines the amount of nickel that leaches out of grade 304 stainless steel cups with respect to time. The hypothesis of this experiment is that if given enough time, the liquids will react to the nickel in the stainless steel cups, and then nickel will leach out into the cup's contents. The null hypothesis being that if the cups, since they are not given enough time and/or do not react to the nickel in the stainless steel cups, will not leach nickel into the cup’s contents. 15 grade 304 stainless steel cups contained 300 mL of tap water, and 15 cups contained 300 mL of white distilled vinegar. Using the equation of a calibration curve of Absorbance vs. Known Nickel Amounts to calculate the amount of nickel in the liquids, samples were taken from each of the 30 cups at 8, 24, and 32 hours. At 8 hours, on average the cups containing tap water leached 5.16 μg/mL of nickel, and the cups containing vinegar leached 0 μg/mL of nickel. At 24 hours, on average the cups containing tap water leached 24.5 μg/mL of nickel, and the cups containing vinegar leached 110. μg/mL of nickel. The results of 32 hours were not included in the final analysis because of uncertainties. Although the final analysis of this data proved significant, there were statistical uncertainties.

**NUMERICAL ESTIMATION IN GLASS PATTERNS**

Alannah Quinn  
Governor’s School for Science and Mathematics

The Random Regular Numerosity Illusion (RRNI) is a phenomenon in which an organized array of dots is perceived to be more numerous than a random array of dots. Previous studies have focused on the correlation between the organization of the pattern and the subject’s ability to enumerate the dots. The current research tested the possibility that other spatial features – such as density or area – could be the source of this illusion by using Glass patterns. Glass patterns are two random arrays of dots which have been copied and layered on top of one another. They allow a manipulation of organization or coherence while controlling for density and area. Subjects were shown two Glass patterns with varying coherence and asked to choose which was more numerous. While there was a clear effect of relative quantity, there was no effect of organization, contrary to previous RRNI studies. Future studies would directly manipulate area and density to further test the idea that organization is not the limiting factor in the estimation of quantity.

**EXPLORING CHRONIC HICCUPS**

Meredith Radtke  
Center for Advanced Technical Studies

Hiccups are defined as involuntary spasms of the diaphragm which causes the glottis to force shut resulting in the act of hiccups. In this study, research will be conducted on myself and my condition of chronic hiccups. To many doctor’s knowledge, their studies have come back inconclusive on to what this condition is. There will be a series of research conducted to determine if I can find any new information for a diagnosis of these unknown hiccups. If I induce myself in different environmental factors, like food, my hiccups will increase. The way to utilize the hiccups to determine the results of the different environmental factors were to record the amount of times I hiccuped for a week while I was at home and for another week while I was at school. The induced environmental factors are food, stress and exercise. Studies and experiments will be conducted in each of these factors to see if one may cause hiccups to increase more than others. Studies will also be conducted to see if my diagnosis of Celiac disease and GERD also have an impact on the condition. Ideally the results will conclude as the environmental factors will result in an increase of hiccups. The data will be analysed through the number of hiccups performed by each factor. In conclusion,
IMPLEMENTING TENSORFLOW TO ASSIST THE AUTONOMOUS AGENT IN SELF-NAVIGATING VEHICLES

Shashaank Rajaraman
Governor's School for Science and Mathematics

When it comes to autonomous vehicles, one issue usually brought up is whether a computer can be trusted to navigate a car, something thought only to be operable by humans. With advancements in the field, autonomous vehicles have become the focus of the automotive and computer science fields of research. At the Clemson University International Center for Automotive Research, the project focused on developing the program in an autonomous vehicle in order to recognize traffic signals and signs. This was assisted by the use of a software package named TensorFlow developed by Google. TensorFlow assists the autonomous programming through a process called “Deep Learning”, where the device itself essentially learns what to do in a given situation. Using this application, images were classified into one of six, unique, traffic signals using Inception, a pre-trained model trained on a vast library of pictures. By retraining this model to assist us on our endeavour, a powerful software was developed that could help recognize traffic signs. Developed using the Python language, an algorithm was constructed that classified images according to their function. The images could be recognized at any angle and at a modest distance. We successfully trained the software to work at an accuracy of 60%, after training the code with a relatively low number of images in each category. This accuracy rate suggests that with more training, this program can become more accurate and efficient, thus improving safety in the long run.

ANTIBIOTIC RESISTANCE ASSESSMENT IN AGRICULTURAL PRODUCTION

Zeanmarj Ramos and Morgan McManus
Governor’s School for Science and Mathematics

Antibiotic resistance has become one of the most significant global threats to human health. The CDC reports at least 2 million cases a year have been found in the United States alone. Antibiotic drugs work on the microbial level to treat and prevent infections caused by bacteria, but the FDA reports that 70% of these infectious bacteria have become resistant to the antibiotics with which they are often treated. Widespread antibiotic use in animal production agriculture creates risk of direct exposure to antibiotic resistant pathogens and creates reservoirs of antibiotic resistance that may be transferred to pathogens through environmental contamination. To determine which animal production system had the highest frequency of antibiotic resistance genes, DNA was extracted from a panel of 140 Escherichia coli isolates and PCR was used to identify samples that contained the CTX and intL antibiotic resistance genes. We found the CTX antibiotic resistance gene in 32% of dairy cattle samples, 24% of beef cattle samples, and 50% of swine samples. We found the intL antibiotic resistance gene in 5% of dairy cattle samples, 0% of beef cattle samples, and 75% of swine samples. These results suggest that different animal production systems may foster antibiotic resistance at different rates with dairy cattle and swine having higher frequencies than beef cattle.

THE EFFICIENCY OF MODIFIED TEMOZOLOMIDE IN GLIOBLASTOMA CELL DEATH

Daniela Ramos Mendoza
Governor’s School for Science and Mathematics

Glioblastomas are a neurological disease and its standard treatment is the chemotherapeutic drug, Temozolomide [TMZ]. However, the use of TMZ only prolongs the one-year survival rate by 6-10%. One way to increase the efficiency of TMZ is to modify the chemical structure. The aim of this research is to modify TMZ by either adding an Ester group [TMZ-E] or a carboxylic acid [TMZ-A] to the chemical structure. And to test these modified drugs along with unmodified TMZ on an oligodendrocyte cell line, LN-229. The cells were treated at a concentration of 0-50 μM for twenty-four hours, followed by a trypan blue assay to determine cell death. The results indicate that TMZ-E was more effective at killing glioblastoma cells than TMZ and TMZ-A. At 0.8 μM TMZ-E killed about 67.4% of the cancerous cells as to compared to unmodified TMZ which killed 30%. These various TMZs will also be tested on other cancer cell lines.

THE EFFECT OF KCL (POTASSIUM CHLORIDE) ON SORGHUM PLANT HEIGHT

Victor Ran
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Potassium Chloride, KCl, is added into the fertilizers for plants and crops. Sorghum, especially, needs some KCl fertilizer when they grow. The purpose of this experiment is to define how initially adding different amount of KCl affects the height of growth of sorghum seeds. The independent variable is KCl concentration in percentage (%). The dependent variables are Light, water, temperature, soil, wind, ages and variety of plants. The hypothesis states that if the amount of KCl is increased, then the sorghum will grow taller. The null hypothesis states that increasing KCl will not affect sorghum plant height. The research technique is experimentation. The effect of KCl on sorghum plant height is summarized in the tables above. Since the height of sorghum plants is proportion to from 0% to 12.5% concentration of KCl solution added, the hypothesis is supported by the data. This research project will help the scientific community fund out how to use Potassium Chloride to affect the growth of sorghum plant.
THE EFFECTS OF CIRCUMIN ON FIBROBLAST CELLS AND CIRCUMIN WITH METFORMIN ON FIBROBLAST CELLS
Madison Ranalli and Carter Duke
Hamilton Career Center

Previous experiments have been performed testing circum in with gemcitabine on pancreatic cancer but not many others. The results show that the mice which were treated with circum in and gemcitabine suppress proliferation, angiogenesis, NF-κB, and NF-κB-regulated gene products. These results provide further evidence supporting the hypothesis and an experimental basis for using circum in alone. Circum in could stop cancer cell growth and be an effective treatment for pancreatic cancer. Metformin pills were crushed and circum in pills were opened. The water used to dilute the metformin must first be distilled so it is sterile. One metformin pill, 500mg, will be diluted into one liter of water. One circum in pill, 500mg, will be diluted in 10 ml of water. Each concentration was exposed UV light under a fume hood for approximately 20 minutes before introducing them to the fibroblasts. The fibroblasts were passaged on CO2-dependent media and incubated to ensure there was a high enough count of viable cells to perform the tests on. While the cells were growing, they had to be fed or given nutrients through FBS (fetal bovine serum). 10% FBS and 1% antibiotics were added to the media. Then, the entire solution of media was filtered to ensure no extra particles or bacteria got into the plates. Once the cells were plated and allowed to grow for a 48 hour period, the circum in alone, metformin and circum in together, metformin alone, paclitaxel alone were introduced for an exposure time of 48 hours. Next, 125 microliters of paclitaxel was added in the 1st row of wells, 125 microliters of metformin in the 2nd row, 125 microliters of circum in in the 3rd row, 62.5 microliters of metformin and circum in together, and a control with 1 mL of media in a different plate. Assays were run and results showed combination metformin and circum in to have the highest viability while circum in alone had the highest percentage of cell death.

THE EFFECT OF MONOSODIUM GLUTAMATE ON PLANARIAN MEMORY RETENTION
Pallavi Rao
Spring Valley High School

Monosodium glutamate (MSG), a food additive, is widely consumed, but is speculated to have adverse effects on health. It is known to impact the nervous system through excitoxin production. The purpose of this study was to determine how MSG affects developing and fully functional nervous systems by using planaria as a model organism for memory retention. It was hypothesized that regenerating planaria in a 10 mM dose of MSG would display the longest learning times and make the most number of incorrect decisions within the maze. Planaria were conditioned to enter the right branch of a Y-maze using an LED light as a negative stimulus. After being trained, the planaria were split into a group in MSG and a group in water. Within these groups, half of the planaria were dissected and half were not. After two weeks, the planaria were tested for memory retention using the same process as the training period. A one-way ANOVA revealed that mean learning times were significantly different from each other at α = 0.05, F (3, 115) = 55.90, p < 0.05. A Tukey test identified that the group which regenerated in MSG displayed significantly higher learning times compared to the other groups. Another one-way ANOVA displayed that the mean number of incorrect decisions were significantly different from each other at α = 0.05, F (3, 115) = 25.53, p < 0.05. A Tukey test showed that the group which regenerated in MSG made a significantly greater amount of incorrect decisions in the maze. The hypothesis was supported, as the group that regenerated in MSG displayed both significantly higher mean learning times and mean number of incorrect decisions. It was concluded that MSG had a negative effect on both fully functional nervous systems as well as developing nervous systems.

EVALUATING LIMITS OF SERIES
Brennan Ravan
Governor’s School for Science and Mathematics

Mathematicians are interested in classifying numbers and distinguishing between different sets of them. Work in pure mathematics has been used in such diverse fields as encryption, astrophysics, and phylogenetics. Riemann sum are a method of approximating an integral with a summation, and the reverse can be done to approximate a summation with an integral. The squeeze theorem states that if an upper bound and a lower bound of a function converge to the same limit, the function of approximating an integral with a summation, and the reverse can be done to approximate a summation with an integral.

THE EFFECT OF TRENDING WORLD EVENTS ON SENTIMENT ANALYSIS AND RELEVANCY INTERVALS USING ANALYTICS SOFTWARE ON TWITTER DATA
Bridge tta Ravindra
Spring Valley High School

Data analytics is emerging as a critical field to intelligently utilize the vast trail of data we create in our daily lives. An analysis of data trends can reveal patterns that can predict human behavior in areas such as health care, Ecommerce and consumerism, among others (Kim, 2017). The purpose of this experiment was to study the correlation between a Twitter hashtag’s sentiment and its trending duration using IBM Watson Analytics. The hypothesis was that a major event associated with a more positive sentiment would trend longer than more negatively associated counterparts. The experiment relates to Hedonic adaptation, the psychological theory that states that humans will return to a relatively happy state despite a negative or positive turn of events (Halvorson, 2012). The sentiment was first analyzed on a smaller scale by randomly selecting 30 tweets within each hashtag.
studied and then on a larger scale using IBM Watson Analytics. For the trend analysis test, the total number of tweets for each hashtag was recorded daily. Manual sentiment analysis yielded a strong correlation of “happy” sentiment with entertainment hashtags, “sad” with natural disaster, “fearful” with health and medicine, and “neutral” with the control group #selfie. A Chi Square Test for Independence was run at alpha = 0.05 on the average number of tweets for the hashtags in each category and showed a direct correlation between the category and sentiment $X^2 (15, N = 120) = 37.731, p<0.05$. Thus, the hypothesis was supported because the entertainment hashtags with positively associated sentiments trended longer than more serious hashtags exhibiting negative sentiments, and there was a direct correlation between the category of the tweet and its sentiment.

**COCRYSTALLIZATION AND PREDICTIONS OF COCRYSTAL STRUCTURE BASED ON ELECTRONEGATIVITY**

**CALCULATIONS**

Thomas Richburg

Governor's School for Science and Mathematics

In this research, the electronegativity of several compounds was calculated by a computer program and cocryystals were successfully grown. The compounds were assembled in the program, which output the information with which predictions were made pertaining to the structure of the cocryystals before their growth. Two observable crystals were created: one of 1,3-bis(pyridine-4-ylmethyl)urea and (E)-3-(perfluorophenyl)acrylic acid, and one of 1,3-bis(pyridine-4-ylmethyl)urea and 4,4'-dihydroxybenzophenone. The general predictions made by the group proved to be accurate, thus validating the predictions. Further research can be done to pre-emptively predict structures in more complex scenarios.

**THE RELATIONSHIP BETWEEN TEMPERATURE AND ANEUPLOIDY OF HELA CELLS**

Faith Robertson

Heathwood Hall Episcopal School

The purpose of this experiment is to investigate the relationship between aneuploidy and the storage temperature of HeLa cervical cancer cells. An aneuploid cell is a cell that has an abnormal amount of chromosomes, either more or less than 42 chromosomes. The goal is to further research the “medical mystery” of HeLa cervical cancer cells, the first line of human cells to survive in vitro, or in a test tube, and provide research for stimulating an accurate environment for studying. Cells were stored at three different temperatures for 24 hours prior to examination. The hypothesis is that the cells closest to body temperature would be the least aneuploid and the coldest ones would be the most. This data supports half of the hypothesis. The data suggests that the coldest cells, the 25°C room temperature cells, are the most aneuploid. However, this data also suggests that the 33°C cells were the least aneuploid, followed by the body temperature (37°C) cells. The conclusion that can be drawn is that cells stored at temperatures other than body temperature will behave differently than how they would behave in the body. As this study demonstrates, it is critical that scientists are able to accurately study HeLa cells.

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**OXYGEN CARRIER SYNTHESIS AND CHARACTERIZATION BY CHEMICAL LOOPING WITH OXYGEN UNCOUPLING**

Victor Ruan

Governor's School for Science and Mathematics

Global warming has become an increasingly pressing issue and many seek to mitigate the effects of these increasing temperatures or to stop them altogether. One way to do so is through a process called chemical looping with oxygen uncoupling (CLOU), which was the topic of my research. Current carbon capture technologies are capable of capturing carbon, but the problem is that this process is too expensive due to the separation of the carbon emissions from the nitrogen in the air that must be performed before the carbon is captured. The CLOU process provides an alternative to this costly separation process by providing a source of pure oxygen. Doing so allows the separation of the carbon emissions from nitrogen to be avoided altogether.
My research focused specifically on finding the combination of oxygen carriers and support compounds that would yield the largest percent of oxygen, thereby optimizing the amount of carbon emissions that react with the oxygen from the oxygen carrier. It was found that among those tested, the ones without support compounds released the highest percentage of oxygen.

**THE EFFECT OF CANCER CACHEXIA AND PDTC TREATMENTS ON CARDIAC PROTEIN SYNTHESIS**

William Rumfelt
Governor's School for Science and Mathematics

Cancer cachexia, a severe wasting disease, often accompanies the advanced stages of cancer. This experiment examined the impact of cachexia and Polycyclic aromatic hydrocarbons (PDTC) on cardiac protein synthesis. PDTC increased protein synthesis and attenuated wasting in the liver and skeletal muscle in previous studies, but its impact on the heart has not been determined. Male B6 and Apc min/+ mice were randomly selected to either cage control or PDTC treatment at 16-18 weeks of age. The groups were injected with either PBS or PDTC daily. Following two weeks of treatment, tissues were snap frozen to be homogenized at a later date. Western blot analysis was used to determine cancer and PDTC’s effects on P70S6K, AKT (T308), and pS6K protein expression. Cancer did not alter heart mass in weight stable mice and short-term PDTC treatment did not alter heart mass, Phospho-Akt expression, or P70S6K protein expression. Interestingly, PDTC increased Phospho-RpS6 levels. This is intriguing because Phospho-RpS6 is a downstream marker of protein synthesis, while levels of upstream markers that are found before the synthesis of protein were not increased. Future research is needed to determine whether PDTC altered inflammatory signaling in the heart and if PDTC has a different effect on mice with severe weight loss.

**THE EFFECT OF FLAVONOID GALANGIN ON THE CELL VIABILITY AND TOXICITY OF MCF-7 HUMAN BREAST CANCER CELLS EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)**

Abhimanyu Sailesh
Blythewood High School

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds ubiquitous in the environment; many of which are known human and animal carcinogen. The purpose of this study was to investigate MCF-7 epithelial breast cancer cell’s™ viability and toxicity following a short-term in vitro exposure to a cocktail of PAHs and benzo[a]pyrene (B[a]P) separately in the presence and absence of varying concentrations of flavonoid galangin. It was predicted that presence of galangin will completely or partially block the damaging effects of PAHs. It was hypothesized that exposing the cells to 7µM cocktail of PAHs or 10µM B[a]P in the presence of 30µM galangin would reduce the toxicity and increase the mitochondrial activity of the cells as compared to that in the absence of galangin. Experimentation was accomplished by exposing identical samples containing 75,000 MCF-7 cells each for 24 h to exposure medium containing 10µM B[a]P alone, 7µM cocktail of PAHs alone, various doses (5µM, 10µM, 100µM) of galangin alone, mixture of 10µM B[a]P and the various doses of galangin, and mixture of 7µM cocktail of PAHs and the various doses of galangin. Viability of the sample cells were measured by MTT assays, whereas their toxicity were measured by LDH assays done on spent exposure media. The results are as follows, at significance level (α) = .05, 7µM cocktail of PAHs in the presence of 100µM galangin was found to be highly toxic to the cells after 24 h of exposure. At α = .05, 7µM cocktail of PAHs, 7µM cocktail of PAHs concomitant with 5, 30 or 100µM of galangin, 10µM B[a]P concomitant with 100µM of galangin, and 100µM of galangin alone considerably reduced the viability of the cells.

**EXPRESSION AND PURIFICATION OF FEP1 INVOLVED IN IRON REGULATION IN S. POMBE**

Marie Sanyang
Governor’s School for Science and Mathematics

The aim of this project was to purify and characterize the His-tagged Fep1 protein through the use of bacterial expression plasmids with the aid of biochemical and spectroscopic tools. Schizosaccharomyces pombe is a useful model eukaryotic system for studying regulation of iron homeostasis. Results from both S. pombe and Saccharomyces cerevisiae have shed light on the key players of this complex regulation. Proteins like monothiol glutaredoxins (Grxs) are present in both types of yeasts yet display different regulatory functions. Since S. pombe and S. cerevisiae share a common ancestor, the lab hypothesized that extrapolating the knowledge obtained from S. cerevisiae to S. pombe would allow the lab to fully understand the function of monothiol glutaredoxins in S. pombe. The lab planned to obtain these results through the purification and characterization of Fep1 (from S. pombe) in vitro using the bacterial expression plasmids pET-28a(+6xHIS-Fep1(2-564)WT and pET28(+Fep1-6xHIS(1-564)WT.

**BUILDING A MULTI-SENSOR MOBILE ROBOT THAT CAN FREELY MOVE, DETECT HUMAN MOVEMENT, AND DETERMINE THE GENERAL SHAPE AND POSITION OF A HUMAN SUBJECT TO BE COMPATIBLE WITH AN AUGMENTED REALITY HEADSET.**

Nithin Saravanapandian
Spring Valley High School

Augmented reality is a recent application of technology that has brought a new world of opportunities. One such application could be the addition of robots to be compatible with an augmented reality headset, which would allow for many new ways of efficient communication and work. One such use of robots along with AR is in military or police applications, such as reconnaissance or survey operations, as they can gather much more information and data and are less likely to be detected than
a human. The purpose of this project was to build a mobile multi-sensor robot that could use various sensors to detect and determine human movement, general shape and position. This information would be used in future studies to allow an augmented reality headset to generate a 3D digital marker of where the human subject is located. This would allow a user to scan a subject with the robot, and then see where that subject is physically located in relation to the user, regardless of any obstacles restricting the user’s view of that subject. It was hypothesized that such a robot can be built to the size constraints of 20cmx20cmx20cm using only Raspberry Pi, Brickip, and Lego Mindstorm related items. The robot was tested on its sensor functions and mobility to determine how well it could detect human movement. After further tests the robot was found to not be able to detect human movement on its own, but could obtain basic information on the location of a human subject.

TARGETING THERAPEUTICALLY RESISTANT HER2+ BREAST CANCERS
Alexander Schaffer
May River High School

Mammary Carcinomas are one of the leading causes of cancer. In 20% of these cancers, the cause is related to an overexpression of the Erb-B2 gene, leading to an excess of the HER2 protein. Treatments are available; however, these treatments tend to see a therapeutic resistant recurrence. A novel target, target A, has shown to overcome this resistance. By treating HER2+ cells with inhibitor A and studying the effects with PCR, IHC, and Western Blotting, the resistance can be overcome: limiting cell proliferation and increasing cell apoptosis.

THE EFFECT OF WATER FILTRATION ON TERRAIN
Riana Shelley
Heathwood Hall Episcopal School

The purpose of this project was to determine the effect different methods, with a focus on terrains, with respect to water and its filtration. Four methods of filtration were used in this experiment: a grassy terrain, a sand and gravel filled terrain, a dirt terrain with plastic and trash throughout, and a Brita® filter. Water was first collected from a rain water pond in five different bottles. The water was then tested for dissolved oxygen (DO) and pH levels. Then, water from each bottle was filtered through each terrain and filter. They were then tested for dissolved oxygen and pH after filtration. The independent variable was the filtration method and the dependent variable was the DO and pH levels. The hypothesis is if the terrain has nutrients and plants, then the water will have lower levels of dissolved oxygen and pH. The null hypothesis is if the terrain has nutrients and plants, then the water will not have lower levels of dissolved oxygen and pH. The results of this experiment are statistically insignificant. However, the difference in pH levels before and after the plastic terrain and sandy terrain are notable. No filter works significantly best to clean the pond water. In conclusion, neither terrain or Brita® worked better to clean the water.

THE RELATIONSHIP BETWEEN RACE OF SHOOTER OF MASS SHOOTING, NUMBER OF VICTIMS, NUMBER OF FATALITIES, AND LOCATION OF MASS SHOOTINGS ON NUMBER OF TWEETS POSTED BY A GUN ADVOCACY GROUP
Elizabeth Shytle
Spring Valley High School

Twitter, a social networking site with over 330 million monthly users, allows the average person access to people around the world, as well as news about what is happening in different regions. In this project, a chosen gun advocacy group’s Twitter was analyzed to find correlation between the number of Tweets posted in a single day by the group based on the number of people killed or wounded in a mass shooting that day, the race of the perpetrator, and the location of the shooting. NCapture was used to collect the Tweets from the Twitter account, and the Mass Shootings Database and Stanford Geospatial Center provided the majority of the data for individual shootings. All independent variables were expected to have a negative linear impact on the number of Tweets. In the case of location, it was predicted that shootings occurring in the Southeast would cause a smaller amount of Tweets than shootings in other parts of the country. All confidence intervals were tested at α = 0.05. The claims that when x ≥ 5 were wounded would show a significant decrease in number of Tweets (p = 0.296), and a nonwhite shooter would cause a decrease in Tweets (p = 0.256) were not supported. The claims that less tweets would occur if ≥5 people were killed (p = 0.022) and that less Tweets would occur if the shooting took place in the Southeastern US (p = 0.002) was supported by the data.

THE EFFECTS OF INTELLIGENT PACKAGING ON SALES
William Simpson
Governor’s School for Science and Mathematics

Companies are always searching for a method to increase their product’s desirability, and intelligent packaging has gained some attention for its potential to increase sales. Intelligent packaging refers to packaging that monitors its contents and provides the consumer with information about the contents. There are very few examples of intelligent packaging being used in the current market, and its impact on sales hasn’t been investigated. The Sonoco Institute of Packaging Design and Graphics was asked to investigate intelligent packaging’s effect on sales by Braskem, a Brazilian petrochemical company. Braskem submitted their own intelligent packaging design, a package that detected when the product was no longer optimal. Braskem’s intended audience was parents, so the lab tested the packaging’s appeal when applied to baby food and kid’s sunscreen. A total of 59
participants participated in the study, which gave promising results. The kid's sunscreen and the baby food were purchased 20% more often when intelligent packaging was utilized. The eye tracking data showed that the labelled package was looked at more often and for longer periods of time, both of which support the increase in sales. The collected survey data indicates interest in intelligent packaging, but also indicated a lack of knowledge. The results indicate an increase in sales when intelligent packaging is utilized, but also indicates that some advertising will be necessary to promote the concept.

HIRES ANALYSIS OF EIGHT CANDIDATE DUSTY ABSORBERS: IMPLICATIONS FOR CHEMICAL EVOLUTION IN GALAXIES
Ishrat Singh
Governor's School for Science and Mathematics

Quasar absorption systems (QASs) offer a way to spectroscopically study chemical evolution in galaxies, allowing one to better understand important astrophysical processes like stellar evolution, planet formation, and the development of life. Because their rich H I content can produce a substantial fraction of observable stars, classes of QASs including Lyman limit systems (LLSs) and damped Lyman-$\alpha$ absorbers (DLAs) provide a direct probe for analyzing the chemical evolution of metals in galaxies. QASs exhibiting dust absorption lines, known as “dusty” galaxies, are hypothesized to be more metallically enriched than similarly-redshifted QASs lacking dust-related absorption. Using the IRAF data reduction package and the apparent optical depth method, the quasar spectra of two candidate dusty QASs, a DLA at $z=0.692$ toward the quasar 3C 286 and an LLS at $z=1.795$ toward the quasar Ton 618, were analyzed. A search for rare elements led to a novel identification of Ga in the LLS. Relative to comparable dust-free QASs, at $-1.34\pm0.05$ dex, the DLA's metallicity was significantly lower than the mean metallicity at its redshift, whereas the LLS's metallicity, $0.86\pm0.12$ dex, was much higher than the mean metallicity at its redshift. However, due to the insufficient sample size of this study, more data is needed to determine a definite trend. Raw data for six additional QASs located along the sightline toward the quasar Q1246-057 ($z=2.247$) are provided as well, and will be analyzed in full in a future study.

INHIBITION OF PHOSPHATIDYLINOSITOL-3-KINASE BY THE FURANOSESQUITERPENOID HIBISCOME C AND ITS DERIVATIVES
Elizabeth Skeie
Governor's School for Science and Mathematics

Furanosteroids like Wortmannin are proven to inhibit the continuation of the phosphatidylinositol-3-kinase (PI-3K) pathway. This pathway is upregulated in highly proliferative cells, such as cancer cells. Although it is able to effectively inhibit the PI-3K pathway, Wortmannin has off-target effects, is unstable in neutral pHs, and needs a time-consuming chemical synthesis, all of which prevents it from being considered as a chemotherapeutic drug. Recently published work from this lab showed that Hibiscone C, a structurally similar furanosteroid, has the ability to inhibit PI-3K. Using activated T-cells which are known to upregulate the PI-3K pathway, the ability of Hibiscone C derivatives to inhibit the PI-3K pathway were tested and the requirements of the carbonyls in the inhibitor necessary to inhibit the pathway were investigated. The hydrolyzation of the left carbonyl proved to prevent inhibition of the PI-3K pathway while the hydrolyzation of the right carbonyl still allowed for inhibition. The results of this research will direct future synthesis projects to create a more specific, stable, and potent inhibitor of the PI-3K pathway.

ESTIMATING PERSISTENCE LENGTH OF SSDNA USING FLUORESCENCE CORRELATION SPECTROSCOPY AND A COMPUTER SIMULATION
Patrick Smith
Governor's School for Science and Mathematics

DNA molecules are critical to cell life and development, as they are the basis for cell replication and synthesis of crucial proteins. Due to the phosphate in the backbone of DNA, it is negatively charged, so, with positive particles in the solution, the overall charge of the DNA will be changed. This increase in the overall charge of the molecule allows it to bend as the negatively charged backbone held the helical DNA in a straight progression of the helix, but, without the negative charge, the helix contours and folds over itself. Because of these effects, a model for the shape and interactions of the cations and the DNA is critical. For the simulation, experimental results of the diffusion coefficients of DNA at multiple cation concentration serve as a basis for the simulation. For experimentation, we used Fluorescence Correlation Spectroscopy to obtain the diffusion times of the molecules, and, by using a known dye with a known diffusion coefficient, converted the diffusion times to diffusion coefficients of the DNA molecules. The simulation then made multiple virtual chains of DNA and found their diffusion coefficients, which were then compared to those of the experimental results using a defined cost function. This simulation yielded results that express a clear pattern, but contains too much noise in data, so we could not be certain of the conclusions we obtained. From this, we saw that our data showed potential for improvement, but shows that we were not successful in making an accurate simulation.
The Effects of Talcum Powder on Mouse 3T3 Cells
Sidney Smith and Emily Brideau
Center for Advanced Technical Studies

In the 1970s, doctors found particles of talcum powder in a number of ovarian tumors which sparked the controversy about whether or not talcum powder is linked to ovarian cancer. Studies since then have suggested that talcum powder does in fact directly cause ovarian cancer; however, those studies tend to exhibit response bias. Due to the structure of the female reproductive system, the talc would first have to travel through the cervix before it were to come in contact with the ovaries. This study’s goal is to determine if there is a correlation between talcum powder and cervical cancer. In this study, Mouse 3T3 Cells will be used in this experiment as they closely emulate the behavior of cervical cells. Each sample of cells will be exposed to different amounts of talc powder, each for a different interval of time in order to observe if increased talcum powder use for an extended amount of time makes it more likely for a woman to develop cervical cancer. Cancer takes up to 10 years to develop, so for this particular experiment signs of dysplasia in the cells will be recorded as cancerous activity. In order to analyze the data, the transformation and growth of the 3T3 cells will be observed. This will be done by noticing if the cells have created clusters within the petri dishes. If the cells develop clusters, change in morphology can be assumed and further observation can be done to determine if cancer is forming.

Determination of HOX D11 Gene Influence on Chicken Evolution in Embryonic Development
Harrison Snow and Rebecca Flanagan
Governor’s School for Science and Mathematics

There is overwhelming evidence that supports the belief that present-day birds evolved from prehistoric dinosaurs. From similarities in genotypes to striking resemblances in limbs, all evidence points in the direction of such a lineage. The mechanism driving this evolution is not as well known. However, recent discoveries have revealed the importance of Hox genes (a category of homeotic genes) in this process. Hox genes are clusters of genes involved in the embryonic development of most organisms. In short, they determine the specialization of cells along the crania-caudal axis, and give rise to vertebrae, limbs, and other structures such as body segments as seen in insects. All Hox genes contain homeoboxes that code for transcription factors responsible for this differentiation. This research studied one Hox gene in particular, Hox D11; its role, its prevalence, and its locations where its expression was most visible in chicken embryos via in situ hybridization. It was found that limb and tail regions showed heavy prevalence of Hox D11 mRNA expression, indicating that this particular gene could be responsible in part for the patterning of these specific structures, but this needs to be confirmed by western blot analysis for proteins. Since Hox genes have been present between various species across time, further research could also be conducted to compare the Hox gene expressions of chicken embryos with alligators, an older relative of the dinosaur, to prove their shared lineage.

The Effects of Weather Conditions on Solar Photovoltaic Panels
Brandon Snyder
Center for Advanced Technical Studies

Solar energy is one of the largest renewable energy sources available in today’s market. The energy that a solar photovoltaic panel obtains from the sun is related to the sun’s irradiance and weather conditions of the operating panel. The purpose of this project is to determine how different weather conditions can impact the efficiency of a solar panel? Weather conditions such as cloud coverage, ice, dust, and snow will be tested with simulation materials on miniature solar panels rather than industrial solar panels due to the multiple weather conditions to be tested. If the surface of the solar photovoltaic panels are covered by the weather simulation material, then the materials will have an effect on the output of the panels. In the project, six solar panels will be used in the experiment, three of the 2-volt photovoltaic panels and three of the 10-volt photovoltaic panels. One out of the three of both of the 2-volt and 10-volt panels will be the control and not have a weather simulation material on the panel. Out of the weather conditions that were tested, cloud coverage, Ice, dust, and snow each showed how each weather simulation material effected the pv cell. The hypothesis is accepted because through the data obtained during the trials shows the trend of the solar panels producing less voltage as more weather simulation material is added. More weather conditions will be tested in the future such as fog and rain etc.

Residents’ Perception Toward Total Eclipse Weekend
Mary Sox
Spring Valley High School

The research was conducted to examine the residents’ of Columbia, SC, perception of the Total Eclipse Weekend in 2017. The study involved analyzing three hundred five online surveys using exploratory factor analysis. It was hypothesized that there would be a list of significant factors with at least three items. In the survey there were eleven demographic questions and twenty-three statements. The sample was obtained via Facebook by using the snowball method. Participants ranked their agreement of the statements using a seven-point likert scale. Using varimax rotation for the factor analysis, four factors were considered significant, namely, environment, influence on community, tourism, and infrastructure. The results are important and useful for helping the city to improve its methods in tourism for the benefit of the residents which ultimately results in adding significantly to the local and state economy.
THE EFFECTS OF A METAL OBSTRUCTION ON A GPS TRACKER

Brianna Stanley
Heathwood Hall Episcopal School

The purpose of this study is to determine the effects of a metal obstruction (aluminum foil) on a GPS tracker and how these effects may change the reliability of the tracker. The hypothesis states that if an 8x8 piece of aluminum foil is wrapped around a GPS tracker then the tracker will become extremely inaccurate. Two different kinds of GPS trackers were moved down a course as a control; the Whistle 3 and the DreamClub. Every minute the location of the trackers was recorded. This was repeated twice to get the most accurate results. The trackers were then wrapped in 8x8” sheets of aluminum foil and the whole process was repeated two more times. The distance between the points the trackers recorded and where the trackers actually were at the time was measured and placed on a graph. The trackers during the aluminum foil trials were completely inaccurate. The information that the trackers recorded said that they had never left the starting point. In conclusion, it is very possible for a metal obstruction to render the tracker completely useless, if not making it highly inaccurate. The same may be the case for areas with any sort of other obstruction, such as a large building, canyon, or cavern.

THE EFFECT OF THE ANGLE OF A BICYCLE WHEEL RELATIVE TO A CAR ON THE VOLTAGE INDUCED DUE TO ITS ROTATION

Aaron Stark
Spring Valley High School

When a bicycle is connected to the back of a car with a bike rack, the bicycle’s wheels spin while the car is in motion due to the wind coming over the top of the car. This accessible mechanical energy is most often wasted. The purpose of this research was to try to reuse that mechanical energy as a raw “generator” to produce electricity for the car through Faraday’s law. It was hypothesized that if the bike wheel was angled at 30 degrees, then more voltage would be induced than if the wheel were angled in other positions. Data was collected by manipulating the angle of the wheel via the straps of the bike rack and then spacing 24 magnets equally around the wheel. A coil was placed next to the wheel so that the magnets would pass under it as the wheel rotated. The coil was connected to an oscilloscope which showed the waveforms of the voltage that was induced each time a magnet passed under the coil. The hypothesis that the 30 degree configuration would induce more voltage than other configurations was supported. The 30 degree angle configuration induced significantly larger voltages than any other angle configuration tested for both directions at α = 0.05, F(3, 116) = 1670.01, p < 0.001 (South), respectively. It was concluded that tilting the wheel at an angle parallel to the curvature of the car (in this case, 30 degrees) would maximize the induced voltage for the contraption and thus would be most efficient for future application.

THE EFFECT OF TRANSITION METALS AND ORGANIC ACIDS ON ESCHERICHIA COLI

Kierson Sutton
Spring Valley High School

Escherichia coli is a gram negative bacterium that is commonly found in the intestines of warm-blooded organisms such as the human species. The purpose of this study is to see if people could use transition metals and organic acids as an alternative for antibiotics. It was hypothesized that transition metals would inhibit the growth of E.coli more than organic acids. Twelve different variable groups were tested in three sets. The first set was made of two different organic acids groups, glutamic acid and aspartic acid. The second set was made up of two different transition metals: Iron (III) Sulfate and Copper Sulfate. The third set was made of a combination of both the transition metals and the organic acids. Escherichia coli was grown in nutrient broth and exposed to the appropriate independent variable. Growth was measured using optical density. After 24 hours of growth, optical density was measured via absorbance using a SpectroVis at a 420nm. The data was analyzed using a multiple regression test. An ANOVA test was ran based off of the hypotheses H0: μ1 = μ2 = μ3 = μ4, and H1: at least one mean is different, at α = 0.05. The results of the ANOVA showed that at α = 0.05, F(8, 81) = 3.00220, p < 0.001. Based on this, it can be concluded that at least one mean was statistically significant from the others because p < 0.001 < α = 0.05. The variable that inhibited bacterial growth the most was the Iron (III) Sulfate.

CAN PAIRED ASSOCIATIVE STIMULATION MODULATE BRIAN PLASTICITY AND MOTOR EXCITABILITY IN STROKE PATIENTS?

Melat Tarekegne
Governor’s School for Science and Mathematics

In the United States, stroke is the fifth leading cause of death. A stroke occurs when blood circulation to a region of the brain is cut off, causing there to be a lack of oxygen in the brain. Strokes often result in impairment of the motor pathways of the body, leading patients to experience lack of motor control. In this experiment, a new technique, Paired Associative Stimulation (PAS), was tested to see its effects on the motor control of stroke patients. Specifically, increased motor cortical excitability was looked for. Through a series of four visits, PAS10, PAS25, PAS100 were tested on seven healthy controls and seven stroke patients. CSP, tMT, PP, RC, and MEP were measured in each visit. With these results, the MEP rate was calculated, as well as the Motor Threshold difference to see the effects of the PAS. Through these calculations, it was found that PAS10 inhibits motor cortical excitability instead of facilitating it.
HOW MOTHER’S BELIEF IN MISINFORMATION IMPACT’S THEIR CHILDREN’S MEMORY  
Kathleen Tatusko  
Governor's School for Science and Mathematics  

It is known that interviewer bias is able to influence how children recall events (Ceci and Bruck, 1993; Bruck, Ceci, and Hembrooke, 2002). Principe et al. (2013) found that when mothers have been misinformed about their children’s experiences it can lead to children’s false report of events. In this study, we manipulated mother’s belief in the misinformation and their degree of control to examine how these factors can influence children’s memory recall. In this study, we used those two categories of mothers and then used a belief manipulation in order to make the two categories into four: outcome-oriented/strong suggestion, process-oriented/strong suggestion, outcome-oriented/weak suggestion, and process-oriented/weak suggestion. The results concluded that the two groups of mothers who were given the strong suggestion manipulation had a higher belief. Those mothers also were the most biased in their conversations with their children. The children of the outcome oriented/ strong suggestion mothers made the most false reports had the most details in their false reports.

THEORETICAL EXAMINATION OF PHASE BEHAVIOR IN MULTI-COMPONENT MODEL MEMBRANES  
Austin Taylor  
Governor's School for Science and Mathematics  

Many structural and safety hazards, especially in the aerospace and automotive industries, are invisible to an outside observer. More automotive and aerospace manufacturers are becoming more focused on composite materials, where many parts are now bonded. As of now, there are few feasible methods of detecting defects within the bond layer without implementing destructive evaluation. Non-contact methods of non-destructive evaluation (NDE) for bond layer inspection could allow for faster manufacturing, quality assurance, and cheaper manufacturing. The research conducted explored two methods of non-destructive evaluation (NDE) for structural health monitoring (SHM). One, a hybrid method, employs a piezoelectric lead zirconate titanate (PZT) - scanning laser Doppler vibrometer (SLDV). The other, a fully non-contact method, employs two air coupled transducers (ACT-ACT). It was found that both of these methods could detect damage to a specimen, and each method has different benefits. More research must be conducted to determine the full extent to which each method can analyze a specimen.

DNA SELECTIVITY OF AT HOOK PEPTIDES  
Madeline Tedrick  
Governor's School for Science and Mathematics  

Certain proteins bind to DNA that contain specific sequences. HMGA proteins use AT hook motifs to bind to adenine and thymine rich DNA. During embryonic development, the binding between these proteins and DNA is present and normal. However, if these proteins bind to DNA during adulthood, the process can result in metastatic cancer. The purpose of this project is to gain a greater understanding of peptides that mimic the AT hook motif and their preference for different DNA sequences. This project tests the binding of a few peptides with many different DNA sequences. To do so, peptide is titrated into DNA and the fluorescence, which is affected by binding, is measured. The fluorescent emission value at 517 nm is measured as a function of peptide concentration and the data are then fit using the Michaelis-Menten equation, giving the average K value for each experiment. This value is the binding constant for the binding of each DNA by the peptide, and it represents how readily the peptide binds to that particular DNA. If the value is a low number, then the peptide binds to the sequence more tightly, but if the value is higher, it binds with more difficulty. The purpose of this experiment is to determine whether peptides with AT hooks show an affinity for specific DNA sequences over others. Results show that DNA sequences with “AT” in them tend to have lower binding constants and, therefore, are bound more easily by AT hook peptides than other sequences.

DEVELOPING AN AUTONOMOUS COGNITIVE ASSISTANT IN THREE MODALITIES OF DATA  
Jaden Tennis  
Governor's School for Science and Mathematics  

Due to advances in computing power and increased access to large datasets, machine learning has become a viable way of fostering productive and intuitive interactions between humans and computers. However, previous research and product developments, such as Apple’s Siri and Amazon’s Alexa, have been primarily limited to processing single modalities of data. This project sought to develop a more flexible and human-like cognitive assistant capable of making decisions based on its understanding of auditory, visual, and natural language input. This involved creating software that identifies songs based on short clips, recognizes the faces of users, and understands and produces language using a combination of statistical analysis and machine learning. To facilitate smooth user interface, the front end of the application used Amazon’s voice recognition software hosted on the Echo Dot. Systems of this kind have widespread applications, including cognitive assistants for personal use and various professional uses.
Glycerol is a byproduct in the production of biofuel that can be converted into hydrogen gas and carbon dioxide by way of an aqueous phase reforming (APR) process. Our focus was to bridge the gap between computational simulations and the physical world. The reactor that was built to run the APR processes needed a few optimizations, including heating the glycerol solution to reaction temperature by the time it reached the catalyst. Heating tape, adjusting the reaction temperature, and increasing the oven temperature were all tried in order to reach the desired 200°C reaction temperature. A 4.3 weight % Pt supported SiO2 catalyst was also synthesized by dissolving tetramineplatinum (II) nitrate in water and saturating the powder SiO2 support with the solution, heating it overnight at 120°C, and performing calcination by allowing the other elements to burn off in a furnace at 600°C with nitrogen gas running over the powder. Our catalyst and reactor are going to be used to create H2 from an otherwise unused byproduct, glycerol, which in turn will help create clean energy via hydrogen fuel cells etc. This advancement can help bring the planet one step closer to depending solely on clean and renewable energy.

THE EFFECT OF HYPERACCUMULATOR BIOCHAR APPLICATION ON SOIL PROPERTIES AND PLANT GROWTH OF VIGNA RADIATA
Kristina Trifonova
Spring Valley High School

Unlike fertilizers that lead to nitrate leaching, biochars have emerged as a natural way to increase plant nutrient uptake and crop yields and to improve soil acidity and quality. However, often large biochar amendments are required to produce significant effects on soil. This study aimed to determine the effectiveness of biochar made with hyperaccumulator plants, which are characterized by high cellulose levels and porosity. It was hypothesized that hyperaccumulator biochar-amended soil would lead to an increase in soil pH over time, plants with higher root to shoot ratios and total dry mass yields, and higher amounts of nitrogen, phosphorus, and potassium than wood biochar amended soil and soil with no amendment. Biochar was made from sunflower, kale, and pine wood bark at 330°C, and mung beans were grown in a 2% biochar soil mixture for 75 days. There was no significant difference between the effects of the different types of biochar on soil pH, nitrogen, potassium, or plant root to shoot ratios (p>0.05). However, biochar-amended soil showed increased phosphorus retention (K(3)=12.786, p=0.005). The relationship between soil pH and time was modeled by a quadratic trend (F(3, 180)=3.21, p=0.024<α=0.05), as pH decreased for 60 days and then increased, while the control decreased constantly (p=0.057<α=0.05). Plants in the bark and control groups had significantly higher total dry masses than those in the kale group, while dry masses of plants in the sunflower group were not significantly different from any others (F(3, 27)=5.02, p=0.007<α=0.05). It can be concluded that, while not more advantageous than bark biochar, hyperaccumulator biochar is an equally effective way to increase soil cation-exchange capacity, while repurposing contaminated hyperaccumulator plants.

THE MECHANICAL STUDY OF HYDROGELS AND AN ORGANOGEL AS POTENTIAL SYNTHETIC BRAIN PHANTOM
Allison Troup
Governor's School for Science and Mathematics

The brain is an intricate organ, composed of white matter, gray matter, blood vessels, nerves, and dura matter. The study and surgical intervention of the brain is limited by the availability of cadavers for research and experience in the operating room. This work proposes the use of a 3D phantom brain tissue to create a realistic model of the brain with accurate mechanical properties of the brain. In particular, this study assess the mechanical properties of synthetic materials and porcine brain and tests properties of stress, strain, relaxation, and adhesion. Gelatin-based hydrogels and oil-based emulsions served as the two candidates for a brain substitute material. Results demonstrate that 1.7% Chromium 3.5% Gelatin was more similar to porcine brain in compression properties as shown by compression stress strain analysis and the other properties. This study has found a viable material substitute for the fabrication of a 3D brain phantom that aims to improve the learning experience of medical students and the preoperative planning of surgeons.

THE EFFECT OF THE BICYCLE SAFETY DEVICE ON CYCLISTS’ ABILITY TO DETECT CARS BEHIND THEM
DuRose Tuller
Heathwood Hall Episcopal School

The purpose of this study is to determine the efficiency of the Bicycle Safety Device (BSD) on how far away cyclists can detect a car behind them. The BSD is a device that can detect objects behind it, chimes when it does so, and records how far away the object was in feet (up to 23ft.). The independent variable for this study was whether or not the BSD’s chime was turned on, and the dependent variable was the value recorded by the BSD. The null hypothesis stated that the BSD would have no effect on cyclist’s car detection ability, and the hypothesis stated that a cyclist would be able to correctly detect cars behind him/her from a greater distance and more accurately. The BSD was added onto a cyclist’s bike, and the cyclist used it to determine how far away cars were behind him with and without the chime and how often he correctly predicted that there was a car behind him. After 20 days of cycling the BSD was determined to be slightly more efficient than the control, meaning that the cyclist was able to detect cars behind him from farther away. However, the difference was not large enough to be statistically significant, so the null hypothesis was supported. The cyclist was correctly able to identify cars behind him without the chime more consistently, suggesting that the BSD may yield false positives.
THE EFFECT OF CYCLOPS COPEPOD PREDATION ON THE PROMOTION OF GROWTH WITHIN MICROCYSTIS AERUGINOSA POPULATIONS THROUGH CHEMICAL SIGNALING

Sachet Urs
Spring Valley High School

Harmful cyanobacterial blooms are a major threat to the world and need to be studied and researched more carefully. This research is aimed towards finding out if the predation of cyanobacteria actually causes more harm than good. There were three groups of 15 dishes that were all filled with 200 mL of distilled water. Cloth boundaries were made to split each dish in half (side A and side B) and they were hot glued to the glass. Each of the dishes contained 4 mL of Microcystis aeruginosa in both side A and side B. One group of dishes contained 4 mL of Cyclops copepods in side A, another group contained 6 mL of copepods in side A, and the last group contained no copepods at all. Five cyanobacteria diameters were measured and recorded from each dish over the course of four days. An ANOVA \( F(2, 177) = 84.10, p<0.001 \) indicates there was a significant difference between the amount of copepods added and the cyanobacteria cell diameters. The 4 mL of copepods group had a noticeably larger average cyanobacteria diameter than the control group and the 6 mL of copepods group had a substantial difference from the control group. This data supports the claim that predation of Microcystis aeruginosa by Cyclops copepods does indeed cause increased cyanobacteria growth in the long run.

EPHA4B EXPRESSION IN THE CRANIOFACIAL DEVELOPMENT OF AFRICAN CICHLID FISHES

Chelsea VanAtter
Governor’s School for Science and Mathematics

Epha4b gene expression may contribute to variances in facial formation including functional differences such as nose shape and clinical conditions such as cleft palate. During craniofacial development, neural crest cells migrate to the pharyngeal arches then differentiate to form bone, muscle, and cartilage cells. The Eph/ephrin signaling pathway guides the streams of migrating neural crest cells into the pharyngeal arches; epha4b, a gene encoding an Eph receptor, contributes to this signaling pathway. To determine how epha4b expression differs between species at different developmental stages, in situ hybridization, a process that stains areas of gene expression, was performed. African cichlid fish are an ideal model because species have evolved various morphologies based on their feeding. For instance, species such as Labeotropheus fuelleborni evolved a short mandible for biting and species such as Maylandia zebra evolved a long mandible for suction feeding. M. zebra embryos demonstrated low epha4b expression in pharyngeal arch one while L. fuelleborni demonstrated more epha4b expression, suggesting a negative correlation between level of epha4b expression and mandible length. Understanding the factors contributing to craniofacial development and variation will help discover treatments for facial birth defects and conditions.

THE EFFECT OF HORDEUM VULGARE, RICE HULL, AND OAK LEAF LITTER ON THE PREVALENCE OF MICROCYSTIS

Sreya Varanasi
Spring Valley High School

Cyanobacterial harmful algal blooms are becoming more prevalent issues throughout the world, threatening ecosystems, posing risks to human health, and resulting in millions of dollars in economic damage. Conventionally, treatment approaches have been chemical or physical, but these are harmful to aquatic life or inefficient, respectively, which presents the biological approach as a favorable alternative. To assess the effects of low-effort and cost-effective treatments, Hordeum vulgare, rice hull, and oak leaf litter were individually applied to Microcystis cultures and compared to two negative controls (Microcystis alone and cotton on Microcystis) and a positive control (CuSO4). This research was aimed at comparing the capabilities of these treatments on minimizing the size of cyanobacterial blooms, through optical density. It was hypothesized that Hordeum vulgare would be the most effective treatment because barley straw releases phenolic compounds. Separately, observations of the effects of these treatments on Daphnia magna populations were noted in separate cultures without Microcystis. Optical density was taken of the groups with cyanobacteria at 730 nm prior to adding treatments and repeated twice on weekly intervals. After calculating the decrease in OD, an ANOVA at alpha equals 0.05 was used to determine whether there were any significant differences between the means. The ANOVA determined that the values were not significant, as \( p>\alpha \) \( F(5, 37) = 1.31, p=0.283 \), showing that none of the treatments had significantly different effects. Thus, the hypothesis that Hordeum vulgare would be the most effective in decreasing Microcystis prevalence was not supported.

CLEANER DIESEL EMISSION VIA PARTICULATE FILTRATION

Isaac Vardi
Center for Advanced Technical Studies

Diesel engines are infamously known for dirty emissions, so how can diesel emissions potentially be cleaner? There are many ways to reduce pollution via biofuels, diesel particulate filtration (DPF) or EGR (Exhaust Gas Recirculation), catalytic oxidation, pre-DPF water injection technique and many more. This project focuses on 2 major types of reduction biodiesel and particulate filter. In this study multiple experiments will be performed to identify the cleanest burning diesel fuel, B25, B30, and B50 were chosen to test. The particulate filter part of the project will be designing a new filter that will be affordable and self installable. What kind of solution could be used to reduce pollution from a diesel engine? If biodiesel is used and a particulate filter is installed then the emissions coming from the diesel engine will be cleaner. The first phase of the project involved burning B25,
The purpose of this research experiment was to find a reproducible method for scaling up tensegrity robots physically. Many of the tensegrity robots that have been previously designed have not been prototyped physically. They have only been simulated, due to complications that arise as they get larger. The reason behind this is that complications arise when tensegrity robots begin to get larger; the arms of the robot arms get larger and bulkier, and therefore more power is needed to move the robot. In this research experiment, the ultimate goal was to find a set of parameters that could remain the same over gradually larger models. The parameters that were chosen to be controlled were the bending moment of the tensegrity robot's arms and the spring constant of the elastic that holds the arms together. Polylactic acid (PLA) was used to create the tensegrity robot's arms, and a spring constant of 0.6253 kg/s² was measured. These parameters were used successfully to double the size of the tensegrity robot by keeping constant the ratio of the bending moment of the arm to its elasticity.

Soccer is the most played sport in the world, with over 256 million people actively playing “The Beautiful Game.” Soccer is also the only sport where the players intentionally use their head to clear, pass, and score the ball. An estimated 300,000 sport-related brain injuries occur every year in the United States, and 8.9% of high school injuries and 5.8% of college injuries are concussions (Gessel et. al, 2007). In response to multiple studies showing the dangers of heading, soccer headgear was created. Its purpose is to reduce forces on the brain caused by contact to the head, whether it be via ball, player, or ground. These headgears wrap around the head and are made of foam and other force-absorbing materials. The purpose of the experiment was to determine the best material for force reduction for soccer headgear. It was hypothesized that the modified headgear, B30 and B50 in lanterns with chimneys. Each chimney has a layer of cheesecloth on top to collect the particulate matter. Each trial is tested for 1 hour and the mass of the cloth is collected. In the second phase a particulate filter is being redesign to be more affordable and easily replaced. For each trial, the particulate filter is connected to a modified exhaust pipe that is connected to a engine. Each trial is ran for 1 hr. The data collected for the bioblends show that B50 makes the most amount of emissions while B25 makes the most and B30 is in the middle. So if biodiesel and a particulate filter are used on a diesel engine then it will reduce the amount of pollution that is made. These are just 2 ways to reduce pollution. Some future work that will be conducted would be making a finish filter product that can be tested in a diesel vehicle.

THE EFFECT OF KAPOK FIBER AND RAW COTTON FIBER WITH FERROMAGNETIC PARTICLES ON OIL REMOVAL FROM WATER
Anmol Verma
Spring Valley High School

Oil spills have accompanied the development of the industrial economy, but oil spill contingency plans are costly and inefficient. Sorbents have been gaining popularity as cost efficient and abundantly available materials to be used, but they have a relatively low oil sorption capacity. This can be fixed through the use of magnetic nanoparticles. This research was aimed at combining ferromagnetic nanoparticles and various natural sorbents to maximize the sorption of oil. The sorbents used were cotton and kapok fiber. Experimentation was conducted by randomly placing sorbents into jars filled with water and oil, and weighing how much oil was absorbed by each sorbent after a day. It was hypothesized that the cotton with the ferromagnetic nanoparticles would work the best at absorbing oil. Five trials were tested for each sorbent, and the average oil absorbed by all the bags was recorded. The results indicated that ferromagnetic nanoparticles had a significant impact on the amount of oil absorbed by the sorbents: (F(3,16)=19.33, p<0.001). The results also showed that the cotton absorbed more oil than the kapok fiber. It was concluded that the cotton with ferromagnetic nanoparticles worked the best out of all the sorbents to absorb oil. The Tukey test indicated that Cotton with ferromagnetic particles and Kapok with ferromagnetic particles as well as the Cotton Fiber and Kapok Fiber show significant difference.

CORRELATION OF FACTOR ANALYSIS OF CONSUMER DISPOSITION TOWARDS COUNTERFEIT GOODS WITH RESPECT TO SOCIO-DEMOGRAPHIC VARIABLES
Annelise Waling and Andrew Poore
Governor’s School for Science and Mathematics

In this study, we determined if and what parts of a respondent’s background correlated with their concern for brand status, risk awareness, and ethics in terms of counterfeit goods using factor analysis. The results for this study came from a survey distributed in Charleston, South Carolina and Shanghai, China. We found that respondents from the Shanghai sample were more concerned about brand status, understood more about the risks associated with buying counterfeits, and were more conscious of the ethical concerns regarding counterfeit goods. Additionally, we found that older people were less concerned about brand status. The most interesting finding of our study is that, with all other variables held constant, being part of the Shanghai sample results in higher values for each factor, in our analysis.

PHYSICAL SCALE MODELING OF TENSEGRITY ROBOTS
Aika Washington
Governor’s School for Science and Mathematics

The purpose of this research experiment was to find a reproducible method for scaling up tensegrity robots physically. Many of the tensegrity robots that have been previously designed have not been prototyped physically. They have only been simulated, due to complications that arise as they get larger. The reason behind this is that complications arise when tensegrity robots begin to get larger; the arms of the robot arms get larger and bulkier, and therefore more power is needed to move the robot. In this research experiment, the ultimate goal was to find a set of parameters that could remain the same over gradually larger models. The parameters that were chosen to be controlled were the bending moment of the tensegrity robot’s arms and the spring constant of the elastic that holds the arms together. Polylactic acid (PLA) was used to create the tensegrity robot’s arms, and a spring constant of 0.6253 kg/s² was measured. These parameters were used successfully to double the size of the tensegrity robot by keeping constant the ratio of the bending moment of the arm to its elasticity.

THE EFFECT OF MODIFIED SOCCER HEADGEAR ON THE FORCE OF A SOCCER BALL DURING SOCCER HEADING
Tyler White
Spring Valley High School

Soccer is the most played sport in the world, with over 256 million people actively playing “The Beautiful Game.” Soccer is also the only sport where the players intentionally use their head to clear, pass, and score the ball. An estimated 300,000 sport-related brain injuries occur every year in the United States, and 8.9% of high school injuries and 5.8% of college injuries are concussions (Gessel et. al, 2007). In response to multiple studies showing the dangers of heading, soccer headgear was created. Its purpose is to reduce forces on the brain caused by contact to the head, whether it be via ball, player, or ground. These headgears wrap around the head and are made of foam and other force-absorbing materials. The purpose of the experiment was to determine the best material for force reduction for soccer headgear. It was hypothesized that the modified headgear,
specifically expanded polyethylene, would significantly decrease impact force of the ball on the head. A force sensitive resistor was used to track the force of three groups, expanded polypropylene, expanded polystyrene, and the control. The speed was controlled as well. The statistics showed that the polypropylene was statistically better at reducing force than the control and polystyrene. Polystyrene was not an effective material for force resistance. The success of the polypropylene is possibly due to the hexagonal shape, in comparison to the circular shape of polystyrene and the control headgear.

THE EFFECTS OF TWO DIFFERENT TRAINING SCHEDULES ON THE VERTICAL JUMP HEIGHT OF VOLLEYBALL PLAYER

Mikaila Widener
Spring Valley High School

Volleyball conditioning during off season training focuses on developing core and leg strength. Due to its success in causing hypertrophy, weight training is the primary strategy for building the muscle in the legs. More recently, plyometric exercises have been implemented into the conditioning regimen of many sports. This study aimed to compare the effectiveness of a primarily plyometric schedule versus a primarily weightlifting schedule. It was hypothesized that the weight lifting-based conditioning would improve vertical jump height the most. For this study, a 30 to 70 percent ratio of weight lifting to plyometrics and vice versa was installed into the off season conditioning of a high school volleyball player. The participants’ standing jump and approaching jump was recorded. For the control, the preconditioning vertical jump height of each participant was taken. Group 1 (70% plyometric training) displayed the greatest improvement with an increased height of 3.0004 cm standing and 2.8702 cm approaching. There was only a 0.9144 cm increase in the standing and approaching jump height after training for Group 2 (70% weight lifting group). A dependent t-test (t(14) = -3.25, a=0.05 > p = 0.006) showed that there was a significant difference between the average vertical jump height before and after training for the standing jump of Group 1. Another dependent t-test (t(14) = -3.53, a = 0.05 > p = 0.003) revealed that there was also a significant difference between the average vertical jump height before and after training for the approaching jump of Group 1. The t-test (t(14) = -1.02 a = 0.05 > p = 0.351) used to analyze the difference in the means of the pre- and post- training of the average standing jump and approaching jump (t(14) = -0.95 a = 0.05 > p = 0.361) of Group 2 showed there was no significant difference. These results suggests that a primarily plyometric training regimen will improve a volleyball player’s vertical jump height more efficiently.

THE EFFECT OF THE PACING STRATEGY OF HIGH SCHOOL MALE CROSS COUNTRY RUNNERS ON THE FINISH TIME AND HEART RATE OF THE RUNNERS

Mark Wild
Spring Valley High School

Pacing strategy is something all runners have to consider every time they race. It can be difficult to correctly pace, especially for high school runners. The purpose of this project was to analyze the pacing of the cross country runners tested to better understand necessary pacing for medium distance races. It was hypothesized that if the effect of performing with even pacing in male high school cross country runners was tested, then it would be found that even pacing proved to bring overall faster finishing times and slower increasing heart rate throughout the race compared to pacing that did not qualify as even. The participants of this experiment consisted of a group of ten boys from a high school cross country team, running three threshold runs consisting of 4 miles each. The heart rate was looked at before the workout and at each mile marker, for a total of 5 readings. The evening pacing group showed faster finish times and lower percentage heart rate increase for the means and medians. One-way ANOVAs were done at $\alpha = 0.1$ to differentiate between the two groups in relation to heart rate increase and finish time. The ANOVA dealing with heart rate yielded a p-value of 0.649, meaning the difference in heart rate was not found to be significant. However, the ANOVA testing difference in finish time had a p-value of 0.000. This proved it to be significant, meaning the even pacing group was found to run faster overall finish times.

KDM4B INHIBITION TO HELP CURE PERIODONTAL DISEASE

Rachel Wilkinson
Governor’s School for Science and Mathematics

Periodontal disease is an oral inflammatory disease that affects much of the American population and currently has no cure. The inflammatory response is controlled by the coordinated genes, KDM4B and KDM1A. KDM4B causes inflammation while KDM1A suppresses it. Therefore, a reduction in KDM4B expression and an increase in KDM1A expression would lower inflammation. Previous research has shown that ML324 is a probable candidate for treating periodontal disease through inhibition of KDM4B. During this research derivatives of Drug 8, a drug targeted to inhibit KDM4B, were synthesized. We tested ML324 along with Drug 8 and its two derivatives on cell cultures. The inflammatory response was measured and compared. Our results show that ML324 continues to be a promising candidate, Drug 8 suppressed the inflammatory response to a lesser degree, and the two derivatives of Drug 8 did not suppress any inflammation.
THE EFFECT OF CONCENTRATION-IMPROVING MUSIC ON READING COMPREHENSION
Kate Willhide
Heathwood Hall Episcopal School

In this experiment, the effect of concentration-improving music on students’ reading comprehension was tested. The purpose of this experiment was to determine whether music that claims to enhance concentration would have any noticeable effect on students’ reading comprehension skills. 27 students took 4 reading comprehension tests over the span of a month, with 1 test per week at the same time every week. The time allotted for test-taking was 15 minutes. Test 1 established a baseline score, and the following 3 tests had a different music track playing as background noise while students were taking the assessment. Students completed a post-assessment survey, indicating whether they listened to music while studying, what kind of music, and how distracting they perceived the testing environment to be. Descriptive statistics were run on raw scores, followed by a single-factor ANOVA test. No overarching trends were visible in the data; 14 students improved over the course of the experiment, others declined, still others showed no pattern in their scores. The ANOVA test results (α=0.05) had a P-value of 0.08, an F-value of 2.29, and an F-crit value of 2.69. Therefore, the null hypothesis failed to be rejected. There is no statistically significant difference between the reading comprehension scores in the control group with silence and the experimental groups exposed to concentration-improving music.

THE EFFECT OF WHEEL AND DRIVE TYPES ON THE OVERALL PERFORMANCE OF A ROBOT IN TESTS OF ALIGNMENT AND TRACTION
Alyssa Williams
Spring Valley High School

The purpose of this experiment was to determine which base type produced the most efficient robot in tests of alignment and traction. It was hypothesized that there would be a significant difference between the mean angles of deviation and distances travelled. It was also hypothesized that the robot with the straight drive and combination wheels would have the lowest angle of deviation and farthest distance travelled overall (in meters). The bases were tested for alignment by autonomously driving the bases along a planned path and measuring the angle of deviation from the optimal trajectory in degrees. To test traction, a weighted box was placed in the robot’s path and the robot’s overall distance of forward motion was recorded after a specified number of seconds. Welch’s tests were performed in place of ANOVAs in the absence of equal variances and they revealed a significant difference between the means in the alignment data, F(5, 79.2744)= 106.50, p<0.05, and the traction data, F(5, 78.7056)= 3567.51, p<0.05, supporting the first hypothesis. The bases with the lowest mean angle of deviation were the straight drive bases and the bases with the longest mean distance traveled were the straight driven bases with combination and omnidirectional wheels, partially supporting the second hypothesis. These findings are significant because they suggest that straight drives with combination or omnidirectional wheels are best for performing tasks requiring high linear accuracy and traction. This could influence future robot designs.

MODELING THE ELECTRICAL CHARACTERISTICS OF PLATINUM ELECTRODES FOR USE IN SIMULTANEOUS STIMULATION AND RECORDING OF NEURONS
Joseph Williams
Governor’s School for Science and Mathematics

The most major obstacle to the simultaneous stimulation and recording of neurons is the difference between the energy required to artificially stimulate a neuron and the energy that the neuron releases when it fires. Though models have been generated for platinum electrodes that attempt to predict the extent to which this “noise” occurs in order to facilitate its removal, there are some that question the reliability of the concepts behind these models. In this project, we attempt to generate our own model for the electrical characteristics of platinum in terms of Access resistance (R) and Capacitance (C). We then test our model at a variety of different frequencies, amplitudes, and offsets and attempt to predict R and C. Our experimental setup consists a simple four electrode array of 100µm by 200 µm platinum electrodes, an NaCl solution, two 10 KΩ resistors, an oscilloscope, an arbitrary waveform generator, and a MatLab program.

SEA LEVEL RISE AND COASTAL EROSION’S IMPACT ON LATE-ARCHAIC SOUTHEASTERN UNITED STATES SHELL RINGS
Hannah Willis
Governor’s School for Science and Mathematics

I worked with the South Carolina Department of Natural Resources Heritage Trust Archaeologists on a Late Archaic period shell ring on Edisto Island. I completed punch tests along marked lines of a gridded map to determine how deep the shell ring reached into the earth. I kicked a pointed rod into the earth and measured the difference in height from entering and exiting the shell layers to determine the depth or height of the shell ring. Every fifth punch test included a shovel test, so a shovel would pierce the earth and remove the contents to examine for accuracy of punch readings and possible trends in artifacts. One hypothesis is that part of this shell ring was used as a workshop to make and repair tools for the people who lived there. Another section of the shell ring contained a high concentration of carved bone pins and other rarer artifacts, indicating that part of the shell ring was probably used for ceremonial purposes. The possibility of sections of purpose of the shell ring is a new discovery. These sections give the idea that the shell rings might have been divided into a village of sorts with each section dedicated to a different purpose. This is a new theory that will lead to yet more research and data collection.
REDUCING ENOLASE EXPRESSION AND ACTIVITY TO PREVENT HARMFUL DAMAGE IN SPINAL CORD INJURY

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Approximately one in fifty thousand people suffer from spinal cord injury (SCI). This type of injury is extremely damaging and causes permanent neurological deficiencies. In this study, enolase activity was targeted by treating rats with the injury with ENOblock, Lipopolysaccharides (LPS), and both ENOblock/LPS. In previous studies, it was concluded that it is possible to improve/treat this condition by blocking neuron specific enolase (NSE). Neuron specific enolase is a protein associated with SCI that has been shown to increase the damage after a secondary injury that is due to the activation of inflammatory cascades and changes in NSE levels. It has also been shown that, after treatments of ENOblock (an enolase inhibitor) NSE levels decreased which could result in the development of a salutary treatment. In this study, the effects of ENOblock and LPS on induced rat cells was observed on several proteins. It was concluded that multiple treatments of ENOblock did not result in a significant increase in cell viability. However, the treatments appeared to be harmless to the cells. Further, there did not appear to be a significant effect on cell proteins.

GRP94: A POSSIBLE THERAPEUTIC TARGET FOR MULTIPLE MYELOMA

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Multiple Myeloma is a malignant plasma-cell cancer with little known about its pathogenesis and no cure. Previous studies attribute the cancer's development to the upregulation of the Unfolded Protein Response (UPR) of its cells. This is an evolutionally conserved process that responds to an abundance of misfolded or unfolded proteins released from the endoplasmic reticulum. Among the signaling cascades of the UPR, grp94 is a downstream chaperone protein that assists in the folding of proteins. This protein chaperone proves to be a promising target because greater concentration of the glycoprotein shows a correlation with worsening stages of Multiple Myeloma. If the inhibition of grp94 has a negative impact on the cancer's cell survival, then this supports its use as a promising therapeutic target. Western Blots and Cell Proliferations Assays were conducted to measure the effects of WS13 (a grp94 inhibitor) on Multiple Myeloma plasma cell survival. From the results, WS13 decreases cell proliferation. The Western Blots of Caspase-7 and HSP90 reveal that grp94 induces apoptosis of the Multiple Myeloma cells, but does not induce UPR. Since grp94 is linked to the pathogenesis of the malignant cancer and the UPR, then the fact this study supports that the inhibitor does not induce UPR, but decreases cell proliferation is promising. From this study, the inhibition of grp94 is a promising method for decreasing cell survival of Multiple Myeloma cells.

MOMMA BEAR BRACELET

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Simulated presence therapy is a non pharmacological treatment that utilizes audio recordings of a loved one to calm a distressed patient. As of now, this approach has only been tested on those with dementia. In an effort to reduce the excessive fear children experience at times of separation, the focus of this study is on measuring the effectiveness of simulated presence therapy on children with separation anxiety. Each child selected to participate in this study will wear the Momma Bear Bracelet for two consecutive weeks. This bracelet consists of a fabric wristband and a plush centerpiece that will hold a small recording device. A parent and/or guardian will be able to record short and encouraging messages that their child can easily play back at any moment. A daily log will be kept by the parent of the child to track his or her progression. Along with the daily log, a series of surveys will also help analyze the the benefits, and any improvements that will need to be made, of the bracelet. A survey will be taken before the treatment begins to serve as a base and a control. Another survey will be taken after the treatment to assess if there was any improvement in the child's behavior. If the parent and child follow all the rules that this study entails, the child's separation anxiety is expected to reduce.

THE APPLICATION OF PVP-COATED NANOPARTICLES FOR OIL REMOVAL FROM SYNTHETIC SEAWATER IN THE PRESENCE AND ABSENCE OF FULVIC ACID

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Oil spills have detrimental effects to marine, animal, and human health. Current oil remediation techniques like in situ burning, dispersants, booms, and skimming are ineffective and may further release harmful substances into the environment. Nanotechnology is working to develop a cost-effective and non-toxic method to aid oil remediation by utilizing magnetic nanoparticles. Iron oxide nanoparticles are magnetic and have a low toxicity. A co-precipitation technique was used to synthesize polyvinylpyrrolidone (PVP)-coated iron oxide nanoparticles in ambient temperatures. These nanoparticles were then used to separate MC252 crude oil from synthetic seawater samples under environmentally relevant conditions. Low amounts of Suwannee River fulvic acid (1 ppm) were added to samples in order to simulate conditions in the open ocean. Fulvic acid slightly reduced the oil removal efficiency, decreasing the percentages from 91.9% to 91.0% without and with fulvic acid respectively. Fluorescence spectroscopy was used to measure the oil removal efficiency. There was a high oil removal efficiency under environmentally relevant conditions.
THE EFFECT OF HIGH DENSITY POLYETHYLENE SIZE ON DECOMPOSITION RATE
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As technology evolves there is a constant increase in plastic production and waste. In fact, an estimate 8 million tons of plastic waste is dumped in the ocean every year. This research was conducted on the decomposition rate of high density polyethylene, a plastic in many common plastic products. The purpose of this experiment was to study the effect of high density polyethylene size has decomposition rate. It was hypothesized that microplastics (squares of plastic between 1 mm$^2$ and 25 mm$^2$) would have a higher decomposition than macroplastics (squares with a surface area greater than 400 mm$^2$) in the span of a month. Thirty squares of microplastics and thirty squares of macroplastics were placed in cups of potting soil. These cups were placed outside under a covered area, and were left for one month to decompose. Plastics were massed beforehand and after hand, and a percent decomposition was calculated. A two sample t-test determined that there was a statistically significant difference in microplastics and macroplastics showing that macroplastics, had a higher decomposition percentage.

THE EFFECT OF PET AND PVC PLASTIC POLLUTION ON THE BIOMASS OF NANNOCHELOROPSIS OCULATA
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Marine phytoplankton populations are a vital part of many ocean ecosystems and the biosphere as a whole. Phytoplankton not only produce 70% of the Earth’s oxygen, but are also the largest carbon sink on Earth. However, as a result the recent increase in the production and waste of plastic, many tons of plastic find their way into the plastic each year. This experiment was conducted to see if the presence of plastic in the water affected phytoplankton growth. It was hypothesized that the control group would have the highest dry mass, the PET group would have the second highest, and that the PVC group would have the lowest dry mass. Phytoplankton cultures were grown in a ocean water mix in glass jars below a window for a period of 21 days. There were 45 jars in total, which were randomly assigned to 3 experiment groups. Each group had 1 g of its respective plastic inserted at the start of the growth period. After the growth period, samples of each culture were taken and centrifuged, dried at 70° C for 72 hours, and weighed to find the dry mass. It was found that the PVC and control groups had significantly higher dry masses than the PET group. A one way ANOVA was conducted at a 95% confidence interval a p-value of 0.019 was found. A Tukey post-hoc test was then done and both the control and PVC groups’ masses were found to be significantly greater than the PET groups.